PB-228 654

ENVIRONMENTAL PROTECTION RESEARCH CATALOG. PART I

Environmental Protection Agency
Washington, D.C.

January 1972

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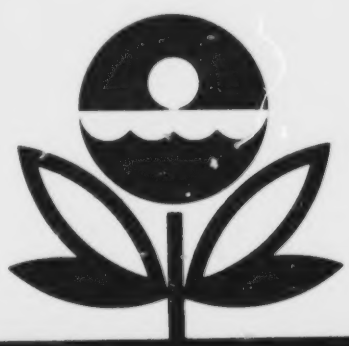
PART I

ENVIRONMENTAL PROTECTION RESEARCH CATALOG



U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND MONITORING
RESEARCH INFORMATION DIVISION
WASHINGTON, D.C.
JANUARY 1972

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PART I

ENVIRONMENTAL PROTECTION RESEARCH CATALOG

Prepared by the Smithsonian Science Information Exchange

for

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND MONITORING
RESEARCH INFORMATION DIVISION

WASHINGTON, D.C. JANUARY 1972

FOREWORD

The National Environmental Policy Act, signed into law on January 1, 1970, established a national policy to "maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."

As a step in implementing this policy, the President, with the consent of the Congress, established the Environmental Protection Agency in December of 1970. His stated purpose was to fill the need for "a strong independent agency" to serve as an effective, impartial arbiter of environmental matters, particularly in establishing and enforcing pollution control standards.

But any sound standard-setting and pollution control program must rest on a solid scientific and technical base. This is the reason for the Agency's concern for an effective research program, both internally and in other government and non-government organizations. Much is known about pollutants—their sources, their transport mechanisms, their effects, and control techniques—but much remains to be learned. Meeting these needs depends significantly upon a strong research capability, which must encompass a broad spectrum of disciplines—physical sciences, health sciences, and engineering, as well as the social sciences.

While these endeavors are supported largely by the Federal Government, they are conducted in academic institutions, State and local organizations and laboratories, private foundations, professional associations, and industrial organization, as well as in Federal laboratories. In addition, many foreign institutions contribute to the programs.

Maximizing benefits from the Nation's growing environmental concerns requires developing the full potential of this widely dispersed research capability. Because of the very number and diversity of organizations and activities involved, however, there is a serious hazard of unwitting duplication or gaps in research efforts. Complete information about on-going research and effective information transfer thus become key elements for assuring that individual scientists, engineers, administrators, and policy officials have access to knowledge of "who is doing what, where, and with whose support."

Toward that end, the Environmental Protection Agency is releasing this report: *Environmental Protection Research Catalog*. The 5,488 project descriptions contained herein should assist participants in Government, industry, and universities to select new areas for research, while avoiding wasteful duplication. By identifying individuals and organizations active in the same or closely aligned fields, communication of ideas, opinions, and data should be facilitated. And policy planning and decision making at all levels should be enhanced by the overview this compilation provides of the scope, balance, and texture of environmentally-related research. It also represents a contribution to our growing cooperation with the international agencies concerned with global pollution.

It is hoped that among the benefits from this publication will be expanded recognition of the value of descriptive information about programs, and support for activities designed to improve the flow of information among specialists working in this area. I commend this report to all of those interested in the environmental sciences—in their endeavors to help this Nation achieve the goals of its new environmental ethic.

I wish to express our special appreciation to the staff of the Smithsonian Science Information Exchange for their skilled and prompt performance of the many onerous and difficult details involved in the production of such a publication.

STANLEY M. GREENFIELD, Ph.D.
Assistant Administrator
For Research and Monitoring
United States Environmental Protection Agency

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EDITOR'S NOTE

The Environmental Protection Research Catalog, sponsored by the Office of Research and Monitoring of the U.S. Environmental Protection Agency, has been compiled by the Smithsonian Science Information Exchange, Inc., from its files of ongoing research Notices as of October 1971. Since research grants may have been transferred from one sponsoring agency to another agency or division within the Government, the supporting agency listed reflects the latest information received by SSIE from the supporting organization at the time this catalog was prepared. In addition to Federally supported research, this volume also includes selected research grants sponsored by private foundations, foreign governments, universities, state agencies and individual scientists.

This compilation is not intended as a complete collection of environmental research, but rather as a selection of ongoing research grants concerned primarily with environmental protection, pollution and contamination, and research involving the deleterious impact of man on his environment. Selection of the research Notices included was based on guidelines established by the Environmental Protection Agency with suggestions from the various contributors. Scope notes preceding each sub-chapter are designed as an aid to indicate the subject area included. Many of the research Notices included in any one chapter or sub-chapter may also be appropriate in other chapters; therefore, use of the Subject Index is recommended in locating specific areas of interest.

The Subject Index is based on terminology developed by the Smithsonian Science Information Exchange, Inc. Specific index terms may be arranged in hierarchies indicating relationships between broader and narrower subject terms. Thus, related terms may be grouped together under a more general subject heading (e.g., PESTICIDES: Insecticides, DDT). Each Index Term is followed by the project title, a list of about six descriptors, and the chapter number of the project. Additional cross-reference information may follow an index term where appropriate. For example, projects concerned with thermal pollution are indicated under THERMAL POLLUTION followed by the cross-reference note "—*see* Water Poll.". Additional thermal pollution studies appear under WATER POLLUTION SOURCES. In other cases, general subject areas may be referred to more specific topics (e.g., RADIATIONS—*see* specifics; or COSTS—*see* Economics Entries).

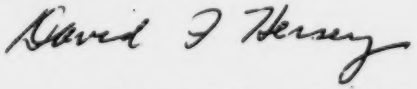
All investigators cited on the source document are included in the Investigator Index. An asterisk is used to designate the individual specified as "principal investigator" on the source document is, in fact, a program manager who is not working at the contractor location given in the project summary.

The Performing Organization Index is an alphabetic listing of the performing organization and its location.

Due to the time of compilation, not all of the entries in the Supporting Agency Index have been updated to reflect transfers of responsibility to the Environmental Protection Agency. All tasks listed as supported by the U.S. Department of the Interior—FWQA are now supported by EPA. Similarly, substantially all the tasks listed as supported by the U.S. Department of Health, Education, and Welfare—P.H.S. are now supported by EPA) Exceptions would be a limited number concerned with health aspects of radiation and a few concerned with occupational health.

All of the indexes in the Catalog were generated by means of a computer, necessitating a limitation of the number of characters available for index terms and captions. In some instances, abbreviations had to be used.

We hope that the users of this Catalog will advise the Smithsonian Science Information Exchange, Inc. of any errors of omission or commission that have been made. Also critiques of this Volume are encouraged so that future editions may best present their information content by means of format and indexes which are convenient and acceptable to the user.



DAVID S. HERSEY, *President*
Smithsonian Science Information Exchange

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DESCRIPTION OF RESEARCH TASKS

1. AIR QUALITY

A. EMISSION SOURCES

Research Concerned Principally With Sources of Air Pollution Including Types, Industries, Materials, and Processes.

1.0001, ATMOSPHERIC DIFFUSION OF TOXIC PROPELLANT BY-PRODUCTS

G. MILES, U.S. Natl. Aero. & Space Adm., Marshall Space Flight Center, *Huntsville, Alabama* 35812

The long range objectives of this effort are: To implement atmospheric diffusion models made available under contracts NAS8-30503 and NAS8-24438, which are to predict downwind concentration of toxic type vehicle exhaust by-products during launch activities as associated with skylab and space shuttle type vehicles, and determine atmospheric data input to models; and make any necessary modifications, and verify the diffusion prediction models. The atmospheric diffusion models applicable to the KSC environment will be implemented in FY-71. A contractor, with a fluent understanding of atmospheric diffusion theory and automatic computer systems, will implement the diffusion models. These models apply to contaminates released into the atmosphere at any point from surface to 30KM. Diffusion models will predict downwind estimates of particulate and gaseous materials. Models were tailored to KSC environment in that much of NASA'S 150-meter meteorological tower data and upper atmospheric data for KSC were used to develop necessary parametric input data. The investigator shown above is the Project Monitor whose telephone is 205-453-1120.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0002, ATMOSPHERIC RADIOCHEMISTRY

P.K. KURODA, Univ. of Arkansas, Graduate School, *Fayetteville, Arkansas* 72701 (AT(40-1))

The objective of this research is to learn more about the behavior and movements of radioactive fallout particles in the atmosphere. Radioactive isotopes injected into the atmosphere by the nuclear test explosions can be used as tracers in the studies of the movement of air masses, and also many other meteorological phenomena. The levels of various radioactive isotopes in rain, snow and ground-level air are being measured at Fayetteville (36 degrees N, 94 degrees W), Arkansas; for example, Sr89, Sr90, Ba140, Ce141, Ce144, I131, Be7, Bi210, Pb210. Daily variation of the concentrations of single fallout particles in the ground-level is also being measured. A long-range air trajectory study is also being carried out for the nuclear debris travelling eastward and circling the earth three or four times at 300 mb 500 mb levels.

The mean stratospheric residence time of Sr90 has been calculated to be about 1.0 year from the radiochemical data. The residence time for Ce144 seems to be somewhat shorter (about 0.8 years). The pattern of daily variation of the single fallout particles and fission product concentrations in the ground-level air at Fayetteville, Arkansas can be interpreted in terms of a) the cycling effect of the nuclear debris in the troposphere and b) local meterological conditions.

SUPPORTED BY U.S. Atomic Energy Commission

1.0003, THE VARIOUS POLLUTING SUBSTANCES EMITTED IN DIESEL ENGINE EXHAUST GASES

E. LECLERC, Belg. Ctr. Stud. Docum. Waters, *Liege, Belgium* (2R52065529)

The discharge, nature and concentrations of various polluting substances emitted in the exhaust gases of diesel engines are to be studied.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY No Formal Support Reported

1.0004, CHARACTERIZING ASBESTOS-BEARING AEROSOLS

P.K. MUELLER, State Dept. of Pub. Health, *Berkeley, California* 94704

In the first two years of the three-year grant to characterize asbestos-bearing aerosols, we have developed a method for the collection and measurement of asbestiform minerals in air. The means to differentiate asbestos from the many other fibers in air has been accomplished. The method will identify the specific type of mineral fiber composing the various forms of asbestos. Morphology and electron diffraction are used. The method will measure the amount of asbestos by means of electron microscopy according to count and size, and enable a mass calculation from density values. The method yields a true picture of the occurrence fo the fibers relative to their size distribution as found in the air with no alteration of their actual airborne size by sample handling. A filter medium of excellent retention for the fine asbestos fibers has been found. Previously it was believed that chrysotile asbestos would be almost the sole type of mineral fiber found, samples of urban air have shown the presence of amosite asbestos, an amphibole type.

The effort of the first two years has produced a method and data on asbestos concentration in a limited of urban and suburban sites. The proposed work for the third year, now in progress, is to sample other sites, such as downwind from industrial sources. The sampling program has prospects of great production, but the laboratory work is necessarily slow because of the complex and lengthy processes involved in quantitative electron microscopy. We propose to extend the asbestos work for three more years to generate laboratory data and reports from the samples of outdoor air to be taken in the third year of the current funding period. A further extension of sampling is proposed for the continuation period: There may exist an unsuspected and anonymous contamination of the air supply of buildings where asbestos-lined plenum chambers have been installed. We propose to survey public buildings for possible contamination.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0005, COMBUSTION GAS COMPOSITION

E.S. STARKMAN, Univ. of California, School of Engineering, *Berkeley, California* 94720

Research is oriented towards investigation, experimentally and analytically, of the more fundamental aspects of the problems of combustion system derived pollutants. In particular the mode

and character of the formation and production of objectionable exhaust materials is to be investigated. Emphasis is directed towards determination of the mechanisms of formation of air pollution precursors in combustion systems in order to further the basic understanding of the kinetic processes by which the deleterious chemical species are formed.

Species currently being investigated include nitric oxide, carbon monoxide, carbon dioxide, unburned hydrocarbons and the hydroxyl radical. The work is being conducted in internal combustion engines, combustors, and flame systems. Methods of investigation include ultraviolet spectroscopy, nondispersive infrared analysis, ionization flame detection, mass spectrometry, chromatography, digital and analog computer techniques.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0006, AROMATIC BY-PRODUCTS OF COMBUSTION

B.D. TEBBENS, Univ. of California, School of Engineering, *Berkeley, California* 94720

The research during the past year has been a continuation of the study concerned with the fate of airborne polynuclear hydrocarbons. Emphasis is on the reactions occurring on the aerosol carrier, namely, airborne soots. This initiating work on photooxidation of hydrocarbons on airborne soot is being related to published results obtained on the same hydrocarbons subjected to oxidations in the laboratory, but not in the airborne state.

The photooxidations occurring on arborne soot apparently follow to some extent the same pathways as non-photostimulated oxidation as the products are the same, but there is considerable variation in the relative abundance of intermediates and stable end products. Only a portion of the hydrocarbon disappears from the soot particle, the degree being directly related to the surface area exposed to light. The intermediate and end products are oxygenated; however, the photooxidation on soot proceeds very readily in an inert atmosphere. The rate of disappearance of the hydrocarbons is directly related to the intensity of light at wavelengths of maximum absorption. Identified products such as intermediate hydrocarbon diones and relatively stable hydrocarbon diacids account for approximately 25% of the lost hydrocarbons. Numerous unidentified intermediaries are known to be present as indicated by a large number of resolved fluoresce. bands on thin layer chromatogeous.

Continuing work will involve a mass balance of products using labeled hydrocarbons; a more thorough evaluation of surface-volume relationship of soot to hydrocarbon oxidation including the degree of carbon activation, the latter may be the source of oxygen on the oxidation; a more thorough look at the oxidation occurring at zero light intensity (10-15% of hydrocarbon disappears) including the use of admix oxidizing gases; relating the laboratory results to comparable phenomena occurring in the outdoor atmosphere; and improving analytical details.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0007, NUMERICAL MODEL OF THE URBAN ATMOSPHERE

L.O. MYRUP, Univ. of California, School of Agriculture, *Davis, California* 95616

We intend to formulate a working numerical model of the processes by which pollution, heat and moisture change above a city. These processes include the emission, transport, turbulent diffusion, and removal of air pollution; radiational, advective and turbulent transfer of heat: evaporation, condensation and advective and turbulent transfer of water vapor. The initial effort will be directed towards the clear- skies, summertime situation.

The model will be tested against measurements to be made, as part of the project, in the Sacramento Valley of California. In particular, verification data will be obtained for a volume of air above the city of Sacramento and a representative upwind rural site.

We shall investigate the feasibility of operational use of the model in routine meso-scale meteorological and air pollution forecasting. We intend to work in close cooperation with the Secramento office of the U.S. Weather Bureau for this purpose.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0008, HYBRID 14-COMPUTER OPTIMIZATION OF DISTRIBUTED PARAMETER SYSTEMS

W.J. KARPLUS, Univ. of California, School of Engineering, *Los Angeles, California* 90024

This research program is directed toward the application of hybrid computer techniques to the optimization of distributed parameter systems. Utilizing the favorable results obtained in the solution of a difficult identification problem in the ground-water area, work will proceed on the investigation of new optimization algorithms to permit a reliable and effective approach to a suitable mathematical representation of the diffusion field in the urban air pollution problem. Nonlinear dynamic systems and modelling of high-speed ground transportation system will be explored.

A unique algorithm to identify time-space-varying parameters in parabolic and hyperbolic partial differential equations effected a considerable improvement in the identification of parameters; however, it does not provide for a true stochastic approach to the problem of identification from noisy input-output data. This identification problem will be reexamined from the standpoint of communication theory and the theory of prediction and filtering.

Additional work will also be performed in applying the newly developed continuous-space-discrete-time methods to field problems governed by hyperbolic and biharmonic partial differential equations.

SUPPORTED BY U.S. National Science Foundation

1.0009, AIR POLLUTION RESEARCH

R.D. KOPA, Univ. of California, School of Engineering, *Los Angeles, California* 90024

Nitric oxide formation during the combustion process in an internal combustion engine can be considerably affected by the properties of the walls of the combustion chamber. According to Rozlovskii in his comparative study of the works of Zeldovich, Frank-Kamenetskii, and others, the reaction of nitric oxide formation and decomposition proceeds simultaneously by a chain and by a biomolecular mechanism. Because the theoretical yield of nitric oxide by the chain reaction is five to ten times larger than that by the biomolecular reaction, the nitric oxide concentration in engine exhaust gas could be noticeably affected by the specific properties of various wall deposits.

To test this hypothesis, an experimental reaction vessel was designed which permits the investigation of the effects of 1) the properties of wall deposits , 2) the surface to volume ratio, 3) the cooling rate of the combustion products, and 4) the fuel composition on the yield of nitric oxide from the combustion of a premixed fuel- air mixture at constant volume. The composition of the combustion products and the resulting concentration of nitric oxide is determined by means of the Magnetic Mass Spectrometer.

The photochemical reaction between hydrogen peroxide and carbon monoxide at 254 mm and 27 degrees C has been studied. With H2O2 at 1.1 torr and CO in the range 5-25 torr, the reaction produces water, carbon dioxide, and trace amounts of hydrogen. The following chain mechanism yields a kinetic rate expression which is obeyed experimentally: (a) H2O2 plus h nu yields 2 OH (to obtain I sub a); (b) OH plus CO yields CO2 plus H (to obtain K sub 2); (c) H plus H2O2 yields H2O plus OH (to obtain K sub 3); (d) OH plus wall yields wall OH (to obtain K sub 4).

Thus, chains are terminated by attachment of OH to the wall of the quartz reaction vessel. For a CO pressure of 12.7 torr, the quantum yield of CO2 formation is 105. The complete integrated rate expression is: 1/(CO)o-(H2O2)o (log (CO)o-(CO2)/(H2O2)o-(CO)-log (CO)o/(H2O2)o) equals 2 k2/k4 lot. (Although I sub o does not appear in the mechanism and I sub a does, I sub o may be introduced by noting that for weak absorption, our case, I sub a equals I sub o(H2O2).)

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0010, DIFFUSION AND DISPOSAL OF AIR POLLUTION
M. NEIBURGER, Univ. of California, School of Letters, *Los Angeles, California* 90024

The overall objective of this project is the development of a numerical simulation model by which the concentrations of air pollution over an urban area can be computed by computer as a function of space and time, given the distribution of meteorological factors (winds and temperature) and the pollution sources in space and time.

During the first year of our research period, our work has been devoted almost exclusively to resolving some of the fundamental theoretical problems which have heretofore hindered the development of generalized air pollution simulation through models. Some preliminary work is being done on programming and testing these models.

During the coming year we plan to complete the development and testing of the models, and to apply them to progressively more complete computations of the transport, diffusion and reactions of contaminants in the Los Angeles Basin for a variety of meteorological situations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S

1.0011, LIDAR OBSERVATIONS OF LOWER TROPOSPHERIC AEROSOL DISTRIBUTIONS DURING BOMEX
W.B. JOHNSON, Stanford Research Institute, *Menlo Park, California* 94025 (AT(04-3-115/PA)

The Stanford Research Institute Mark V lidar (laser radar) will be used to measure the aerosol distribution in space and time from an aircraft platform over the sea east of Barbados during the 3rd BOMEX period. The objectives of the program are as follows: a. To measure, by means of an airborne lidar system, the horizontal and vertical variations of aerosol concentration in the lower troposphere in the trade-wind region during BOMEX, and hence to infer the horizontal and vertical variations in atmospheric thermal structure, particularly those in the trade-wind inversion. b. To compare the lidar-obtained total aerosol distributions and inferred thermal structure with independent measurements of Be super 7 concentrations in an effort to discover any significant relationships, including evidence of possible mechanisms of upward or downward mass exchange through the trade-wind inversion. c. To observe the spatial and temporal changes in aerosol concentrations in the regions surrounding typical trade cumulus and active cloud and precipitation areas, in an attempt to determine estimates of the washout and rainout coefficients in the cloud and subcloud layers. d. To delineate, insofar as is possible, the boundaries of the continental dust stream reaching the BOMEX area, and to determine if any evidence exists of increased cloud activity in the vicinity of these streams of potential nucleating particles.

Results: The lidar instrument used a noedymium laser (1.06 mu wavelength) and had a firing rate of approximately one pulse per 3.5 sec. Most of over 5000 lidar signatures collected during eight flight missions were obtained over the eastern portion of the BOMEX area at 10,000 ft and at a speed of 100 m sec-super 1, with the lidar pointing 60 degrees below the horizon.

The data are sufficient to allow presentation of several vertical cross sections of optical density covering 'slices' of the lower atmoshpere 3000 m deep and tens of kilometers long.

The first data analyzed clearly reveal well-defined haze layers associated with the subcloud layer and with the trade-wind inversion. There may be a dust layer above extensive lower clouds. Within cloud layers, clear air between clouds typically gives less signal return, indicating cleaner or drier air. Experimental runs indicate increasing turbidity above the clean layer associated with the trade-wind inversion. (Text abridged)

SUPPORTED BY U.S. Atomic Energy Commission

1.0012, LIDAR STUDY
W.G. JOHNSON, Stanford Research Institute, *Menlo Park, California* 94025

Complete study of plume rise, geometry, dispersion, and particulate concentration distribution of lidar measurements of power plant plumes in western Pennsylvania area. DM will provide meteorological support to contractor's field studies at LAPPES sites.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0013, STUDIES OF NATURAL AND POLLUTANT SOURCES OF CARBON MONOXIDE
R.C. ROBBINS, Stanford Research Institute, *Menlo Park, California* 94025

We have developed a practical concentration and purification system for atmospheric carbon monoxide (CO). This system will now be used to collect one milligram minimum size atmospheric CO samples, oxidized to carbon dioxide (CO sub 2). The CO sub 2 will be collected and stored at liquid nitrogen temperature for carbon isotope ratio analyses. The concentration of CO in air samples will be monitored during CO sample collection wth the SRI-developed CO analyzer. Concurrent concentration measurements of atmospheric carbon dioxide will be made with a Beckman Model 215 nondispersive infrared analyzer. Isotope ratio measurements will be made on both atmospheric CO and CO sub 2. Urban atmospheres normally contain about 1 to 5 ppm of carbon monoxide. This concentration is 10 to 50 times higher than the ambient CO concentration in clean atmospheres. Thus, 90 to 99% of urban CO will be contributed by combustion of fossil fuel and should exhibit a super 12 C-super 13 C isotope ratio similar to that found in direct auto exhaust samples. The isotope ratio measurements on CO sub 2 will also tend to corroborate the degree of pollution by combustion. Samples will also be taken at California coastal areas such as Fort Bragg or Point Reyes.

Two field programs are proposed for remote acquisition of atmospheric samples; Wake Island in the northern hemisphere, and American Samoa in the southern hemisphere. Sites within the trade wind latitudes would ensure collection of a homogeneous sample during the required sample collection interval of three to four hours.

It is expected that this research will provide quantitative data on the contributions of natural CO sources to the total CO found in the atmosphere.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0014, DYNAMICAL MECHANISMS PRODUCING LARGE-SCALE ATMOSPHERIC TRANSPORT OF TRACE SUBSTANCES
J.D. MAHLMAN, U.S. Navy, Postgraduate School, *Monterey, California* 93941 (AT(49-7)3026)

The overall objective is to delineate the important dynamical mechanisms leading to systematic transport of trace substances in the troposphere and stratosphere. The method consists of a number of quantitative diagnoses of various circulation and transport phenomena. These consist of: case studies of surface fallout phenomena, analysis of the mechanics of jet stream maintenance and associated transport implication, numerical diagnostic computation of ozone balances in the stratosphere using the AFCRL 'Ozonesonde Observations over North America', and numerical integration experiments on long-term transport and diffusion of stratospheric trace substances using actual data. This latter approach incorporates separately the effects if sub-grid scale diffusion, large-scale eddies, and the mean meridional circulation. Each of these experimental approaches requires development of separate diagnostic techniques. A necessary condition for success in almost any of these approaches is that the vertical motion field be satisfactorily resolved. As a result, one of the basic endeavors in this project has been to develop acceptable techniques for resolving the vertical motion field.

Results: The most important as yet unpublished results are summarized below. Demonstrated that the net transverse flow about the polar front is thermally direct and completed a study of the energy balance in jet oriented coordinates. Completed initial ozone balance case and demonstrated that large-scale vertical eddy flux is quantitatively important for producing a systematice downward transport of ozone in the lower and middle stratosphere. Completed preliminary numerical integrations of strato-

spheric trace substance transport from arbitrary initial distribution. This showed that the large-sclae quasi- horizontal eddies are capable of effecting a net northward-downward trace substance transport even when such an action is opposed by the mean meridional circulation.

SUPPORTED BY U.S. Atomic Energy Commission

1.0015, CHARACTERIZATION OF SMOKE FROM CELLULOSIC FUELS
E.F. DARLEY, Univ. of California, Air Pollution Research Center, *Riverside, California* 92507

The general objectives of this project are (1) the determination and characterization of the effluents produced in the pyrolysis and combustion of cellulose under different atmospheres, and with differing amounts of inorganic contaminants and (2) the determination of the specific reaction mechanism whereby these effluents are formed--both in pure and in 'treated' cellulose. It has already been established that trace inorganic impurities and slow heating rates can drastically change combustion rates and products formed, even changing an essentially flaming process to a completely glowing one. By preparing specifically- labeled radioactive cellulose and pyrolyzing or combusting it under carefully controlled conditions, the evolved products can be traced to their locations in the origional cellulose, thus helping to establish the mechanism of their formation. Since specifically-labeled cellulose is not available commercially, a major aspect of the current work involves its preparation and the development of techniques and procedures for its assay.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0016, AIR POLLUTION FROM FOREST AND AGRICULTURAL BURNING
E.F. DARLEY, Univ. of California, Air Pollution Research Center, *Riverside, California* 92507

The increasing use of controlled burning of accumulated forest fuels in public and private land is an important factor in reducing fire hazard and maintaining favored plant species. Some forest fuels are treated with fire retardants to reduce the danger of escape from controlled burns. Also considerable amounts of agricultural wastes are burned including brush from rangelands contiguous to forests, grain stubble and fruit orchard prunings. It is important to know the pollutant contributions of such burning. It is therefore the objective of this project to determine the kinds and amounts of gaseous and particulate emissions from various types of open burning. The principal research will be conducted in specialized equipment which simulates open burning. Special attention will be given to burning under varying conditions of composition and moisture, loading, slope, ignition pattern and chemical treatment. Much of the work will be conducted in close cooperation with the U.S. Forest Service Fire Laboratories at Riverside, California, Missoula, Montana, and Macon, Georgia. Where appropriate, results from Grant AP 00568, wherein the chemical process of combustion is being studied with the aim of reducing harmful pollutants, will be applied to the burning situations of the present proposal.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0017, CALIFORNIA ASSEMBLY - STEAM BUS
UNKNOWN, State Assembly, *Sacramento, California* 95814 (000047)

a. To procure and demonstrate four transit buses equiped with external combustion engines in transit operation to substantiate the advantages over internal combustion engines, obtain performance, descriptions, and substantiate the public acceptance of such service. Special advantages claimed are better acceleration, higher speed, absence of noise, fumes and hazardous exhaust emission, and reduced operating costs. b. Report

Document provided to SIE by the Highway Research Information Service

SUPPORTED BY U.S. Dept. of Transportation - U.M.T.A.

1.0018, LEAD ISOTOPIC CHEMISTRY FOR POLLUTION RESEARCH
T.J. CHOW, Univ. of California, Graduate School, *San Diego, California* 92038

The objectives of this project are to conduct basic research on the isotopic biogeochemistry of lead, the use of lead isotopes as pollution tracers, the relationship between lead and other constituents in various environments, and the dissipation and removal of lead from the atmosphere.

The trend of lead isotopic variation in potential pollution sources such as gasolone, oil, and gas fuels, coal and industrial chemicals will continue to be monitored. After having established lead isotopic composition in source materials, the lead isotopes in the aerosols, river and harbour waters, municipal reservoirs, industrial wastes, sewage and soil will be determined. By correlating isotopic composition of lead in the source materials and in the environmental pollutants, the transport mechanism of the pollutants will be elucidated. The relationship between lead and silicate, iron, zinc, boron in the atmosphere and rain water will be investigated to determine the effectiveness of the rain as a scrubbing agent to cleanse the atmosphere.

The distribution of lead and other elements in the 'natural' environment will be studied by sampling air and rain water away from continental contamination. This part of the sampling program will be carried out at mid-ocean regions aboard research ships during oceanographic expeditions and on weather ships. The results will establish the 'background level' of lead and other pollutants and will serve as the basis for evaluating the degree of contamination in the urban and industrialized regions.

For long range research, effects of chemical pollutants in the atmosphere, foodstuff and potable liquids will be evaluated by the isotopic technique. Furthermore, the lead and other metallic ions in biological specimens such as plants, animal tissues and body fluids will be investigated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0019, ATMOSPHERIC POLLUTION AND ISLAND OF HEAT
M. PANISSETT, Univ. of Montreal, *Montreal, Quebec, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

1.0020, KINETICS OF ASSOCIATION-DISSOCIATION REACTIONS
G. BURNS, Univ. of Toronto, *Toronto, Ontario, Canada* (AF-AFOSR-2016-71)

Technical Objective: AFOSR support of Burns' work has been since 15 Oct. 1963 and jointly with the Defense Research Board of Canada since 1964. The relevance of this chemical research is in furthering our understanding of shock waves such as those created by supersonic missiles. The scientific work in the past has been the study of the dissociation and association of halogens using shock tubes and high temperature flash photolysis apparatus. Study of the chemistry of dissociation association reactions of halogens should give indirectly information on the O2 reactions and thus is of importance both in shock wave studies and the atomic recombinations which occur in the exhausts of rockets. A side issue is the importance of the work in upper atmosphere chemical reactions and pollution.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0021, METEOROLOGY FOR NUCLEAR TESTING
P.W. ALLEN, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302

Provide meteorological support for all nuclear detonations, tests and rocket experiments at the Nevada Test Site. Research into meteorology of diffusion of effluents. Develop instruments, measurement techniques. Develop atmospheric models to predict the transport, diffusion and deposition of nuclear effluents.

Meteorological support of nuclear tests is planned at near the FY- 69 level. Continue study of radionuclide transfer processes. Expand research on problems connected with trajectories and fallout from small cratering and contained industrial applications. Provide complete meteorological support for all programmed experimental plans (detailed weather forecasting and documentation, radiation estimates, climatological support). Evaluation and improvement of models for use in weather, fallout and diffusion predictions.

Prediction estimates of radioactive effluent transport and resulting exposure levels for all underground nuclear explosions and rocket engine tests were used for event scheduling, area clearance and control, and monitoring in off-site areas. Available numerical/statistical prediction techniques involving computers were evaluated. Radar weather surveillance over most of the southwestern states was arranged for evaluating and predicting precipitation as a factor in radioactive cloud tracking and in deposition or rainout. Published and distributed a comprehensive climatology of the Nevada Test Site.

SUPPORTED BY U.S. Atomic Energy Commission

1.0022, METEOROLOGICAL STATISTICAL STUDIES

G.W. BRIER, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (001140)

Technical Objective: Continue development and application of advanced techniques to geophysical problem analysis.

Approach: Exploitation of the new predictive statistical technique developed by Mr. Brier with applications to a variety of geophysical problems including the prediction of mesoscale winds over time periods of 1-24 hours, the occurrence of solar activity, and the analysis of the error fields resulting from numerical model predictions. Participate in the statistical design of a study testing the influence of urban effluents of air pollution and heat on the distribution of precipitation around a major urban area. As a result of these tests, improvements and advancements were made in the statistical model utilized in making predictions. Provide statistical assistance and analysis to Project Stormfury, to weather modification experiments such as the tropical cloud seeding work of Dr. Simpson.

Progress: Analyses of the solar flare predictability were conducted and improvement in sunspot predictions demonstrated. This has considerable potential for improvement in telecommunications interference forecasting. A new statistical prediction technique for single or multiple time series was developed. The procedure will accept any number of prediction parameters and divide them into influence bands from which prediction equations are derived to calculate the future state of the atmosphere. The model is essentially self correcting and allows for updating the coefficients of the prediction equations as new data arrives. A study, by means of a carefully designed statistical methodology, shows an apparent correlation between jet aircraft flights and the increase in the amount of cirrus clouds.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0023, METEOROLOGY FOR URBAN AID POLLUTION

R. GRASS, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (000286)

Support ARL Program Objectives, which are: to relate meteorological elements to the generation, transport and modification and removal of air pollution.

Conduct airborne (helicopter) measurements of ozone, total oxidants and sulfur compounds in conjunction with ARL field efforts to determine a pollution climatology in the Los Angles area.

Data is being evaluated and a report is programmed for the end of FY-70.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

1.0024, THERMAL MODIFICATION

P.M. KUHN, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (001127)

Approach: This program area will continue to materially contribute to the laboratory field efforts: (1) Great Lakes - study the heat island effect of large metropolitan areas such as Buffalo; (2) Mitigation of Severe Storms (Hail) - hailstreak analysis with airborn IR remote probing; and (3) Inadvertent Modification - study of the atmospheric thermal radiation budget.

Progress: In-situ infrared and solar radiometric observations of supersonic and convential jet contrail sheets coupled with radiative transfer calculations have revealed no significant decrease in the mean surface temperature.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0025, METEOROLOGY FOR RADIOACTIVITY

R.J. LIST, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (011630)

Collection, quality control, and summarization and analysis of data on radioactivity in the atmosphere and the earth's surface for estimating atmospheric concentrations and fallout levels. These data are used to predict future fallout and to investigate atmospheric processes.

Continued improvement of data collection procedures through development of new sampling devices and exercise of immediate quality control both for the Northern Hemisphere and Southern Hemisphere (Australia) activities. A three-dimensional global diffusion model is being developed for computer simulation in which known injections of radioactivity will be used for verification. This will be a cooperative program with the Geophysical Fluids Dynamics Laboratory. A medium range empirical type K theory box model has been developed and is being tested on the computer facility at the National Meteorological Center activity. Additional tracers (CO_2, H_2O, and naturally-produced radionucludes) will be incorporated both in the data analysis procedures and in the diffusion modelling. Considerable emphasis on three-dimensional trajectories and their verification through the use of known releases of radioactivity will be pursued using the National Meteorological Center's existing model and improvements thereto.

Program to study long term trends of oxygen content of the atmosphere was completed with the results that the oxygen fraction of the atmosphere appears unchanged since 1910. The study of the movement of radioactivity in the stratosphere along sloping isotropic surfaces has successfully indicated the importance of organized circulation systems (Carbon-14 molecular sieve and air ejector whole air sampling) have been successfully tested and operation use initiated. Significant data improvement is expected as a result of these modifications. The study of the movement of radionuclides has now reached the stage that permits numerical simulation and the computer software has been developed for calculation of simplified models as well as preliminary extension to more complex dynamical meteorological models.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0026, METEOROLOGY FOR URBAN AIR POLLUTION RESEARCH

R.A. MCCORMICK, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (000350)

Relate meterorological elements to the generation, transport and modification and removal of air pollution.

Conduct research on boundary layer dynamics in urban areas, study the meteorological of secondary air pollution. Conduct field experiments on large power plant effluents. Develop air pollution climatology and pollution potential forecasting. Investigate large scale effects of pollution on weather and climate. Provide consultation, field studies and training programs on meteorology.

Successful completion of a year's study of a large power plant with lidar and aircraft. Support the establishment (by WB) of urban soundings. Completion of urban diffusion analysis. Inaugurate urban boundary layer studies. Complete development of new turbidity instruments on indirect x temperature probe. Conduct numerous field studies in support of NAPCA activities.

1. AIR QUALITY

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

1.0027, METEOROLOGY FOR NUCLEAR REACTORS
I. VANDERHOVEN, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302

Study the transport and diffusion of radionuclides by the atmosphere with emphasis on: dispersion over distances of tens of miles and over time periods of many hours: factors affecting plume deposition and subsequent; depletion; the effect of diffusion in built-up urban areas, and the delineation of diffusion incides and engineering methods to estimate diffusion.

Conduct a full-scale study of the aerodynamic effect of various buildings shapes and sizes on downwind diffusion. Continue controlled experiment to separate and analyze the effects of various types of surface on deposition and depletion. Continue studies to determine what effect 'real' conditions in the near-surface boundary layer and planetary boundary layer have upon transport and diffusion. Obtain quantitative information on the mesoscale flows and its contribution to transport and diffusion of special effluents.

Completed a joint AEC-HEW field study of the characteristics of the urban planetary boundary layer at Columbus, Ohio. Begun computer analysis of derived data to determine comparative vertical motions, variations in Reynolds stresses and trajectories over urban versus rural areas. Investigated the feasibility of realistically depicting mesoscale flow patterns through objective analysis of wind data from a network of wind stations. Published several papers and reports on studies and test results conducted over the past years.

SUPPORTED BY U.S. Atomic Energy Commission

1.0028, ESSA ANTARCTIC METEOROLOGY RESEARCH PROGRAMS
H.K. WEICKMANN, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Boulder, Colorado* 80302

Surface and upper air meteorology research will continue at South Pole Station with the following programs: (1) a qualitative evaluation will be made of the heat and mass budget of the high altitude southern hemisphere region and its relation to the global budgets. (2) the descriptive picture of the atmospheric structure and circulation at high south latitudes over Antarctica and the surrounding oceans will be improved, (3) observed atmospheric motions will be related to known physical laws, (4) further knowledge of the Spring Atmospheric Warming, dynamics of the boundary layer inversion, and mechanics of atmospheric snow transport will be sought, and (5) information about weather modifications (either intentional or inadvertent, by way of gaseous or particulate atmospheric contamination) will be collected. Studies of incoming and outgoing radiation in various ranges from UV to long IR will be continued and related to the radiation balance. All of the above investigations will be made with data collected at Pole Station in CY 1971. The parameters to be measured include temperature, wind velocity, incoming and outgoing radiation, atmospheric composition (CO_2 and O_3) and the size, distribution and concentration of particulates. The data will also be used to evaluate the sounding techniques in use on Nimbus III.

SUPPORTED BY U.S. National Science Foundation

1.0029, GEOCHEMICAL EXPLORATION STUDIES OF VOLATILE ELEMENTS
J.H. MCCARTHY, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: Arizona, California, Colorado, Nevada, and Utah.

Measure the distribution and abundance of volatile elements in the atmosphere; study their relationship to ore deposits and application to geochemical exploration. Particularly to measure the concentration of those elements associated with ore deposits that are given off in gaseous form. Mercury anomalies have been found in air over most ore deposits, and SO_2 and halogen gases are to be studied. Evaluate the factors that influence the distribution, abundance, and movement of volatile elements in the atmosphere.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0030, GASEOUS PLUME DIFFUSION ABOUT ISOLATED STRUCTURES OF SIMPLE GEOMETRY
R.N. MERONEY, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521 (AT(11-1)-2053)

Interest in the mechanisms of gaseous plume dispersal has increased rapidly over the past forty years. Most efforts have been directed toward understanding diffusion in idealized situations. During the last ten years many authors have stressed the importance of understanding the dispersal processes of gas plume in situations of practical importance. In spite of the high quality and extent of these initial tests, the lack of a complete understanding of pollutant behavior in the vicinity of building structures is evident. Many important situations have not been correctly described and the majority of measurements made are not easily correlatable or comparable.

This proposal suggests a systematic experimental study of the air flow and diffusion in the vicinity of simple geometrical shapes. The approach attempts to isolate the peculiarities of such configurations in an effort to make appropriate field predictions possible.

The ultimate objective of this study on gaseous effluent behavior is to help develop a technology which will result in faster, safer and more economical dispersal of gaseous reactor wastes.

Results: During the last half year a set of wind-tunnel measurements have been made for gaseous plumes emitted at the surface of a simple cubical geometry building into neutral and stratified boundary layers. These experiments were designed in coordination with the National Reactor Testing Station which plans to perform a series of equivalent prototype measurements. Gaseous plume behavior was examined by flow visualization techniques utilizing a visible smoke, and by gas tracer techniques using a mixture of Kr-85 and air as a tracer

SUPPORTED BY U.S. Atomic Energy Commission

1.0031, THE BEHAVIOR OF NEGATIVELY BUOYANT GAS PLUMES
R.N. MERONEY, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

Recent practice in the air pollution control of fossil-fuel power and heating plants suggests the use of pollution abatement equipment to meet Federal and State pollution standards. Frequently wet flue gas- washing process equipment are used to reduce particulate and SO sub 2 load levels. Unfortunately the flue gases are always cooled and almost certainly become saturated. Subsequently the release of these saturated gases often is followed by vapor particulate evaporation; cloud cooling; and descent of the gaseous plume to the ground. Plume descent by evaporative cooling of entrained water vapor may increase significantly odor, toxicity, and in some cases explosion potential.

Dense plume behavior will be studied in the Micro-Meterological Wind Tunnel at Colorado State University. Measurements of concentration utilizing tracer gases in neutral, stable, and unstable atmospheres will be examined. Modifications to existing plume rise formula will be prepared to allow field computations of wet plume behavior.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0032, THE ROLE OF THE GENERAL CIRCULATION OF THE ATMOSPHERE IN RADIOACTIVE DEBRIS TRANSPORT
E.R. REITER, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521 (AT(11-1)-1340)

Writing of Vol. IV of a 'critical and creative review' on Atmospheric Transport Processes will commence. This volume will deal with the nature and origin of natural and artificial radioactive trace constituents of the atmosphere, their identification, and their applicability in portraying tropospheric and upper-atmospheric circulation regimes. A composite empirical 'model' of the general circulation, derived from tracer evidence, will be compared with numerical models.

Using conventional and satellite data we will study the stratospheric ozone transport in both hemispheres. Transport processes in the jet-stream region in both hemispheres will also be studied and the relative role of planetary and cyclone waves in these transports will be assessed. The differences in the circulation patterns of the northern and southern hemispheres will be examined.

Vol. I of the review (Energy Transfers and Transformations) is available as TID-24868. Vol. II (Chemical Tracers) is in print as TID- 25314. The manuscript of Vol. III (Hydrodynamic Tracers) is being readied for printing. Data banks for the global ozone and jet stream studies have been established.

SUPPORTED BY U.S. Atomic Energy Commission

1.0033, STUDY OF RELATIONSHIP OF ENGINE DETERIORATION TO EXHAUST EMISSIONS
L. SMITH, Automotive Research Associates, *Washington, District of Columbia*

This contract is designed to determine, on an accelerated basis, the interrelationship of engine wear-incipient component failure and exhaust emission increases that cannot be recovered by normal maintenance as specified in the regulations. The vehicles are to be operated on a 1000 mile-per-day-five day per week schedule with exhaust emission and engine diagnostic measurements at 10,000 mile intervals. Mileage accumulation will continue until major failure, such as valve burning occurs or, until 100,000 miles if no failure occurs. After deficiency correction operation will be extended through 5,000 to 10,000 additional miles to see if emissions return to the original stabilized levels. Engines will receive normal maintenance.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0034, ENERGY, AIR QUALITY, AND THE SYSTEMS APPROACH
G. BLACK, George Washington University, Prog. of Pol. Stud. Sci. Tech., *Washington, District of Columbia* 20037

This study is an analysis of the implications for 1) national energy and fuel resource policy and 2) air pollution policy, the means by which national goals which are dependent on the use of energy, such as economic growth, can be achieved simultaneously with air quality goals. Since the overwhelming portion of air pollutants are the by- product of energy generation, changes in the mix of pollutants which result from alterations in fuels, means of energy conversion, or pollution abatement are of major air quality significance. Special attention is given to sulfur oxides and particulates. The basic energy model is derived from the Department of Commerce interindustry study (input-output table for 1963), from engineering data on: power generation; pollution abatement; vehicular power. The pollution model combines an emitter model, a diffusion model, and a recipient model. The overall model merges the energy and the pollution model so as to permit a comparative analysis of alternative programs, with respect to costs, air quality and technology.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0035, ATOMIC REACTION KINETICS
J.T. HERRON, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Rates of reaction of atomic oxygen with a series of haloethylenes have been measured at room temperature. Particular attention has been paid to the formation of product formaldehydes and halogen substituted formaldehydes which may play a role in air pollution through the burning of halogen containing plastics.

A critical review of rate constants for the reactions of atomic oxygen with methane and ethane has been completed.

A study of the reactions of O2 1 delta g with unsaturated organic compounds has been initiated. Rate constants have been obtained for reactions with simple olefins and more complex ring compounds. From this study it is possible to demonstrate that reactions with the simple olefins are not of major importance in air pollution, contrary to recent speculation. This work is being extended to more complex reactants which may be of importance in other aspects of environmental health.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0036, MISCELLANEOUS ENVIRONMENTAL ENGINEERING TESTS (OA)
T.W. WATSON, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Technical Objectives: To provide engineering services including data obtained as a result of laboratory and/or field investigations on problems dealing with the performance of systems or sub-systems used to control the indoor environment of buildings.

Approach: At the request of government agencies services such as investigations concerning air cleaners, humidifiers, air conditioning equipment, heat transfer measurements, etc., are conducted on a reimbursable basis.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0037, MISCELLANEOUS ENVIRONMENTAL ENGINEERING TESTS (P)
T.W. WATSON, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Technical Objectives: To provide engineering services including data obtained as a result of laboratory and/or field investigations on problems dealing with the performance of systems or sub-systems used to control the indoor environment of buildings.

Approach: Upon request from the public (private industry, commercial laboratories and universities), services such as investigations concerning air cleaners, humidifiers air conditioning equipment, heat transfer measurements, etc., are conducted on a reimbursable basis.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0038, CHEMICAL COMPOSITION OF POLLUTED AIR
H.W. WOOLLEY, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

The objective of proposed work under this project is to estimate the magnitude of effects on equilibrium constants and equilibrium compositions in air due to interactions between molecules, with particular regard for substances of interst in atmospheric pollution.

The major portion of the work under this project will involve calculations of the effects on the equilibrium composition of air of added chemical reactions appropriate to various industrial and technological processes as deemed of interest in consultation with Project MAQ management. These processes will include chemical reactions which take place in the automobile power plant.

A second part of the work will include an incidental exploration of comparative rates of change of composition for different constituents in such cases as involve reaction rates for which the dependence on temperature and 'third body' identity are given by empirical equations.

Output Expected: Computer Programs.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0039, INFRARED STUDIES IN ICELAND
J.D. FRIEDMAN, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

The cooperative U.S.G.C.-National Energy Authority of Iceland (and University of Iceland Science Institute) project, Infrared Studies in Iceland, has been undertaken with the objective of recording on film and videotape the major and changing surface thermal manifestations of the neovolcanic zone of Iceland. The area was selected because of its unique position astride the rift zone of the North Atlantic ridge system.

The project is being carried out by aerial infrared-scanner investigations and concurrent field investigations by Icelandic and U.S.G.S. geologists and geophysicists. The detailed objectives include the determination of the practical threshold of detectability of convective heat transfer at the earth's surface by the airborne IR technique, and the study of the relationship between infrared anomalies and tectonics, seismic events (microearthquakes) and other geophysical anomalies (e.g., resistivity lows). Energy-yiel

estimates of volcanic events and convective heat-flow estimates will be made where possible. Changing anomaly patterns have been of particular interest. The next stages of this project will be continued studies and completion of reports on Hekla and other Iceland volcanoes.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0040, JET AIRCRAFT AIR POLLUTION
UNKNOWN, U.S. Dept. of Transportation, Engineering & Safety Division, *Washington, District of Columbia* 20590 (000637)

Document provided to SIE by the Highway Research Information Service

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

1.0041, CONTINENTAL AEROSOLS IN THE MARINE ATMOSPHERE
J.M. PROSPERO, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

This grant is for continued research on the concentration and composition of marine aerosols. Special emphasis is placed on the investigation of African dust which transits the Atlantic Ocean carried by the Northeast Atlantic Trades and enters the Caribbean area in high concentrations. A sampling station has operated on Barbados West Indies for the past four years and additional stations will be established in the Cape Verde Islands, on Bermuda and at Miami. Radon 222 will be used as an indicator for continental air parcels and as a tracer to study the interaction of African air parcels with tropical disturbances.

The composition of the aerosols will be analyzed to identify those components which are indicators for specific source regions which will allow distinctions between man made and natural aerosols.

SUPPORTED BY U.S. National Science Foundation

1.0042, PRODUCTION AND DISPERSAL OF PATHOGENIC BACTERIAL AND VIRAL AEROSOLS BY AERATION OF CONTAMINATED WATERS
R. KING, Georgia Inst. of Technology, School of Civil Engineering, *Atlanta, Georgia* 30332

The mechanism of bacterial aerosol production from polluted waters has been demonstrated for selected bacteria. These investigations, however, have not been expanded to include pathogenic bacteria and viruses.

It is proposed to investigate aerosol production from polluted waters as a possible pathway for the spread of tuberculosis and viral diseases.

Effects of tuberculosis have been demonstrated at extremely low concentrations of tuberculosis bacteria in the air. The spread of tuberculosis in the vicinity of certain sewage treatment plants by aerosol formation is, therefore, a possibility. Studies utilizing organisms which demonstrate similar characteristics to Mycobacterium tuberculosis will be conducted. Such an organism may be Mycobacterium smegmatis.

The survival rate of viruses has been shown to be quite high in air. An investigation to demonstrate aerosol formation by aeration of polluted waters as a means of dispersing viruses to the atmosphere will be undertaken using as subjects those viruses which attack bacteria (bacteriophages) to simulate those which are of importance to man.

Experimental equipment will include a controlled atmosphere (wind tunnel) equipped with devices for the aeration of bacterial and viral solutions under varying conditions (simulated sewage treatment processes). Down wind aerosol samples will be collected by means of slit samplers, settling plates, and others, analyzed by means of applicable microbiological techniques, and subjected to statistical analysis.

SUPPORTED BY Georgia Institute of Technology

1.0043, DEVELOPMENT OF IMPROVED TECHNIQUES FOR USING PRESCRIBED FIRE IN SOUTHERN FORESTS
R.W. COOPER, U.S. Dept. of Agriculture, S.E. Forest Experiment Station, *Macon, Georgia* 31202 (SE2101)

OBJECTIVE: Develop improved methods of using fire to reduce fuel areas and to accomplish silvicultural objectives; determine stand, fuel, and weather conditions under which appropriate firing techniques will produce a fire of the required intensity and behavior; to be alert to alternative methods of fuel reduction.

APPROACH: Developing improved instrumentation for documenting both the prescribed fire and its environment. Time-temperature relationships, heat yield, and flame characteristics are of primary interest. Continuing studies on firing techniques. Studying the use of prescribed fire for fuel or hazard reduction. Evaluating other promising means of hazard reduction or prevention of fire from hazard areas.

PROGRESS: Prescribed burning is normally a daytime operation, but research has shown that productive burns can be accomplished at night as well. Forest fires, both wild and controlled, produce changes in air quality that are not fully understood. Products of forest fuel combustion are CO(2), H(2)O, CO, and minor amounts of hydrocarbons. Sulfur products are apparently not present in significant amounts. Particulate concentrations are highest immediately downwind from the burn and taper off as samples are taken further from the source. Particulates produced by burning forest fuels are commonly in the 0.2 to 0.5 micron range--smaller than other common sources of pollution. Predicting crown weights of loblolly pine from standard crown data can be accurately done using d.b.h. for both Piedmont and Coastal Plain trees. These data can be used in planning fuel reduction measures for thinnings and harvest cuttings. Controlling fire intensity in hilly terrain may be partially accomplished by using the 'Chevron' burning technique. Predicting tree mortality in young stands is closely related to the amount of crown consumption and bole damage resulting from free- burning fires.

SUPPORTED BY U.S. Dept. of Agriculture

1.0044, CONTUNUOUS MEASUREMENTS OF AIRBORNE AND PRECIPITATION RADIOACTIVITY AND METEOROLOGICAL APPLICATION
R. REITER, Physicalisch Bioklim. Forsc., *Munich, Germany* (AT(30-1)4061)

The object of this project is to identify the mechanism of the air mass exchange between stratosphere and troposphere.

The radionuclides P32 and Be7 are predominantly produced in the stratosphere by cosmic rays. Hence, the variations of their concentrations with time measured at an undisturbed location indicates the variations of the influx of stratospheric air to the measuring site. For interesting periods it is possible to describe the mechanism of air mass exchange stratosphere and troposphere by a detailed analysis of he meteorological conditions prevailing in the lower stratosphere, tropopause and troposphere. Jetstream formation, topography of the tropopause, and temperature distribution in the troposphere are also taken into account.

In order to gain the basic data for this work membran. filters are exposed daily at Zugspitze peak (3000 m a.s.l.) with 2000 cu m air per 24 hours. The radionuclides P32, Be7 and some fallout elements are separated chemically and their concentrations measured by beta- and gamma-ray spectrometry.

From April 1, to December 1, 1970, 227 filters have been exposed and analyzed. Comparisons between the variations of the radionuclide concentrations and meteorological data (radiosonde ascents of Atlantic and Europe) have been made by computer techniques.

Results: It was found that there is a strong correlation between the influx of radioactive aerosol from stratosphere to the measuring site and typical variations of tropopause structure and jetstream formation. It has been possible to fix exactly the location where an injection of stratospheric air had taken place. By the continuity of the series of recordings and measurements and by a modification of the computing technique it will be possible to deduce laws which control the mass exchange between stratosphere and troposphere.

SUPPORTED BY U.S. Atomic Energy Commission

1.0045, AIR-SPORA IN HAWAII
I.W. BUDDENHAGEN, Univ. of Hawaii, School of Agriculture, *Honolulu, Hawaii* 96822

The qualitative and quantitative nature of the air spora in Hawaii is to be investigated by sampling the atmosphere with spore-trapping devices. Special attention will be given to spores of plant pathogenic fungi and spores and pollens of suspected and known allergens. Total spore loads in agricultural and urban areas will be compared. Attempts will be made to detect biologically significant particles in the atmosphere at the Mauna Loa Observatory on the Island of Hawaii (elevation kk,150 feet), and to determine their likely points of origin. At Atlas of air-borne spores in Hawaii will be compiled. The processes of spore formation, release and dispersal are to be studied and the effects of meteorological and other factors on these processes will be studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0046, CHICAGO AIR POLLUTION SYSTEMS MODEL
J.E. CARSON, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

A numerical model to simulate and forecast SOsub2 pollution concentrations in Chicago from source emission and meteorological data and forecasts is being developed under a joint contract with the Department of Environmental Control, City of Chicago, and the National Air Pollution Control Administration. A secondary objective of the study is to develop and test effective and economic pollution abatement techniques, using the SOsub2 diffusion model as a component. The Meteorology Group has participated in the program by supplying meteorological data and advice, identifying and analyzing meteorological conditions causing high pollution levels, operating experimental programs to measure diffusion parameters and dispersion rates, and developing a receptor-oriented urban pollution model.

This summer, an extensive series of diffusion experiments will be made in chicago, using SFsub6 as the tracer. The analytical studies will be continued.

Results: The numerical prediction model has been developed and is being verified. Three pollution abatement exercises, the fuel-switch tests, have been conducted in the City of Chicago. Chemical analysis procedures for SFsub6 have been developed; a sensitivity of 0.5 parts per 10super12 parts of air has been achieved. The Tabulation Prediction Scheme, a receptor-oriented urban model, has been completed. Numerous helicopter surveys have been made. Several published reports and papers presented at scientific meetings have been generated by the Meteorology Group.

SUPPORTED BY U.S. Atomic Energy Commission

1.0047, PLUME RISE STUDIES
H. MOSES, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

A state-of-the-art study is being made to determine techniques for determining plume rise. This study consists of a review of the basic thinking in this area as well as a summary of measuring techniques. An analysis and critique of the theory underlying current plume rise summaries are being made. Plume rise data based on single stacks from all over the world have been assembled. An objective of this study is to develop recommendations concerning the best techniques for calculating plume rise.

Results: Most of the background material discussing the historical development, measuring techniques, and basic theory has been written up. Preliminary computer runs testing currently used formulas with data sets have been completed.

SUPPORTED BY U.S. Atomic Energy Commission

1.0048, STUDY TO DETERMINE THE FATE OF CO IN THE ATMOSPHERE
C.M. STEVENS, Argonne National Laboratory, *Argonne, Illinois* 60439

Argonne National Laboratories is to investigate the consumption of carbon monoxide in the atmosphere, Argonne will perform the following: (1) World-Wide Sampling of the Atmosphere to analyze the carbon isotopic abundance and concentration of natural CO in the atmosphere. (2) Analysis of CO emissions from the land biosphere to determine the kind and extent of natural sources from the various kinds of soil and humus. (3) Residence times of CO in the atmosphere and mechanism of scavenging processes by measuring concentration as a function of altitude and studying reaction rates under in situ conditions. (4) Determine C14 content of natural carbon monoxide in the atmosphere.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0049, WORKSHOP ON GLOBAL ECOLOGICAL PROBLEMS
R.F. INGER, Field Museum of Nat. History, *Chicago, Illinois* 60605

Twenty or more leading ecologists will be convened by the Inter- American Institute of Ecology to evaluate environmental issues, the results to be offered as a Basic Paper for the UN Conference on the Human Environment scheduled for Stockholm in 1972. Four to six critical ecological problems will be studied, selected on the basis of their global and international significance and on the basis that the science of ecology can usefully be applied toward their clarification or solution. The workshop will be patterned after the Williamstown, Mass. Study of Critical Environmental Problems (SCEP) sponsored by the Massachusetts Institute of Technology in 1970 and published in the report Man's Impact on the Global Environment. It will build on the ecological section of that report.

SUPPORTED BY U.S. National Science Foundation

1.0050, MINERAL MATTER IN COAL
H.J. GLUSKOTER, Univ. of Illinois, State Geological Survey, *Urbana, Illinois* 61801

The investigation is concerned with the nature, distribution and origin of the inorganic constituents of coal. In order to obtain a relatively unaltered sample of mineral matter from coal to use as a starting material for our investigations, an electronic low-temperature ashing technique is routinely used. After ashing the coal at temperatures below 150 degrees C, the mineral matter residues are investigated by x-ray fluoresence spectroscopy, atomic absorption spectroscopy, optical emission spectroscopy, neutron activation analyses, and general wet chemical methods for elemental analyses; and by sieve and Coulter Counter analyses for size determination.

In recent years this research has resulted in publications concerning chlorine in coal, the mode of occurrence of sodium and chlorine in coal, sulfur in coal, clay minerals in coal, phosphate minerals associated with coals, and mercury in coal.

Studies of the areal distribution of the minerals in coals of the Illinois Basin, the use of boron content as a paleosalinity indicator of coals, and the heavy metal (As, Hg) concentration in sulfide minerals in coals are all currently being actively pursued. The results of these investigations will, hopefully, be published during the next one or two years.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0051, NUMERICAL ANALYSIS OF TURBULENT FLUID FLOW MIXING
W.L. HULL, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

An implicit finite difference technique is used to solve the combined conservation equations of a turbulent, constant pressure, non- homogeneous, axisymmetric fluid flow mixing problem for various flow field parameters.

This problem is applied to mixing conditions between the venturi and the throttle plate of a carburetor. This model is then applied to optimize the conditions governing the mixing of fuel and air in an effort to get a more homogeneous mixture, enabling improved mixture distribution wih consequent improvements in fuel economy and reduced exhaust pollutants.

1. AIR QUALITY

SUPPORTED BY Ethyl Corporation - Richmond, Va.

1.0052, INTERDISCIPLINARY STUDY OF ENVIRONMENTAL POLLUTION BY LEAD
R.L. METCALF, Univ. of Illinois, Graduate School, *Urbana, Illinois* 61801

The proposed research involves the planning and development of a comprehensive study on environmental pollution by lead with special emphasis on lead from gasoline but including the movement of all forms of lead through the environment. The various states, processes, transformations and transportation agents by which lead migrates from its original points of deposition to its final destination will be examined. Concurrent with the above model development will be the development of a systematic procedure for the location, collection and evaluation of data relevant to the diverse aspects and processes involved in environmental pollution. An integral part of the planning will involve the establishment of an analytical facility to develop and test methodology.

Specialists in agriculture, engineering, biochemistry, physiology and medicine, economics and law will assist in the development of a comprehensive research program. Collaboration with investigators from other institutions has been assumed.

SUPPORTED BY U.S. National Science Foundation

1.0053, RESEARCH INITIATION - DISPERSION OF POLLUTANTS FROM TALL CHIMNEYS.
D.L. BRENCHLEY, Purdue University, School of Engineering, *Lafayette, Indiana* 47907

Tall chimneys are used as an effective method of dispersing effluents. Under certain meterorological conditions, however, a phenomenon called 'fumigation' can cause relatively high concentrations of pollutants at certain ground locations. This research will employ a gaseous tracer technique in order to study this process. Field measurements will be correlated with the various models which have been proposed for calculating the ground level concentrations.

SUPPORTED BY U.S. National Science Foundation

1.0054, PRODUCTION PRACTICES FOR FRUITS
R.A. HAYDEN, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01347)

OBJECTIVE: Develop pollution-free methods of combating cold injury to fruit plants. Study the effects of rootstock and training on hardiness of peach. Evaluate fruit varieties in Indiana's climate.

APPROACH: Study methods of protecting fruit plantings from frost and low winter temperatures through heating with oil, propane and electricity emphasizing systems free of air pollution. In Purdue Orchards, develop planting and training systems for peach trees on standard and dwarfing rootstocks for adaptation to Midwestern climatic conditions. Continuously evaluate in Purdue and grower orchards, apple, peach and strawberry varieties for adaptation to the midwest.

PROGRESS: Oil, propane and electric heating systems were installed in an apple orchard. Oil system operated satisfactorily providing 3 to 5 degrees of protection against spring frost. Propane system also operated satisfactorily, except that the problem of fuel vaporization would be severe in a larger installation. Protection was 3 to 5 degrees. Electric system gave only minimal protection of one to one and 1/2 degrees, and appears at this point to be impractical for commercial orchards. Evaluation of apple and strawberries varieties continued. Significant differences occured in the precocity, yield, color, and desirability of various strains of Delicious apples tested. Peach plantings were established to study pruning, population, and yield potential of close plantings of peach. Hardy varieties of peach were worked on 2 hardy peach rootstocks to study effect of all combinations on tree performance under Mid-Western environmental conditions.

SUPPORTED BY U.S. Dept. of Agriculture

1.0055, SWINE HOUSING ENVIRONMENT
T.E. HAZEN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01596)

OBJECTIVE: Develop and verify design criteria for control of air quality for swine production.

APPROACH: Test building constructed to house swine and control resulting atmosphere for identification. Chromatographic technqiues to be used to separate and identify atmospheric gases. Variations in management, temperature, humidity and ventilation will be studied as they effect gaseous composition. Several compositions of steel will be exposed to identify effect of atmosphere on corrosive properties. As progress permits the effects of the various gases on animal performance will be studied.

PROGRESS: Thirty gaseous compounds have been identified to date in a hog house atmosphere. Of these two groups, amines and mercaptans, have been subjectively associated with undesirable odor. Procedures for quantitatively measuring and numerically indexing the atmospheric quality have been only partially successful. Approximately 16 steel- based materials are being exposed to the atmosphere and periodically evaluated for resistance to deterioration. Of the gases identified, those of corrosive interest are being quantitatively measured. Of related interests are observations on the physical properties of the atmosphere and of animal management practices as they affect both the subjective and measured quality of the atmosphere.

SUPPORTED BY Iowa State Government - Des Moines

1.0056, VEHICLE AND HIGHWAY SAFETY ON WINTER TIRES, WINDSCREENS, BRAKING SYSTEMS AND AIR POLLUTION
G. POCCI, Italian Min. Transp. Civ. Avn., *Rome, Italy* (2R52061118)

Tests are being conducted to determine the relative safety and to establish standard specifications for metal studded tires, braking systems, windshields, and air pollution. The effect of metal studs embedded in the tire on the reduction of skidding on icy roads is being tested in the laboratory. Various types of glass used in windshields were tested to determine the relative safety features of each. The accumulation of carbon monoxide in the interior of passenger cars during idling was also investigated.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY Italian Government

1.0057, SELENIUM AND ITS SIGNIFICANCE AS AN AIR POLLUTANT
P.W. WEST, Louisiana State University, Graduate School, *Baton Rouge, Louisiana* 70803

Perfected sampling and analysis techniques would now be applied to the study of sources of selenium and its distribution. Previous work on this project has proved that selenium concentrations reported by other investigators are incorrect because of improper sampling techniques that were used. We have found SeO sub 2 as high as 240 mu g per cubic meter which is approximately two orders of magnitude higher than the highest values reported elsewhere. The common use of high-volume samplers or other filtration methods leads to the proposed studies will be based on samples that are collected by scrubbing to obtain stable aqueous systems that will be analyzed by the specific catalytical method developed during the first phase of the project. Incinerator emissions would be evaluated as would a variety of other sources of selenium such as diesel exhausts, stump burning, etc.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0058, CHEMICAL ASPECTS OF AIR POLLUTION FROM KRAFT PULPING
I.B. DOUGLASS, Univ. of Maine, Graduate School, *Orono, Maine* 04473

The investigative work is concerned with: 1. The volatile compounds formed in the digester during the pulping of wood by

the kraft process and at other points in the manufacturing process. 2. Chemical reactions which can lead to the destruction of the malodorous compounds and help to control air pollution. 3. The fundamental organic chemistry of low molecular weight sulfur compounds derived from methyl mercaptan and dimethyl sulfide, the malodrous compounds formed during kraft pulping. 4. The measurement of kraft odors in ambient air downwind from kraft pulp mills.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0059, COMBUSTION STUDIES RELATING TO CETANE IMPROVERS, COMBUSTION CATALYSTS AND SMOKE SUPPRESSANTS
M.E. LEPERA, U.S. Army, Coating & Chemical Lab., *Aberdeen Proving Ground, Maryland*

Technical Objective: To investigate the compression-ignition combustion process and determine the effects and mechanisms of fuel and related additive properties on engine performance, exhaust emissions, and specification requirements.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0060, KINETICS OF NO AND CO FORMATION IN COMBUSTION GASES
J.C. KECK, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The mechanism of NO and CO formation in combustion gases will be investigated theoretically and experimentally. The theoretical program involves the developmett of a rate-controlled partial-equilibrium method for treating complex reacting gas mixtures. The method will be used to develop improved models of the freezing of NO and CO in Rankine cycle burners and during the expansion and blown of an internal combustion engine. The experimental program involves the development of improved diagnostic techniques for the detection of NO by absorption and scattering of light and the application of there techniques in shock tube studies of NO formation in hydrocarbon rich combustion products at high pressures. The formation of NO and CO in atmospheric pressure flames will also be studied in a burner designed to simulate the features of a Rankine cycle combustion chamber.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0061, 1970 SUMMER STUDY ON CRITICAL ENVIRONMENTAL PROBLEMS
C.L. WILSON, Mass. Inst. of Technology, School of Management, *Cambridge, Massachusetts* 02139

A summerstudy of four weeks is proposed for the month of July 1970 which will bring together about forty scientific and professional experts from many disciplines, and from the academic, government, and private sectors.

During the Study, the global climatic and ecological effects of pollutants in the atmosphere-ocean system will be analyzed, and procedures for understanding, monitoring, and abating these effects will be extensively explored. The Study will outline the types of focused research, monitoring and modelling programs which will be required tc obtain definitive knowledge about these effects. The pollutants to be considesed will include the following: CO2, particulate matter, combustion products, water vapor, heat, inorganic and synthetic compounds, and phosphorous-nitrogen-potassium.

Approximately 60 scientists will participate in the study with scientists from federal laboratories and various federal agencies included. About 40 scientists from non-federal institutions will participate. No participants from Eastern European nations are expected to attend.

SUPPORTED BY U.S. National Science Foundation

1.0062, EFFECTS OF GASOLINE VOLATILITY ON EMISSIONS AND DRIVEABILITY
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Complete cooperative research documenting the influence of gasoline volatility on emissions and vehicle driving characteristics.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0063, UPPER ATMOSPHERE AIRCRAFT EMISSIONS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Provide estimates of the emissions from supersonic and other aircraft operations in the upper atmosphere.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0064, PARTICULATE EMISSIONS FROM TWO-CYCLE GASOLINE ENGINES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Identify and qualify particulate emissions from two cycle gasoline engines.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0065, COMBUSTION PRODUCTS FROM THE INCINERATION OF PLASTICS
E.A. BOETTNER, Univ. of Michigan, School of Public Health, *Ann Arbor, Michigan* 48104

Combustion products of three plastics (polyimide, polycarbonate, and polysulfone) are currently being studied under various conditions of temperature and air supply and work on a fourth plastic (polyphenylene oxide) has been completed. Purposes of this research include determination of products which could be air pollutants or corrode equipment on incineration, analysis of products at various stages of the combustion process to aid those currently designing incineration systems capable of recovering by-products for their fuel or crude chemical value, and evaluation of the toxicity of combustion products. Work on polyethylene, polystyrene, and polyurethane are scheduled to begin shortly.

Polyphenylene oxide and polycarbonate present minimal pollution and corrosion problems as they break down almost completely to CO sub 2 and water under incineration conditions. Under deficient oxygen conditions, they depolymerize to form phenol and substituted phenols, small amounts of hydrocarbons, CO, CO sub 2 and water. The phenols are in condensed form and could be recovered. Polyimide forms CO sub 2, CO, water, ammonia, cyanides and oxides of nitrogen under incomplete combustion conditions. The nitrogen compounds can present a pollution problem. Polysulfone gives off SO sub 2 as well as CO sub 2, CO, water and hydrocarbons. It thus presents pollution and corrosion problems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0066, AIR STERILIZATION
D.R. HELDMAN, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00703)

OBJECTIVE: Isolate and investigate methods of controlling airborne microorganisms in food processing plants; determine mechanisms causing transport of airborne microorganisms from source to point of contamination; investigate methods of providing localized control of airborne contaminants.

APPROACH: Study food processing plant operations - processing and packaging and dispersion of bacterial aerosols in an enclosed space.

PROGRESS: Research during the indicated project period has dealt with improvement of air quality in enclosed spaces by (a) evaluation of potential sources of air-borne contamination, (b) factors influencing air-borne microorganism populations and (c) the description of surface deposition by small particles. The role of a flat surface as a source of air-borne contamination was determined by investigating mechanisms influencing removal of small particles (5-40 mu) from the d surface. The new two-part mechanism of particle re-entrainment was proposed and verified. Free-stream air turbulence was found to have a significant in-

fluence on the degree of particle re-entrainment. The results illustrate that flat surfaces of sufficient size can be a source of airborne particles even at low air velocities which exist in enclosed spaces. The influence of temperature and relative humidity on viability of air-borne Salmonella newbrunswick was investigated. Results indicated that death rate was decreased when skim milk was used in place of water as a suspension medium. The introduction of a bi-polar oriented electrical field into an enclosed space reduced the air-borne microorganism population by 37 to 62% depending on species present. The field tended to increase deposition on surfaces but increased death rates seemed to contribute, also. A mathematical expression to describe bacterial aerosol diffusion and deposition was developed. The influence of source height above deposition surface and aerosol generation rate on location of deposition was illustrated.

SUPPORTED BY Michigan State Government

1.0067, URBAN CLIMATOLOGY

D.G. BAKER, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-25-066)

OBJECTIVE: Provide a detail d study of the climate of metropolitan St. Paul-Minneapolis and surrounding rural area including local (on micro-) climates within. Investigation will be made into such questions as the actuality of a temperature differential and its magnitude between urban and rural sites, the influence of the city upon local precipitation, and the presence of a heat island its demarcation.

APPROACH: The investigation will be based upon the data available from the dense network of 24 cooperative observing stations and one Class A Weather Burea station, and also upon meterological data taken from moving vehicles specifically for this study.

PROGRESS: A special map of the Twin Cities metropolitan area was drafted that can be printed as either a station locator-plotting map or an analysis map. The area mapped is about 6300 square miles and the detail even includes township numbers. The Weather Bureau has printed several hundred copies of the weather analysis map for our use. The maps are required for the detailed study of the temperature and precipitation of the metropolitan area. Precipitation data from 4 different agencies were assembled and the acceptable data analyzed in detail for a 5 year period. Ten years data have been analyzed in less detail. The analysis is centered upon the areal distribution of precipitation within the metropolitan area. As a follow-up to a study on temperature inversions in an urban environment (see publication list), we are analyzing low-level temperature inversion data from a sod covered plot in a nearby rural environment.

SUPPORTED BY U.S. Dept. of Agriculture

1.0068, PARTICLE DYNAMICS

M.R. SMITH, Mississippi St. University, School of Engineering, *State College, Mississippi* 39762

This study is designed to determine the effect of meteorological conditions and engine characteristics on the diffusion of exhaust clouds produced by rocket engines. This program is motivated by personnel safety considerations and the desired result of the program will be a diffusion model that is capable of predicting gas concentrations profiles such that toxic exclusion distances may be reliably established.

Due to the complexity of the associated aero-thermodynamics phenomena, the development of a specific diffusion model appeared unfeasible; therefore, a numerical simulation of the diffusion process has been attempted using a high-speed digital computer. A two- dimensional numerical simulation model has been developed and programmed on a high-speed digital computer. The initial results indicate that the method has considerable potential. Presently the model is being programmed on a large computer so that the field size can be enlarged and grid size decreased. This should result in greater accuracy of the numerical simulation.

The experimental phase of this project is being conducted at the NASA-Miss. Test Facility, Bay St. Louis, Mississippi. During the past eight months, experimental data have been acquired on three (3) S-IC static firings. Photographic records have been made of the growth and dissipation of the associated rocket exhaust cloud and airborne acquisition of meterological data and cloud data has been employed to define the characteristics of the exhaust cloud. The airborne data acquisition system has been fabricated at the NASA Mississippi Test Facility utilizing an excess telemetry system. The system has been modified to permit simultaneous on-board recording and telemetry to the MTF Data Handling Center where the data are processed in real time.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0069, PARTICULATE POLLUTANT SYSTEM STUDY - MODIFICATION AND EXTENSION

VANDEGRIFT, Midwest Research Institute, *Kansas City, Missouri* 64110

Objective: Complete the study.

Description: The modification entails a time and money extension to the contract to permit the estimation of fine particle emissions from significant sources and the projection of these emissions through the year 2000. In addition an extension was requested by Midwest Research Institute to complete the present study. It is the purpose of this present study to estimate total particulate emissions and project these through the year 2000 and to tabulate the important particulate and carrier gas stream characteristics for each significant emission source.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0070, AEROBIOLOGICAL SURVEY IN THE NORTHERN ROCKY MOUNTAINS AND PLAINS

W.E. BOOTH, Montana State University, Graduate School, *Bozeman, Montana* 59715

This project now is going into its third year and has given measurements of the air borne particle load over natural grasslands in central Montana. Identifacation of pollen grains and most of the larger particles have been made; they have in turn been correlated with the plant community over which the samples were taken. Certain climatological data is associated with air borne materials in an attempt to explain the variation in the amount of the particulate air load.

The next phase of the project will be the examination of the smaller particles that are below the range of the light microscope. This study will make use of the electron microscope and the scanning electron microscope. Weights of the smaller particles per volume of air have been taken, but there is a need to substantiate these findings with another set of data.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0071, CONTROL AND USE OF FIRE PARTICULARLY IN WILDERNESS, PARK, AND OTHER RECREATIONAL AREAS

C.E. HARDY, U.S. Dept. of Agriculture, Intermtn. For. & Rg. Exp. Sta., *Missoula, Montana* 59801 (INT2102)

OBJECTIVE: Incorporate research findings into the most effective means of solving the fire control problems of wilderness, park, and recreational area management. Determine how to use fire in resource management and the fire retardant material characteristics most suitable for fire control.

APPROACH: Develop a problem analysis of wilderness, park, and recreational area management in reference to fire control needs. Determining use of fire for hazard reduction and other land management purposes. Screen fire retardant chemicals for suitability in fire control. Other research will focus on fire danger rating and its interpretation by user agencies.

PROGRESS: Investigations into the effects of ammonium sulfate and diammonium phosphate on pyrolysis and combustion of cellulose using thermal analysis methods show distinct differences. Ammonium sulfate decomposes at lower temperatures, and may be unavailable to alter reactions at the time glowing combustion occurs. Correlation of pyrolysis and combustion data with data being taken during wind tunnel burning tests may assist in understanding the overall effect of retardants on flammability. Replication of slash burning treatments within the western larch--interior Douglas-fir forest type confirmed our ability to predict:

(1) fuel consumption, (2) duff reduction, (3) water- can weight loss, and (4) convection column height from broadcast fires in 1-year-old fuels. Prediction equations derived from this large scale cooperative study are benefiting hazard reduction, tree regeneration, wildlife habitat, watershed, and air pollution control programs. An EDP program which computes and summarizes fire-danger indices is available to use with teletype collection of fire-weather data. A handbook being prepared will serve as a primary reference for installation, maintenance, and operation of fire-weather stations and instruments; it will be applicable nationwide.

SUPPORTED BY U.S. Dept. of Agriculture

1.0072, URBAN AIR POLLUTION AND CLIMATIC CHANGE
P. SQUIRES, Univ. of Nevada, Desert Research Institute, *Reno, Nevada* 89507

The underlying practical objectives of these efforts will be to measure the contribution of urban areas to the pollution of the atmosphere as reflected by the urban addition to the atmosphere of specific aerosols. A further practical objective is the assessment of the influence of specific pollutants on the formation and distribution of precipitation as a factor in climatic change resulting from urban contamination. Initially, direct physical measurements will be made of the meteorologically active particulate component in the contaminated plume of air generated in cities. This will be used to obtain an indication of the contribution of such particles to the atmosphere as a whole by the cities in the U.S. When this contribution is compared with natural production rates, it will give an estimate of the continental- scale significance of urban pollution in relation to the microphysics of clouds and the formation and distribution of precipitation, and thereby an estimate of the contribution of urban air pollution to climatic change.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0073, NATURAL CONCENTRATIONS OF SILVER AND IODINE IN PRECIPITATION
J.A. WARBURTON, Univ. of Nevada, Desert Research Institute, *Reno, Nevada* 89507

Ice core samples 3 ft. long by 3 inches in diameter will be collected at South Pole, Byrd, Siple and McMurdo in austral summer 1971- 72 in order to determine absolute concentrations of silver and iodide at points in Antarctica and to compare the efficiency of methods of removal of particulate matter from the atmosphere. The methods by which particulate matter is removed from the atmosphere include wash out, rain out, diffusional collection by sublimation, electrification, riming, and vapor pressure gradients. The precipitation forms at a coastline or inland station are very different; riming being a coastal phenomena whereas diffusional growth accounts for practically all the precipitation at inland stations. The different growth characteristics may result in different scavenging properties for different particles. Deep cores will be used to establish natural base line, pre large scale weather modification seeding, levels of atmospheric sodium and iodine. Comparison will be made with samples from seeded and unseeded lower latitude areas in order to learn about the N-S transport of seeding materials which could have effect on climatic changes, the ecological and sociological effects which may result, and on military applications and international relationships. The silver and iodine will be extracted by ion exchange methods and their quantities determined by neutron activation analysis. The analysis technique includes activation of a known standard of silver and iodine at the same time as the unknown thus obviating changes which could occur in thermal neutron flux, transfer time, counting geometry or other unknown variables.

SUPPORTED BY U.S. National Science Foundation

1.0074, NITROGEN-OXIDE KINETICS IN AUTO COMBUSTION EXHAUST
R.F. MCALEVY, Stevens Institute of Technol., School of Engineering, *Hoboken, New Jersey* 07030

Nitric oxide (NO) is emitted as a combustion product in modern, automotive internal combustion engines. In centers of high population density there is mounting evidence of a health hazard caused by this air pollutant.

Experiments conducted to date using a mechanical analog for the spark-ignition engine, have yielded data on the steady state concentrations of nitric oxide inside the cylinder at different fuel-air ratios, initial pressures and temperatures following different rates of combustion product expansion.

During the period of the continuation of the grant, work will continue on obtaining time resolved concentration data during combustion at different distances from the center of the piston simulator. Work will also continue on the theoretical model which would predict the spacial and temporal variations of the nitric oxide concentration inside the simulator during compression and expansion. Fuel-air concentration mixtures will be the same as they exist in a high compression engine.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0075, GASOLINE COMPOSITION AND VEHICLE EXHAUST GAS POLYNUCLEAR AROMATIC CONTENT
T.W. STANLEY, Standard Oil Co. of New Jersey, *Linden, New Jersey* 07036

Determine the emission rates of polynuclear aromatic hydrocarbons and phenolics as these rates are influenced by: fuel composition, engine operating variables, and exhaust emission control systems. Determine the effect of the following factors on the emission of selected polynuclear aromatic and phenolic compounds: (1) The effects of lead antiknock (a) instantaneously, as a result of its presence in the fuel being tested, and (b) long-term as lead residues appear in deposits, or disappear by extended use of reduced-and zero- TEL gasolines. (2) The effects of increased fuel aromatics content. (3) The effects of fuel PNA content. (4) The effect of heavy catalytic naphtha as a potential source of high-boiling aromatics that are not PNA, but may act as PNA precursors beyond their expected contribution to overall aromaticity. (5) The effect of current exhaust emission control systems. (6) The effect of any available advanced exhaust emission control systems (7) The effect of NOx reducing systems.

Routine measurements of total hydrocarbons, CO, CO2, and NOx will be made.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0076, CHANGING VEGETATION AND ATMOSPHERIC POLLEN
M.F. BUELL, Rutgers the State University, School of Arts, *New Brunswick, New Jersey* 08903

This work has been directed at describing changes in atmospheric pollen and vegetation which have occurred with the recent suburbanization of northeast New Jersey. It has utilized data from past and present aeroallergen surveys taken daily by gravity slide and rotoslide methods; data derived from pollen deposited in the sediments of man-made lakes; and data from contemporary pollen produced in various land-uses including rural, suburban, and urban land-uses.

Past aeroallergen surveys and reservoir sediments indicate declining weed pollen production with changeover from rural to urban land-uses. Strongest in grass pollen and weakest in ragweed pollen, this phenomenon is also evident in contemporary land-uses, but to a lesser degree than in the past.

To provide local allergists with the details of northeast New Jersey's recent atmospheric pollen history, the relationship between land-use and atmospheric pollen in both the past and the present, and to provide an up-to-date calendar of local pollination the authors are presently writing a manual for the allergists of northeast New Jersey which encompasses these topics as well as illustrating for identification purposes the types of pollen encountered in routine pollen sampling in this region.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0077, ARAP MODEL
C. DONALDSON, Aeronautical Res. Associates, *Princeton, New Jersey* 08540

The method of 'invariant' modeling, as developed by ARAP, will be further developed to the stage where it can be specifically applied to the calculation of the dispersion of an inert pollutant released into the lower layers of the atmosphere, under various conditions of atmospheric stability. Theoretical results will be compared with observational data.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0078, INCINERATION--COMBUSTION OF PLASTICS, FILMS, ETC.
T. ROTHMAN, U.S. Air Force, Weapons Laboratory, *Albuquerque, New Mexico* 87117

Technical Objective: The objective of this study is to determine the gaseous products resulting from the incineration of the plastics found in municipal refuse. Results will determine need for Air Pollution Control techniques or devices to reduce pollution potential from the burning of plastics. Techniques and information will be applied to studying the combustion products, and need for their control, generated by the incineration of film.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0079, TRAVELS OF AIRBORNE POLLEN
E.C. OGDEN, New York State Mus. Serv., *Albany, New York*

The basic objective of the proposed research is to gain a better understanding of pollen dispersion, transport and removal in the atmosphere. This objective includes four separate but related aspects: 1. Study of pollen dispersion over intermediate distances (tens of miles) and heights to ten thousand feet using an aircraft-mounted isokinetic sampler. 2. Continued study of the efficiency of forested areas and strips of vegetation, comparable to greenbelts or shelter- belts, for filtering pollens and other particulate matter from the atmosphere. 3. Study of the variation in time and space of natural pollen concentrations at both rural and urban locations, not directly influenced by local sources, to determine peak to mean concentration ratios over various sampling intervals and to assess the representativeness of single station measurements. 4. Continued study near local sources of the diurnal pollen emission patterns of plants producing potentially allergenic pollens and variation in concentration with height, time, source, location, terrain, vegetation and weather.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0080, MECHANISM FOR THE WATER-TO-AIR TRANSFER AND CONCENTRATION OF BACTERIA
D.C. BLANCHARD, State University of New York, Graduate School, *Albany, New York* 12203

This proposal is for research to investigate the transfer of bacteria to the surface of water from underneath and thence to the air by bubbles which rise in the water and then break at the surface ejecting droplets into the air.

Experiments by the principal investigator have shown that in this way, bubbles can transport organic matter from the main body of the liquid to the surface layer and then transfer it thence to the air. Such droplets have been found by the principal investigator to contain 10 to 1000 times the concentration of bacteria found in the body of water and this concentration varies with droplet size.

A series of experiments will investigate concentration droplet size effect, the ratio of live to dead bacteria, and the effects of different or multiple bacteria species. Bubbles are easily produced in natural bodies of water and this mechaaism for the concentration and transfer of bacteria or possibly virus to the atmosphere could be of considerable significance.

SUPPORTED BY U.S. National Science Foundation

1.0081, ELECTRIFICATION OF DUST STORMS
A.K. KAMRA, State University of New York, Graduate School, *Albany, New York* 12203

The objective of this research is to clarify the mechanisms of charge generation, to gatner data on the electrical characteristics of dust storms, and to estimate their contribution to the electrical budget of the atmosphere. A program of field and laboratory experiments is proposed.

The laboraory experiments will involve the movement of dust by air and the measurement of the charging that occurs under controlled yet variable conditions.

The field experiments will be conducted at an appropriate region in the Southwest where dust storms occur with reasonable frequency. Potential gradient, point discharge currents and space charge will be among the variables measured together with wind speed, temperature and humidity.

SUPPORTED BY U.S. National Science Foundation

1.0082, A STUDY OF THE FACTORS CONTROLLING THE FORMATION OF LARGE NUMBERS OF CONDENSATION NUCLEI IN CLEAN GLOBAL AIR
V.J. SCHAEFER, State University of New York, School of Arts, *Albany, New York* 12224

The objective of this research is to investigate the apparent strong enhancement of condensation nuclei by turpenes in apparently clean air. Evidence supports that turpene vapor polymerizes clusters of molecules to form condensation nuclei in very high quantities in air which originally had a low nuclei content.

Field studies, including the effects of light on these phenomena, will be carried out in the Adirondacks and at Schenectady airport. Laboratory studies will be performed in the large fog chamber at SUNYA (State University at Albany).

SUPPORTED BY U.S. National Science Foundation

1.0083, NON-EQUILIBRIUM EFFECTS IN AN INTERNAL COMBUSTION ENGINE
W. CHINITZ, Cooper Union, School of Engineering, *New York, New York* 10003

Analyses of samples of the exhaust gas from internal combustion engines indicate substantial departure from equilibrium for species such as nitric oxide and carbon monoxide, leading to larger quantities of these species than would be predicted. In this investigation, we will determine the non-equilibrium composition and thermodynamic properties of the combustion gases at various points in the engine cycle, with the objective of relating the quantities of unburned hydrocarbons and oxides of carbon and nitrogen to the engine operating variables. Analytical, as well as experimental verification of the effects of the engine variables on the production of atmospheric pollutants will be sought. Methods for reducing the level of these pollutants by altering the kinetics of the combustion process will be determined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0084, CRC AIRCRAFT EXHAUST STUDY GROUP
M.K. MCCLEOD, Coord. Research Council, *New York, New York*

Participate in joint activities with aircraft powerplant manufacturers, aviation fuel producers and other government representatives on cooperative studies designed to evolve acceptable techniques for obtaining all types of emissions data from aircraft.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0085, DOCUMENT ODOROUS CONSTITUENTS IN DIESEL EXHAUST
A.E. ZENGEL, Coord. Research Council, *New York, New York*

Continue with research presently in progress under joint sponsorship of CRC-APRAC Project Group CAPE-7 on the isolation and identification of specific odor-causing materials in diesel exhaust. Document in terms of odor qualities or types and develop similar odor measurement techniques.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0086, FORMATION OF THE STRATOSPHERIC AEROSOL
J.P. FRIEND, New York University, School of Arts, *New York, New York* 10003

The objective of this research is to continue an investigation into the mechanisms of formation of stratospheric sulphate aerosol. A laboratory system has been designed and built and the generation of particles at ground level temperatures and pressures investigated. The research vessel can be evacuated down to 10 to minus the 3rd power torr and can be maintained at a fixed temperature over a wide range. Low concentrations of gases such as sulfur dioxide and ammonia are introduced through permeation membranes. Photochemical reactions can be studied and particles created by such reactions are monitored through a sampling manifold by scattering techniques or by a condensation nuclei counter.

The proposed research will continue to test the ability of various combinations of possible reactions and reactants to produce particulate sulphates and to study in detail the kinetics of the more significant reactions. Model studies will be performed of the effects of eddy diffusion and reaction rates on the distributions of sulphate in the stratosphere. The effects of volcanic emissions of sulfur dioxide on the stratospheric aerosol will be considered.

SUPPORTED BY U.S. National Science Foundation

1.0087, TRANSVERSE JET PLUMES

J. HALITSKY, New York University, School of Engineering, *New York, New York* 10453 (AT(30-1)3673)

The object is to obtain velocity and concentration distributions in the jet region of a chimney plume under several wind turbulence conditions. No full-scale and few wind tunnel experimental data are available for development of good mathematical models of this region of the plume. Tests will be run on a 30 m high stack in the atmosphere and a model of the stack in the wind tunnel. The tunnel air stream will be oscillated to simulate the low frequency components of the atmospheric spectrum of azimuthal fluctuations. Concentration tracers will be sulfur dioxide for both field and tunnel tests. Atmospheric turbulence will be measured by Vectorvane. Tunnel turbulence will be measured by constant temperature hot-wire anemometer. Spectrum analysis of long period oscillations will utilize a special frequency step-up system and a standard wave analyser.

Results: All experimental facilities and equipment have been completed. Field sample analysis procedures have been successfully applied in wind tunnel tests.

SUPPORTED BY U.S. Atomic Energy Commission

1.0088, SULFUR DIOXIDE OXIDATION

J. HAPPEL, New York University, School of Engineering, *New York, New York* 10453

The objective of this research is a study of the mechanism and kinetics of the catalytic oxidation of sulfur dioxide. The oxidation of sulfur dioxide is important as a means of conversion of this material in stack gases to sulfur trioxide which may then be removed as sulfuric acid. Although this problem has been studied extensively there is still no general agreement as to the mechanism involved. In the course of the present investigation we have found that the use of isotopic tracers such as 35S show great promise in better understanding this process. It appears that at low concentrations of sulfur dioxide the mechanism is different that at the higher concentrations normally employed in industrial conversion of sulfur dioxide for sulfuric acid manufacture. It would be desirable to extend these studies further employing super 18 O as a tracer to further narrow down the mechanistic sequence involved. Work during the final year of the current project will accomplish this. A versatile tool will then be available to screen various materials as possible catalysts which it is hoped will lead to techniques for economical conversion of sulfur dioxide in stack gases and their removal as sulfuric acid. Another application will be the establishment of the mechanism involved in oxidation of sulfur dioxide by atmospheric particulates to arrive at better understanding of the processes governing sulfur dioxide conversion in nature.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0089, THE USE OF LEAD-210 TO TRACE TRANSPORT PROCESSES IN THE FREE ATMOSPHERE

W.S. BROECKER, Columbia University, Graduate School, *Palisades, New York* 10964

The objective of the proposed research is to test the usefulness of lead-210, which has its source in the troposphere, as an atmospheric tracer for transport processes within the lower stratosphere and between the troposphere and the stratosphere.

The proposed measurements will indicate whether certain well documented atmospheric events, which occurred in 1963 and 1964, which should have affected the distribution of lead-210 did indeed so. These events were: 1. Changes in the circulation of the northern polar stratosphere in 1964-1965. 2. The advection of air into the lower polar stratosphere in January 1963 ('sudden warming'). 3. Changes in stratospheric circulation which apparently caused a rapid influx of bomb debris into the stratosphere in late 1963.

Measurements will be made on filter samples collected between 1962 and 1966 in the stratosphere and troposphere as part of Project Stardust. Four hundred filter samples will be analyzed by a procedure which involves the measurement of the daughter product polonium - 210. This procedure has worked successfully on a previous 200 samples.

SUPPORTED BY U.S. National Science Foundation

1.0090, STUDY BY CONTRACT THE INDOOR-OUTDOOR POLLUTION RELATIONSHIPS AT AN AIR-RIGHTS STRUCTURE AND A CANYON TYPE STRUCTURE

W. GILES, General Electric Company, *Schenectady, New York* 12305

Objective: Define the relationship of indoor-outdoor pollution concentration in an air-rights and canyon structure where people are exposed to high automotive emissions.

Approach: The contractor will measure concentrations of CO, total hydrocarbons, particulates, TSP and lead as well as traffic density and meteorological conditions at two districtly different constructed roadway-housing conditions during a heating and non-heating season.

Goal: Complete the study of the George Washington Bridge Apartments in New York City and begin study of a canyon-type structure also in NYC.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0091, ECOLOGY AND MARINE SCIENCES, METEOROLOGICAL AND AIR POLLUTION RESEARCH PROGRAM

M.E. SMITH, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

The program is concerned with the structure of the lower atmosphere and to the behavior of gases and particles within it. The program is undergoing redirection toward study of both meteorology and dispersion on a 100-km scale. The site of the study will be the New York-Long Island area, and the emphasis will be on the understanding of the influence of urban structure and thermal characteristics on meteorological variables, and through the mechanism of wind structure and turbulence, on the dispersion of pollutants. Conversely, the behavior of pollutants will shed light on the meteorological processes. The Group effort associated with other Laboratory programs on CO2, SO2 and atmospheric aerosols will increase sharply also.

Results: Planning of the study in the transvective range has already begun, and preliminary studies based on the existing meteorological and air quality data will begin during FY 1970.

SUPPORTED BY U.S. Atomic Energy Commission

1.0092, SULFUR DIOXIDE DECAY

UNKNOWN, Brookhaven Natl. Lab., *Upton, New York* 11973

Field studies will be carried out Keystone and Honer City power stations (LAPPES Project sites)to describe the generation, transport,diffusion and chemical reaction of sulfur pollutants

emitted into the atmosphere from the tall (soft) stacks at the power generation facilities. Sulfur ratio (S32/S34) and other trace gases will be used to assess the residence time of sulfur compounds in the atmosphere.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0093, ASSIST OCS IN THE DEVELOPMENT OF COMPUTERIZED SYSTEM FOR PROJECTING MOTOR VEHICLE EMISSIONS AND SUPPLY ADJUNCT ANALYSES

J. BEATY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop and maintain a computerized system for vehicle emissions on a nation-wide basis.

Approach: The emissions will be estimated by examining available statistics on vehicle distribution, projected travel requirements, and characteristics, vehicle speeds and other factors, and combine these with legislated or anticipated emission regulations. This system will allow the projection of motor-vehicle generated CO, HC, NOx, and particulates for the nation as well as selected regions.

Goal: Gather information on projected travel requirements, vehicle age and type, average route speed, and road conditions, and assist in the updating of previous projections.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0094, ODOR ISOPLETHS AND TRANSPORT MODELS

R.C. DICKERSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop isopleth models for odorants from various industrial sources.

Approach: Several techniques for deriving odor isopleths will be investigated. Initially, both the frequency and intensity patterns of odorants will be delinated. The area and population subjected to odorants will be determined so that impact in terms of social or economic response can be measured.

Goals: To develop a method for predicting areas subjected to odorants from various sources.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0095, PROVIDE INFORMATION ON EMISSIONS FROM NUCLEAR FACILITIES

G. DUGGAN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop and maintain information, statistics, and projections on emissions from nuclear facilities.

Approach: One person is assigned to Bureau of Radiological Health to begin to translate their information into a format compatible with NAPCA's emission reporting requirements.

Goal: Develop in-house capability to assess emissions from nuclear facilities.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0096, TESTING OF CONVENTIONAL AND EXPERIMENTAL OIL AND GAS BURNERS

R.H. HALL, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To establish critical destillate burner design parameters in pollutant emission.

Description: Test work will continue to evaluate commercially available burners used in domestic heaters, and will be extended to residual oil-fired burners used in commerical and industrial boilers. In addition to these conventional burners, studies will be made of distillate oil-fired prototype or experimental burners to define what design characteristics of parameters are critical in the emission of pollutants, such as nitrogen oxides and carbon particulate.

These studies will utilize various analytical techniques such as temperature and pressure Probes, thermal photography, high temperature pitot-tubes, and cold flow tracers to relate the burners dimensions to general flame characteristics, (i.e., temperature, turbulence, mixing, and atomization). These correlations will lead to design criteria which can be applied to control emissions from any distillate oil-fired burner and will be useful as a mode for studying burner design-emission levels in other fossil fuel-flame combustion systems.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0097, CHARACTERISTICS OF PARTICULATE EMISSIONS IN AUTO EXHAUSTS - DESIGN AND TEST SIMPLIFIED SAMPLING SCHEME

R. HERLING, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Current emphasis is on development of sampling and measurement technology to facilitate required studies and compliance testing. Several alternate sampling arrangements are being considered. Use of piezoelectric microbalance will be evaluated. Experiments will include size distribution and chemical analyses for important particulate components (Pb, Cl, Br, S, Fe, carbonaceous matter, etc.).

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0098, UPDATE NAPCA DATA FILE OF NATION-WIDE EMISSIONS

A. HOFFMAN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To provide current information on nation-wide emissions of the major air pollutants.

Approach: Compile statistics on motor vehicle travel, fuel consumption, refuse disposal, industrial activity, and other indicators of pollutant emissions such as degree of control. Using average emission factors, calculate emissions of SOx, particulates, CO, HC, NOx Pb, F, asbestos, cadmium, and nickel.

Goal: Re-issue 'NAPCA Data File of Nation-wide Emissions' publication for 1969.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0099, EVALUATION OF CONTRIBUTIONS OF VEHICULAR EXHAUST AND OTHER SOURCES TO ATMOSPHERIC LOADINGS OF POLLUTANTS IN THE N.Y.C. - N.J. AREA

S.L. KOPCZYNSKI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Samples from tunnels and highways will be analyzed to serve as references for vehicular exhaust composition. These samples and previously collected air samples from various localities will include analyses for paraffins, olefins, aromatics, acetylene, CO, NO2, SO2, ozone and aldehydes. Mathematical and statistical tests will be made on data from the air samples to obtain estimates of source contributions (particularly vehicular exhaust), estimates of rates of decay of pollutants in the atmosphere, and evidence of transport of pollutants.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0100, ENGINEERING STUDIES RELATED TO THE TECHNIQUES AND INSTRUMENTATION USED FOR FUEL AND FUEL ADDITIVE EVALUATIONS

M.W. KORTH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Provide vehicles, dynamometer equipment, and operating personnel to support gasoline composition and additives studies. Analyze and report gaseous emission levels for CO, CO2, HC, NOX, and O2 as required.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0101, COMPLETE THE ENGLAND SMOKESHADE - U.S. PARTICULATE COMPARISON STUDY

R.E. LEE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To complete assessment of England Smokeshade Data as compared to U.S. measurements by hi-vol membrane filter, cascade impactor and tape samplers. This will permit equat-

ing health effects studies included in NAPCA's particulate criteria document.

Approach: After weighing particulate samples compare all data obtained with appropriate statistical analysis.

Goal: Complete the gravimetric analysis of collected samples, and perform statistical comparisons of smokeshade vs hi-vol and other particulate data. Prepare report, and subsequently, complete study to completely characterize samples taken. A report will be completed delineating the interrelationships of the U.S. and British particulate measurement methods to provide support for the NAPCA particulate criteria document.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0102, EVALUATION - CAVEN POINT OPEN PIT INCINERATOR

C.S. MANERI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

This unit is a proto type subject to broad evaluation because of the flexibility of its design. A complete evaluation, including stack testing, will be undertaken in FY 71. Teams of other agencies, as well as involvement of Laboratory Branch, Engineering Branch and Federal Facilities Branch personnel will be used.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0103, URBAN RADIATION

J. PETERSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Radiation stations will be located in and around Raleigh, N.C. Each station will measure incoming and outgoing solar and terrestrial radiation. Broad-band spectral measurements of the incoming solar radiation will be attempted to isolate the absorption effects due to water vapor in the near infrared, and due to various pollutant gases (NO_2/O_3) in the ultraviolet.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0104, DATA ANALYSIS OF LAPPES

F. POOLER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Complete analyses of all available LAPPES - Keystone data to determine and describe: a. Sulfur dioxide plume concentrations distributions and plume behavior under selected weather conditions, i.e., stable and unstable cases. b. Sulfur dioxide concentrations distributions and frequencies in the vicinity of the Keystone Power Plant, i.e. a climatological appraisal. c. Representativeness and utility of standard observations for calculating ground-level concentrations.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0105, DETERMINATION OF THE EFFECTS OF FUEL ADDITIVES ON VEHICULAR EMISSIONS

J. SIGSBY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

To determine the fate of fuel additives in combustion and, as required by the 1967 Clean Air Act, to determine their effects on other emissions from motor vehicles. In this year the emphasis will be on the effect of lead removal.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0106, DEVELOP AND MAINTAIN AN INFORMATION SYSTEM ON NATION-WIDE EMISSIONS FROM GASOLINE FUEL ADDITIVES

J. SMITH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To provide information on nation-wide emissions from gasoline fuel additives.

Approach: Through contact with gasoline manufacturers, and various taxation agencies, collect information on gasoline sales, and combine this data with additive concentrations which are supplied to DA under the registration program, to yield information on nation-wide emissions of the various chemicals. This activity also entails development of computer procedures for systematic data handling.

Goal. Produce first report on estimated quantities of pollutants released as a result of using gasoline fuel additives.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0107, DEVELOPING TIME-CONCENTRATION MATHEMATICAL MODEL FOR VARIOUS POLLUTANTS

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Using frequency distribution and other mathematical concepts, develop and up-date models describing air quality in representative AQCR's.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0108, EVALUATE FEASIBILITY AND NATURE OF A POSSIBLE PARTICULATE STANDARD FOR MOTOR VEHICLES

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

In addition to the reduced visibility brought about by the atmospheric photochemical interacton of HC and NOx in motor vehicle emissions, motor vehicle exhaust contains particulate matter which contributes directly to the particulate loading of the atmosphere. This is made up of the residues from additives introduced into the fuel, such as lead, as well as imcompletely combusted fuel itself. Solution of the problem could depend on the determination of the nature and relative importance of these various sources. For example, should the additive residue prove to be the important factor, it may be more appropriate to control its use in the fuel than its existence in the exhaust.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0109, DEVELOP ATMOSPHERIC MODELS

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Utilizing dispersion and kinetic mechanisms, develop models for relating emissions to air quality.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0110, EMISSION FROM THE PHOSPHATE FERTILIZER INDUSTRY - ANALYSIS OF SAMPLES

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Determine the applicability of sampling trains for measurement of gaseous and particulate fluorides. Analyze source samples including scrubber water and raw materials for content of fluoride, phosphate, and total particulates.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0111, EMISSIONS FROM THE PULP AND PAPER INDUSTRY - ANALYSIS OF SAMPLES

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Provide standard gases and delivery systems for calibration of gas analyzers. Analyze source samples for content of total particulates, Na, Ca, and SO_4. Develop and provide methodology and equipment for measuring odor dilution threshold. Test the applicability of the particulate sampling train to measurement of particulates in effluents from the lime kiln and other unit operations.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0112, SOURCE TESTS OF PULP AND PAPER MILLS

E.J. VINCENT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Stack tests will be performed at 2 or 3 West Coast pulp mills. Particulate tests will be performed on recovery furnaces, lime kilns and smelt tanks. Ca, Na, SO_4 and total particulates will be

determined. Gaseous sulfur compounds will be analyzed and measured by a gas chromatograph, and other gas analyzers mounted in a mobile van. Odor dilution threshold will be determined and related to concentration of specific pollutant emissions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0113, WRITE REPORT OF PULP AND PAPER STUDY
E.J. VINCENT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Tabulation and analysis of questionnaire data will be completed and 3/4 of test results will be evaluated. Twenty-five percent of a first draft will be completed.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0114, MODEL RESIDUAL OIL COMBUSTOR
J.H. WASSER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine critical operating and emission parameters in a residual-fired boiler.

Description: The model heavy oil combustion system will be studied to determine the effects of various critical combustion parameters on air pollutant emissions. Those which will be varied are: air-fuel ratio, high temperature gas reaction intensity, fuel pre-heat temperature, and fuel composition. Fuel types rested will range from 02 light distillate through and including 06 residual oil. Air pollutant emissions measured will include: carbon monoxide, total gaseous hydrocarbons, sulfur dioxide, sulfur trioxide, nitric oxide, filterable and condensable particulate, and Bacharach smoke number. Flue gas concentrations of oxygen and carbon dioxide will also be monitored. The special burner designed for this model system will permit a wide range of air-fuel mixing turbulence conditions to be simulated and enable determination of the critical design parameter values in pollution control for heavy oil combustion burners. Later studies will investigate the NOx and carbon particulate control techniques, staged conbustion and flue gas recirculation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0115, ATMOSPHERIC DUST AND MOLD SPORE STUDIES
L.J. SCHERMEISTER, U.S. Veterans Administration, Center, *Fargo, North Dakota* 58102

A five year study has been conducted on the atmospheric incidence of dust in mold spores in North Dakota and nine westerm counties of Minnesota. During this study at the Fargo station it was determined that all veterans who had worked in grain who were included in the study had done so only after serving their time in the armed forces. It was also noted that the amount of organic and inorganic material to which personnel were exposed was extremely high in and around the grain elevators.

Since it has been shown by several authors that these inorganic substances are not dissolved by lung fluids, this continuing study will develop a method to determine the type and amount of inorganic material on the sample slide by means of spectrographic analysis. The total amount of inorganic material at the seven stations in North Dakota and Western Minnesota has been collected on petroleum smeared glass slide. The slide will be washed with pertroleum ether into a small vial, and then the residue dissolved in concentrated HNO3 and diluted with a few cc of H2O and read in a flame spectrophotometer. This would determine inorganic Pb.,Hg., Ag.,P.,S.,etc.

Should any of the data reveal striking regionalization or distribution of any particulate matter of inorganic nature, an attempt could then be made to correlate it with veterans coming from these areas.

SUPPORTED BY U.S. Veterans Administration

1.0116, PILOT PLANT COMBUSTION TESTS OF LIGNITE AND WESTERN COALS
J.L. ELDER, U.S. Dept. of the Interior, Bureau of Mines, *Grand Forks, North Dakota*

The purpose of this project is to study lignite combustion problems, especially those relating to ash fouling in a 75 lb/hr pilot plant furnace and to develop engineering data which will help to alleviate the problems in commercial boilers; and concurrently, as feasible, to use the equipment to study stack emission problems in connection with air pollution.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0117, COMBUSTION TESTS OF LIGNITE AND WESTERN COALS
J.L. ELDER, U.S. Dept. of the Interior, Bureau of Mines, *Grand Forks, North Dakota*

It is the purpose of these tests to correlate operation of the pilot plant combustor with operation of commercial pc-fired equipment. Maintain close contact with electric generating plants burning lignite and other Western coals particularly those that are experiencing fouling problems.

To study ash fouling and air pollution problems relating to combustion of lignite and other Western coals. Tests will be run with a 75 lb/hr pilot plant furnace in an attempt to develop engineering data which will help alleviate problems being experienced in commerical boilers.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0118, KINETICS OF SULFUR-OXIDE FORMATION IN FLAMES
A. LEVY, Battelle Memorial Institute, *Columbus, Ohio* 43201

Kinetic processes in the H2S and COS flames are being examined and developed using flame microstructure techniques. The oxidation of H2S in flames appears to occur through several steps involving the sulfur- containing intermediates SH, S2, SO and SO. The latter three intermediates have been detected in mass spectrometric analyses of samples taken from H2S flames, and appear in the flames in the order given. Mass spectrometric data also indicate that H2O2 may be forming early in the flame reactions. An H2S oxidation mechanism consistent with the observed order of appearance of the intermediates in the flame is presently under consideration. Data from COS flame studies indicate the presence of a considerably smaller quantity and fewer number of intermediates in this flame. Additional flame probings are being carried out at the present time to further clarify the role of intermediates in COS flames.

Studies of the formation of SO3 in H2S and COS flames have shown that the formation of SO3 is pressure dependent in accordance with the three-body reaction SO2 plus O plus M equals SO3 plus M, the amount of SO3 increases with increasing pressure in the system. Attaching hydrogen to the sulfur atom in a fuel decreases the amount of SO3 formed in the system at a given pressure. O-atoms also tend to decrease the amount of SO3 formed in the system through the reaction, SO3 plus O equals SO2 plus O2. This reaction is significant in flames at pressures below 250 torr and at the higher temperatures encountered in the regions beyond the visible flame zone. Rate constants have been determined for the SO3-O reaction which gave an activation energy of 12.0 plus or minus 1.5 kcal/mole for the SO3-O reaction.

Next year's work will involve a detailed study of the oxidation of sulfur compounds in flames supported by dydrocarbon fuels such as CH4. This system will allow one to study sulfur oxidation processes under conditions more closely simulating those found in commercial firing units.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0119, 5 - YEAR BATTELLE COMBUSTION STUDY
D.L. LOCKLIN, Battelle Memorial Institute, *Columbus, Ohio* 43201

This study is established to determine the long range research program required to yield a thorough understanding of combustion processes and how they relate to air pollution emissions and their potential control. Since the current state of the air knowledge of combustion and how it relates to air pollution is not sufficiently developed, this project will encompass the gathering

of background information on combustion research which will be the basis for laying out a 5 year program to fill gap areas described.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0120, EFFECTS OF IMPROVED FUEL ATOMIZATION - VAPORIZATION AND MIXING ON EMISSIONS FROM MOBILE SOURCES
D.L. LOCKLIN, Battelle Memorial Institute, *Columbus, Ohio* 43201

Project objectives include laboratory verification of analytical data and carburetor design requirements developed under an FY 69 program with Battelle Memorial Institute. This will include determination of the interaction of fuel droplet size, manifold geometry, and system vaporization characteristics over a range of conditions existing in an automotive induction system. This information will then be used to select, design, and build a carburetor to meet the design requirements. FY 70 funding includes the development of methods for measuring induction-system mixture properties.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0121, TURBOPROPULSION ENGINE EXHAUST EMISSIONS INVESTIGATION
E.E. HIVELY, U.S. Air Force, Aerospace Propulsion Lab., *Dayton, Ohio*

Technical Objective: To investigate in a systematic way the combustion products emitted by Turbo-Propulsion engine systems which may contribute to pollution or contamination of the atmosphere. Both afterburning and nonafterburning systems will be examined.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0122, AN ENGINEERING STUDY OF LP GAS AS AUTOMOTIVE FUEL
J.R. ALLSUP, U.S. Dept. of the Interior, Bureau of Mines, *Bartlesville, Oklahoma*

Purpose: To obtain engineering data on the relationship between emission levels and engine adjustments using propane as fuel; to the extent possible to describe the potential and practical application of propane as automotive fuel for clean air requirements.

Method: Using propane as fuel, measure emissions from three vehicles representing, respectively, light-delivery, high production passenger, and general-utility categories. Obtain comparative data using three gasolines--(1) national average composition, (2) as preceding except with C sub 4 and C sub 5 olefins replaced with corresponding saturates, and (3) a prototype unleaded fuel. Conduct work at two temperatures, 20 degrees and 85 degrees F, and generate samples operating vehicles on a chassis dynamometer using simulated traffic cycle typical of city driving.

Achievements 1969-1970: Results not ready for reporting. Progress to be reported in the fall of 1970 and completed in the spring of 1971.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0123, EFFECT OF FUEL VOLATILITY ON AUTOMOTIVE EMISSIONS
B.H. ECCLESTON, U.S. Dept. of the Interior, Bureau of Mines, *Bartlesville, Oklahoma* 74003

Purpose: To determine the overall effect on vehicular emissions in changing volatility levels in the light end of motor gasoline.

Method: Evaporative losses from the fuel system of a fleet of vehicles are measured during operations typical of the vehicles' use. Tailpipe emissions are measured during the same period of use. Total vehicular emissions are related to the volatility of fuel with which the emissions are associated.

Achievements in 1968: Results showed that volatility reduction reduced both the quantitative total of exhaust and evaporative losses and the photochemical effect from these emissions. Replacing the olefin in the front end of the fuel with no change in volatility did not change the quantity of total hydrocarbon emissions but did reduce the photochemical effect of these emissions. The reduction in photochemical effect by olefin replacement was greater than the reduction from lowering fuel volatility to the lowest level considered in this study.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0124, PRODUCTS OF COMBUSTION OF DISTILLATE FUELS FOR MOTIVE POWER
R.D. FLEMING, U.S. Dept. of the Interior, Bureau of Mines, *Bartlesville, Oklahoma*

Purpose: To improve knowledge of the products of combustion from diesel and turbine engines using distillate-type fuels; to describe the interacting influences of fuel composition and engine parameters on smoke, odor, and other exhaust products that are objectionable as air pollutants.

Method: For the odor study, continue work on analytical proceduresto complex, isolate, and subsequently regenerate aldehydes. Continue the study of engine variables and fuel composition as factors governing the character and quantity of diesel emissions. Continue work on development of a procedure to measure photochemical reactivity of diesel emissions. When an acceptable procedure is realized, generate information as feasible on the reactivity of 'typical' diesel exhausts to better define the contributions of diesels to photochemically affected areas. Install a small gas turbine; using exhaust from this gas generator as sample, continue work adapting and refining procedures for turbine emission measurement.

Achievements 1969-70: A dynamic odor generator was built and produced gas carrying a good approximation to diesel exhaust odor. The carbonyls present in exhaust were shown to be largely the lower aliphatic aldehydes and aromatic aldehydes. Exhaust NOx was found significantly reduced with decreasing intake air temperature; up to 60 pct reductions in NOx emissions were realized with 20 pct recirculation of cooled exhaust; NOx and smoke emissions were strongly influenced by injection timing. None of the variables significantly reduced unburned HC or odor. Preliminary and highly tentative findings in a study of diesel exhaust reactivity show diesel exhaust and gasoline exhaust to have roughly comparable HC reactivities. Working with cooperators, aircraft turbine emissions were successfully measured; HC and RCHO emissions were found to be significant during the idle mode; NOx was the only emission of any consequence during the higher power modes.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0125, AIR & WATER POLLUTION PPBS-20-55-12 FUELS COMBUSTION RESEARCH
R.W. HURN, U.S. Dept. of the Interior, Bureau of Mines, *Bartlesville, Oklahoma*

Purpose: (1) To provide research and development on analytical methods and experimental methodology for studying abatement of air pollution related to hydrocarbon fuels usage in IC engines. (2) Through experimental research both in-house and in cooperation with industry and/or other agencies, to describe the characteristics of engine/fuel systems as they relate to air pollution problems and as they offer potential for air pollution abatement. (3) To provide a continually updated facility for research on air pollution associated with vehicular emissions.

Method: Experimental research is conducted on light hydrocarbons as automotive fuels for clean air requirements. Working with engines and vehicles representative of both current and near-future production, engine adjustments are determind for optimum balance of hydrocarbon, NOx, CO, and RCHO emissions using natural and synthetic gases as fuel. The safety hazard of a diesel engine operating in an unventilated mine is being experimentally studied. Testing is to determine rate at which the concentrations of toxic materials increase and levels to which they increase in case of ventilation failure in underground mine spaces. A project to survey emissions (HC, CO, and NOx from small utility engines (up to 50 cu.in.) is underway.

1. AIR QUALITY

Achievements 1969-70: Work with one fleet of vehicles using compressed natural gas was completed. HC emissions were about 0.7 gram/mile, CO emissions about . 6 grams/mile, and NOx emissions about 5.9 grams/mile. Emissio.. levels were largely unaffected by ambient temperature within the range 20 degrees to 90 degrees F. Analytical and engine and vehicle test facilities were updated to provide reliable measurements of emissions at the greatly reduced levels expected of mid- 1970 automobiles.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0126, EXPERIMENTAL METHODS FOR DETERMINING OXYGENATES IN AUTOMOTIVE EXHAUST
D.E. SEIZINGER, U.S. Dept. of the Interior, Bureau of Mines, *Bartlesville, Oklahoma*

Purpose: To determine those oxygenates that appear in significant quantities in automotive emissions.

Method: An experimental study is conducted to determine relative levels of carbonyl and noncarbonyl oxygenated hydrocarbons in automotive exhausts. Used as fuels are paraffinic, olefinic, and aromatic pure hydrocarbons and simple mixtures of these hydrocarbons that in the aggregate encompass the hydrocarbon range of full-boiling motor fuels. In generating exhaust samples, engine test procedures are used that simulate metropolitan city driving. Procedures are to be developed for converting carbonyl oxygenates present in IC engine exhausts into oxime derivatives for subsequent analysis of resultant derivatives by gas chromatography.

Achievements 1969-70: Procedures were developed to determine the oxygenated hydrocarbon derivatives in exhausts from SI engines using fuels of simply hydrocarbon mixtures. These analyses included virtually all oxygenates whereas procedures now commonly in use measure only nonaromatic aldehydes of relatively low molecular weight. Several carbonyl and noncarbonyl oxygenates were found.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0127, CHARACTERISTICS AND PHOTOCHEMICAL REACTIVITY OF FUEL COMPONENTS AND COMBUSTION PRODUCTS
G.P. STURM, U.S. Dept. of the Interior, Bureau of Mines, *Bartlesville, Oklahoma*

Purpose: To further define the chemical nature of products of combustion of hydrocarbon automotive fuels and experimentally to determine interrelationships between the emissions that result from fuel usage and their photochemical reactivity in the atmosphere.

Method: Expose diluted auto exhaust to photoirradiation and observe chemical and physical changes that occur in the mixture being photoirradiated. Measure total hydrocarbon, NOx, RCHO, CO, CO2, H2, and O2; determine hydrocarbon composition by GLC. Express reactivity measurements in terms of rate-of-NO2 formation and yields of oxidant, PAN and like compounds, and formaldehyde. Measure visibility reduction by light scatter.

In parallel obtain emissions data on fuels of widely varied composition using automotive equipment representing current and proposed production. To the extent possible relate fuel composition, emission composition, and exhaust gas reactivity.

Achievements 1969-70: Optimum HC and NOx concentration ranges for specified air-quality levels were established. A study of the contribution of aldehydes to reactivity of automotive exhaust suggested that formaldehyde acts synergistically to yield reactivity levels that are higher than expected.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0128, AIR POLLUTION POTENTIAL FROM AN URBAN FREEWAY
R.Y. NELSON, Univ. of Oklahoma, School of Civil Engineering, *Norman, Oklahoma* 73069

Air pollution model of a controlled section of Interstate Highway is used to predict the air pollution levels in the surrounding urban areas. Air sampling program verifying the model is in process on a urban and rural section. After verification of model, future pollution level predictions will be used in highway and urban design.

SUPPORTED BY No Formal Support Reported

1.0129, RESEARCH INITIATION - PHOTOOXIDATION IN HYDROCARBON-NITROGEN OXIDE SYSTEMS: A CHARCTERIZATION OF REACTOR WALL EFFECTS
B.L. CRYNES, Okla. St. Univ., School of Engineering, *Stillwater, Oklahoma* 74074

This purposed research is directly related to several important problems of air pollution and environmental control. Recent studies have been reported which involve photooxidation of hydrocarbon-nitrogen oxide systems as a laboratory simulation of certain conversions associated with atmospheric 'smog' reactions. In the reaction systems containing both reactants and products, reactor wall effects are known to occur. To obtain meaningful results from studies of the chemical aspects of these photooxidation reactions, the influnece of the reactor walls must be defined and characterized with respect to the complex reactions within the reactor boundaries. A systematic study will be initiated to define and characterize the effects and influences of reactor wall material and wall conditions of photochemical oxidation of olefins. Studies of the propylene-nitrogen oxide system will be conducted in a recycle-loop reactor designed to carefully control temperature, irradiation, reaction time, and mixing effects.

SUPPORTED BY U.S. National Science Foundation

1.0130, KINETICS OF NITRIC OXIDE AT HIGH TEMPERATURES
R.A MATULA, Drexel University, School of Engineering, *Philadelphia, Pennsylvania* 19104

It has been shown that once NO is formed in the combustion process it remains fixed or frozen during subsequent portions of the power cycle, and hence essentially all NO generated during the high temperature combustion process is exhausted to the atmosphere. Therefore an understanding of the formation kinetics of NO is of major importance, and efforts directed toward the control of NO formation process must be logically preceded by an understanding of the chemical mechanism for NO formation. The overall objectives of this research project are to determine the mechanism and evaluate the temperature dependence of specific rate constants for nitric oxide production both in the absence and presence of hydrogen and hydrocarbons. These results will be subsequently utilized to suggest modifications of the combustion process which can be effectively utilized to minimize nitric oxide production.

Presently the decomposition of nitrous oxide is being studied in the temperature range 1000 to 1800 degrees K. The experiments are being carried out in a single-pulse shock tube, and the temperature dependence of a number of elementary rate constants are being evaluated. An experimental program in which both hydrogen and hydrocarbons are added to the system in order to determine the importance of H2, H2O, H, OH and hydrocarbons on the formation of oxides of nitrogen in combustion systems will also be carried out under auspices of this grant.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0131, THIRTEENTH INTERNATIONAL SYMPOSIUM ON COMBUSTION
J.P. LONGWELL, Combustion Institute, *Pittsburgh, Pennsylvania*

The Thirteenth International Symposium on Combustion will be held at the University of Utah, Salt Lake City, Utah on August 23-29, 1970. Sessions will be held on the following topics: 1. Hydrocarbon oxidation and combustion--fundamentals and applications in practical combustion systems 2. Combustion of solid organic materials--fundamentals and problems related to fire hazards 3. Propellant combustion--fundamentals and applications in rocket systems and advanced propulsion systems 4. Combustion in turbulent and high speed flow--fundamentals and applications in combustion systems

SUPPORTED BY U.S. National Science Foundation

1.0132, EVALUATIONS OF EMISSIONS AND CONTROL TECHNOLOGIES IN THE GRAPHIC ARTS INDUSTRIES
R.R. GADOMSKI, Graphic Arts Technical Found., *Pittsburgh, Pennsylvania*

Objective: Characterize effluents, determine emission factors, and determine effectiveness of central equipment.

Description: The contractor will use data and methods of measurements and analysis developed under Phase I of this study to : (1) characterize effluents with respect to products and processes; (2) establish process emission factors; (3) determine the effectiveness of available control equipment; (4) determine capabilities of control techniques for existing process equipment; and (5) define material and process modifications (reformulation) that will improve control capabilities. From the data developed under both contracts, the contractor shall recommend a research and development plan designed to alleviate existing air pollution control problems and reduce control costs in the graphic arts industry.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0133, CATALYTIC DECOMPOSITION OF NITROGEN OXIDES
D. BIENSTOCK, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

To develop a rugged catalyst for the decomposition of nitrogen oxides resistant to poisoning from coal and gasoline combustion, and fabricated in a form that offers a low pressure drop. A screening program will be initiated to ascertain catalyst activity using NO in helium as the gas. A non-dispersive infrared analyzer for NO analysis will be used. The most active catalysts will then be tested with a simulated flue gas. The kinetics of decomposition with 2-3 of the better catalysts will be determined. These catalysts will then be deposited on a form to give a minimum pressure drop and exposed to coal- combustion and gasoline-combustion gases.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0134, AERODYNAMICS OF FORMATION OF CLOUDS OF FLOAT COAL DUST
J.M. SINGER, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania*

This investigation seeks to determine the aerodynamic characteristics of weak explosions of firedamp and the physical characteristics of coal dust deposits, which combination of characteristics may lead to the production of explosive clouds of float coal dust in mines. With such information, improved safe practices may be developed to reduce the hazard of coal dust deposits in mines.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0135, ANALYSIS OF CHEMICAL COMPOUNDS IN AN URBAN AEROSOL
J.O. FROHLIGER, Univ. of Pittsburgh, School of Public Health, *Pittsburgh, Pennsylvania* 15213

The objectives of this investigation are (1) to establish the elemental composition of aerosols in the Pittsburgh air basin, (2) to identify the chemical compounds present in these aerosols and (3) to determine if the information obtained in (1) and (2) can be applied to the identification of the various sources of air pollution in the air basin.

The purpose of establishing these objectives is to determine the potential health hazards of the chemical compounds found in an urban aerosol and to see if these data can be used as guides to effectively control the quality of the air environment of the general population.

This investigation will utilize a variety of analytical techniques particularly gas chromatography, microcolumn chromatography, thin layer chromatography, thermal gravimetric analysis, differential thermal analysis, differential thermal gravimetric analysis, and microcoulometry. These techniques will be used separately and in combination to yield the necessary analytical data to establish the elemental and chemical composition of suspended particulate matter.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0136, MODELLING POLLUTANT CONCENTRATIONS
W.J. MOROZ, Penn. State University, Center for Air Env. Studies, *University Park, Pennsylvania* 16802

Maximum concentrations of pollutants develop in urban centers when local or mesoscale meteorological factors strongly influence, and perhaps dominate, the transport and diffusion patterns of the contaminants. Time varying numerical models for mesoscale flow systems and models for pollutant distributions of a static nature have been developed which provide reasonable ability.

In this work numerical mesoscale flow models and dispersion models are being modified and the separate models are being melded to achieve a quazi-dynamic predictive model for pollutant concentrations over an urban area when large scale flow patterns are weak. The effectiveness of representing an urban area as a virtual point source for predicting downwind concentrations of contaminants at some distance from the source to determine the effect of one urban center upon another is also being investigated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0137, TRACE METALS AND HALOGENS IN THE ANTARCTIC ATMOSPHERE
R.A. DUCE, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

It is proposed to study (1) the atmospheric particulate concentration of trace metals (V, Al, Cu, Pb, Mn, Fe, and Ni) in three Antarctic locations and compare the values wth other similar simultaneous measurements made in Hawaii and at various north and south Atlantic Ocean stations, and, (2) to collect particulate and gaseous samples of halogens (I, Br, Cl) in order to study the effect of a large land mass on atmospheric gaseous halogen concentrations. Measurement of concentration and ratio of concentration of atmospheric pollutants will help determine the N-S transport of urban air pollutants and determine the extent to which northern hemisphere continental source particulate matter is penetrating the Antarctic continent. The personnel have more than 10 years continuous experience in this and related studies of atmospheric chemistry. The analysis will mainly use the techniques of neutron activation analysis and atomic absorption spectrophotometry, the facilities and tools for which are available at Kingston, Rhode Island and which will not necessitate the introduction of any radio active materials into the Antarctic. The contribution of the sea, as well as that from urban areas, to the trace metals will be determined by means of ratio determinations. Changes in procedure should result in new low level detection limits. In addition to the Antarctic measurements three scientists will make halogen and trace metal concentration measurements at least two New Zealand station.

SUPPORTED BY U.S. National Science Foundation

1.0138, CONTINENTAL TRACE ELEMENT AIR POLLUTION IN HAWAII
R.A. DUCE, Univ. of Rhode Island, School of Oceanography, *Kingston, Rhode Island* 02881

Atmospheric particulate samples are being analyzed for the trace metals Na, Mg, Ca, K, Sr, Pb, Cu, V, Al, Mn, Fe, Co, Ni, and Zn by a combination of atomic absorption spectrophotometry and neutron activation analysis. Samples are collected on Delbag polystyrene filters using high volume pumps from a 20 meter tower on the windward coast of Oahu, Hawaii. Samples have also been collected from ships over wide areas of the north Pacific Ocean.

The metals Pb, Cu, V, Al, and Fe have considerably higher concentrations in marine air than would be expected if their source were the sea. This has been determined on the basis of the

atmospheric Pb/Na, Cu/Na, etc. ratios, assuming all the Na comes from the sea. There is a strong possibility that the source for the excess amount of these metals in marine air is the continents, and for some of them it may be air pollution. During the coming project year samples will be collected over the south Atlantic Ocean and from Antarctica for comparison with northern hemisphere concentrations of these elements.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0139, WIND TUNNEL STUDIES
B. HELLERS, Natl. Swedish Inst. Bldg. Res., *Stockholm, Sweden*

Object: The passage of air around houses gives rise to several climatological stresses such as penetration of driving rain, distribution of snow loads, deposition of smoke and dust cover. Moreover, the passage of the air influences the internal climate of the building by creating the pressure for air conditioning inside the house. The assignment is intended to establish whether wind tunnel tests can describe the change of the condition of the air from macroclimate to the climatological sheath and if model studies can describe these essential climatological stresses adequately.

SUPPORTED BY Swedish Government

1.0140, VENTILATION DURING TUNNEL CONSTRUCTION
H. GROB, Inst. Strassen & Utertagbau, *Zurich, Switzerland* (005846)

The atmospheric conditions in a large number of gallery and tunnel construction sites were investigated. The concentrations of dust and noxious gases (carbon monoxide, carbon dioxide and nitrous gases) were measured. At present the German maximum permissible values (MAK) are used as a basis. At some large tunnelling sites a closer study of dust and blasting smoke concentrations with different ventilation conditions was made. The object is to supply recommendations for suitable ventilation systems. In the present position only a one-way system is economic, removal by suction being preferred. It may be necessary in certain circumstances to provide additional ventilation although it does not recover quickly enough.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY Swiss Government

1.0141, TVA PLUME STUDIES
F. THOMAS, U.S. Tennessee Valley Auth., *Knoxville, Tennessee* 37902

Obtain better descriptions of the size distribution and the surface area of atmospheric fly ash produced by coal-fired power plants in TVA area.

Determine NOx emissions from power plants and NOx disposition in the atmosphere as a function of plant size, boiler temperatures, and photochemical-meteorological reactons.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0142, AREA SOURCE DIFFUSION MODELLING
F.A. GIFFORD, U.S. Dept. of Commerce, Air Reso. Atm. Turb. Dif. Lab., *Oak Ridge, Tennessee* 37830 (AT(40-1))

In FY 1970, using continuity principles, a method for calculating ground level concentrations of pollutants emitted from surface area sources was developed. The method is sufficiently simple that a digital computer is not necessary. In FY 1971 the area source diffusion model will be further studied and applied to a variety of problems, including the diffusion of heat over an urban area.

Results: In FY 1970 the model was tested using source data from several cities. The resulting ground level concentrations were in good agreement with oservations and the predictions of much more complicated models. In FY 1971 the predictions by this model will be compared with the predictions of other models, using a standard set of source data and observed concentrations.

SUPPORTED BY U.S. Atomic Energy Commission

1.0143, PLANETARY BOUNDARY LAYER STUDIES
F.A. GIFFORD, U.S. Dept. of Commerce, Air Reso. Atm. Turb. Dif. Lab., *Oak Ridge, Tennessee* 37830 (AT(40-1))

The distribution of winds, temperatures, and turbulence in the air over urban areas is being studied using the techniques of simple dimensional analysis and by solving the equations of motion and continuity with a digital computer. The reaction of constant density balloons to sinusoidal vertical air motion is being investigated by solving the equation of motion for the balloon. The role of the eddy dissipation rate in the spread of small smoke plumes is being determined by means of dimensional analysis of the problem and an experiment in which a small plume is released from a meteorological tower. In FY 1971 our model for diffusion from area sources will be used to investigate effects of changes in surface heat, moisture and momentum fluxes from urban areas. The computer model of three dimensional flow over an urban area will be further tested and results obtained for a variety of upstream boundary conditions.

Results: Several empirical relations describing the variation of winds and temperatures over urban areas were derived. The numerical model of the urban boundary layer was tested and will yield results shortly. The analysis of balloon response was completed, indicating that balloons are often out of phase with the air motion.

SUPPORTED BY U.S. Atomic Energy Commission

1.0144, NUMERICAL STUDIES OF TURBULENT FLOW
F.A. GIFFORD, U.S. Dept. of Commerce, Air Reso. Atm. Turb. Dif. Lab., *Oak Ridge, Tennessee* 37830 (AT(40-1))

Continued work on modelling the effect of terrain, buildings, radioactive decay and vertical meteorological parameters on the concentration and deposition of material downwind from an effluent source. Primary emphasis is on using the rather coarse vertical data obtained routinely from radiosonde data for the meteorological parameters.

Results: Preliminary models have been tested successfully.

SUPPORTED BY U.S. Atomic Energy Commission

1.0145, ATMOSPHERIC DIFFUSION STUDIES - LIDAR PLUME STUDY
F.A. GIFFORD, U.S. Dept. of Commerce, Air Reso. Atm. Turb. Dif. Lab., *Oak Ridge, Tennessee* 37830 (AT(40-1))

The objective of this study is to obtain data on the detailed structure of smoke plumes as they emerge from the Bull Run Steam Plant stack. Also, to obtain 'mixing depth' statistics for the Oak Ridge area. The use of a 'Lidar' in a fixed location, for several years, if necessary, to obtain detailed plume data is unique. Moreover, when additional power units are installed at the steam plant, their effluents will add to the burden of effluvium emitted from a single 800 ft. stack. The 'bench mark' studies now under way will be compared to the altered dynamics of the future plume.

Results: A 5 Joule laser radar has been assembled and tested. Studies of stack behavior have already begun.

SUPPORTED BY U.S. Atomic Energy Commission

1.0146, PLUME RISE AND FUMIGATION MODELLING IN A TANK
F.A. GIFFORD, U.S. Dept. of Commerce, Air Reso. Atm. Turb. Dif. Lab., *Oak Ridge, Tennessee* 37830 (AT(40-1))

The objective is to model the rise, spread, and subsequent diffusion of vertical plumes with both initial momentum and buoyancy. This will be done for calm conditions and various stratifications of the ambient fluid; later, convective motions will be induced to simulate the atmospheric mixing layer. These data should fill in some gas in existing plume rise data and, for the first time, provide some empirical basis for reasonable models of diffusion in nearly calm conditions, a situation that is becoming in-

creasingly critical as larger sources of emissions are built. The experiment is to be carried out in a 6 ft. by 6 ft. by 2.5 ft. deep tank, filled with water with a vertical salinity gradient to achieve stratification. The plume will be a hot, dense saline solution introduced through an inverted 'stack.' Dye will be added for cinematography using an overhead camera and a mirror mounted on the one side of the tank which is transparent. Conductivity probes will measure salinity and thermohm devices will measure the plume concentration, using temperature as a tracer.

Results: The tank, two auxiliary storage tanks, and plumbing with solenoid valves activated by float contacts have been built, allowing automatic filling of the main tank with several types of preset density profiles, including a linear one.

SUPPORTED BY U.S. Atomic Energy Commission

1.0147, TURBOPROPULSION EXHAUST EMISSIONS INVESTIGATIONS

K.E. TEMPELMEYER, Aro Incorporated, *Tullahoma, Tennessee* 37389 (F40600)

Technical Objective: The purpose of the AEDC work is to investigate in a systematic way the combustion products emitted by turbopropulsion engine systems which may contribute to pollution or contamination of the atmosphere.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0148, CONDUCT A STUDY OF EMISSIONS FROM OFF HIGHWAY INTERNAL COMBUSTION ENGINES (GASOLINE AND DIESEL)

UNKNOWN, Southwest Research Institute *San Antonio, Texas* 78228

Objective: To provide information on emission factors and nation- wide emissions of CO, HC, NOx, particulates, SOx, CO2 and oxygenates from gasoline and diesel powered off highway internal combustion engines.

Approach: This study is being done by contract which was let in June 1970. The project is co-sponsored by DAQED and DMVRD. The contractor will conduct source testing and perform engineering calculations to arrive at average emission rates of the various pollutants. Statistics on populations of these devices will be combined to yield estimates of nation-wide emissions from this source group. The in-house effort is to monitor this contract.

Goal: Complete 70 percent of the study to assess the emissions from off highway internal combustion engines.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0149, REDUCTION OF POLYCYCLIC AROMATIC HYDROCARBONS

R. LONG, Univ. of Birmingham, *Birmingham, England, United Kingdom*

It has been known for many years that 3.4 -benzopyrene is a potent carcinogen and that some other polycyclic aromatic hydrocarbons are also carcinogenic. Such hydrocarbons are associated with smoke or particulate carbonaceous matter resulting from the incomplete combustion of fuels in heating plants or in engines (e.g. diesel smoke). Whilst cigarette smoking is a most important causal factor in lung cancer there also appears to be an air pollution factor since the frequency of this disease is higher in urban than in rural areas. (cf.Hoffmann and Wynder. Nat. Cancer Inst. Monograph No.9 61 (1962) and Truhaut. Proc. European Conference on Air Pollution, 89 (1964). The two factors may act in association. The potential danger of foodstuffs contaminated by carcinogenic air pollutants must also be recognized. Thus, Grimmer, Erdol u. Kohle 19, 578, (1966) has reported a surprisingly high content of 3.4-benzopyrene in certain vegetables as a result of air pollution.

A considerable amount of work has been carried out by Badger & his associates on the mode of formation of 3.4-benzopyrene during hydrocarbon pyrolysis but comparatively little has been published on the mode of formation of polycyclic aromatics during incomplete combustion in flames. Our work (see report) indicates that in flames pyrolysis processes appear to be responsible for their formation. Such processes are known to be influenced by catalysts and additives and further work is proposed to find out more about them and to attempt to reduce the formation of polycyclic aromatics during flame combustion. The combustion of liquid-fuels - when the fuel is 'atomized' in furnaces or diesel engines probably takes place largely in the form of a diffusion flame rather than as a pre-mixed flame where fuel and oxidant are homogeneously mixed prior to combustion. Consequently attention will be paid to both pre-mixed and diffusion flame combustion. Modern analytical techniques such as programmed temperature gas chromatography, thin layer chromatography and mass spectrometry will be used to investigate the pyrolysis reactions in the presence and absence of additives. Improvements will be sought in these analytical methods (for polycyclic aromatics in particular).

SUPPORTED BY U.S Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0150, PARAMETRIC STUDY OF PETROL ENGINE PERFORMANCE, EFFICIENCY AND EXHAUST COMPOSITION

G.G. LUCAS, Univ. of Technology, *Leicestershire, England, United Kingdom* (002912)

The main research program concerns the effect of the many engine design parameters upon engine performance, efficiency and exhaust gas composition. The aim is to predict these performance parameters at the design stage to enable the designer to optimize to produce an engine to meet a particular specification. The present specific objective is concerned with exhaust emission only, and in particular with the oxides of nitrogen.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY Science Research Council

1.0151, ATMOSPHERIC POLLUTION BY GASOLINE ENGINES

R.A. FOSBERRY, Motor Indus. Res. Assoc., *Warwickshire, England, United Kingdom* (2R52062827)

A test facility is provided for members of Motor Industry Research Association to keep them in touch with legislation. Short-term work is undertaken on specific activities to meet California and U.S. Federal legislation. Long term investigations concern the effect of engine design parameters, including combustion-chamber design and type, stroke/bore ratio, valve timing, etc., on exhaust emissions.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

1.0152, UTAH ATMOSPHERIC WATER RESOURCES (THE WASATCH WEATHER MODIFICATION PROJECT)

G.W. REYNOLDS, Utah State University, Utah Water Research Laboratory, *Logan, Utah* 84321

The purpose of this study is to quantify the effects of cloud seeding on the winter snowpack in the Wasatch Mountains in Utah. Initially, at least, the seeding is to be with silver iodide from two mountain top and two valley generators, along the Wasatch Front, near Ogden. The evaluation is to be based primarily upon data from 150-200 telemetering precipitation gages. Approximately 40 of these stations are to be in operation during the 1967-68 winter. These measurements are to be supported with radar and special radiosonde observations.

Support studies in several areas are required: silver iodide background and plume nuclei studies; inadvertent cloud seeding by air pollution; precipitation analysis for silver and iodine; time and space synoptic climatology-cloud-precipitation studies; and hydrologic studies. These support studies have only been started. The bulk of the effort thus far has been on the development, adaptation, manufacture, and installation of the telemetering system (remote stations and terminal readout system).

The evaluation system will involve the comparison of natural and seeded precipitation patterns. Variations in both time and space will be considered. Both target versus control and seeded versus unseeded comparisons are to be made. Non-parametic statistical significance tests will be applied.

1. AIR QUALITY

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

1.0153, ATMOSPHERIC FLUIDS PROVENANCE USING STABLE ISOTOPES
D.C. GREY, Univ. of Utah, School of Mines, *Salt Lake City, Utah* 84112

Stable-isotope composition is being used to identify sources of atmospheric fluids. Sulfur, carbon and oxygen isotopes are being used and nitrogen isotopes are being examined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0154, ATMOSPHERIC DIFFUSION AND TURBULENCE
S.K. KAO, Univ. of Utah, School of Mines, *Salt Lake City, Utah* 84112 (AT(11-1)-1585)

The investigation of space-time distribution and spectra of the kinetic energy of the large-scale atmospheric motion in the Northern Hemisphere will be extended to the Southern Hemisphere.

The investigation of the cospectra and cross-correlation of the components of the turbulent velocity in the Northern Hemisphere will be extended to the Southern Hemisphere.

The investigation of the space-time distribution and cospectra of the meridional transport of sensible heat in the Northern Hemisphere will be extended to the Southern Hemisphere.

This research will provide information which is useful for the prediction of air pollutants, particularly the radioactive debris in the atmosphere.

Results: The wavenumber-frequency spectra of the kinetic energy and cospectra of velocity components of the large-scale atmospheric motion in the Northern Hemisphere at 100, 200, and 500 mb, at 20, 40, 60 and 80N, show a definite spectral domain of wave activities in the atmosphere. The spectral domain is oriented from a region of low wavenumbers and low frequencies to a region of high wavenumbers and negative frequencies designated for waves moving from west to east.

SUPPORTED BY U.S. Atomic Energy Commission

1.0155, AIR POLLUTION IN TOPOGRAPHICAL DEPRESSIONS
S.K. KAO, Univ. of Utah, School of Mines, *Salt Lake City, Utah* 84112

Air pollution in both cities and suburban areas are affected by local topographic features, urban complexes, thermal stratifications, and the various scales of motion in the atmosphere. The objective of the proposed project is to estimate the amount of pollutant emission and to determine the meteorological and environmental factors for the transport and diffusion of te pollutants in valleys and other depressions. Included in the general description 'other depressions' are mountain canyons and 'metropolitan canyons,' i.e., the streets of the business districts of large metropolises.

A wide range of meteorological conditions will be studied, but emphasis will be given to the inversion and stagnation periods in which a stationary high pressure presides over depressions. It is known that the blanket effect of temperature inversions is the most effective mechanism for trapping air pollutants in topographical depressions.

Three investigative techniques will be used simultaneously. Analytical and experimental models will be constructed of simple depressions and field studies will be conducted to provide a guide for the analytical modeling and experimental simulation. The capabilities of meteorologists will be coupled with the expertise of engineers involved with geophysical fluid mechanics and convection.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0156, COMPOSITION AND DISTRIBUTION OF FOREST FIRE SMOKE
D.F. ADAMS, Washington State University, School of Engineering, *Pullman, Washington* 99163

This is to be a three-phase laboratory, field, and theoretical study of the air pollution potential from the prescribed fires of forest fuels conducted as an integral part of forest land management. The laboratory study will quantitatively and qualitatively define the range of solid and gaseous combustion products produced from the burning of two major fuel species (fir and larch). Fuel variables such as volume and moisture by size classification will be considered in establishing the anticipated range and types of combustion products. The field phase will encompass extensive sampling of the combustion products (and their measurable effects) from thoroughly documented prescribed fires. The theoretical phase will attempt to relate the field-measured pollutants and the quantities of pollutants predicted from the laboratory studies through mathematical models of atmospheric diffusion phenomenon.

The practical objective is to define the range of prescribed fire environmental conditions which will minimize air pollution and achieve the objectives of forest management.

This research proposal represents a cooperative program with personnel of the Northern Forest Fire Laboratory and Region I Forest Administrators.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0157, ANALYSIS OF THE ATMOSPHERIC PHOTOCHEMICAL REACTION PRODUCTS OF TERPENES
R.A. RASMUSSEN, Washington State University, School of Engineering *Pullman, Washington* 99163

The major objective of the proposed investigation is a laboratory and field study of the air chemistry fate of the volatile terpenes emitted into the atmosphere by plant foliages. This study will make measurements on the reaction products, rate of reaction and the carbon balance for different photochemical systems in respect to the specific terpenes studied. Atmospheric photochemistry studies on terpenes and even isoprene are very limited. The potential sources of reactive hydrocarbon-terpenes (alpha-pinene, beta-pinene, limonene) is not solely limited to conifer tree species: many broadleaf tree species in the United States are active releasers of the highly reactive hemiterpene; isoprene. Therefore, it is appropriate to initiate a research project to obtain data leading to an understanding of the air pollution potential and natural atmospheric chemical fate of such ubiquitous, naturally occurring reactive hydrocarbons in our global atmosphere.

A practical objective will be to determine and compare the reaction products of terpenes formed in simulated atmospheric irradiation chambers with the natural atmospheric photochemical products associated with plant foliages and the ambient atmosphere.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0158, FALLOUT PHENOMENOLOGY
W.E. DAVIS, Battelle Memorial Institute, *Richland, Washington* 99352 (AT)

The studies are designed to describe the history of atmospheric debris, including fallout from nuclear devices. A reliable technique for following debris in the lower atmosphere under diabatic conditions is needed to determine consequences of nuclear accidents as well as to follow fallout from nuclear devices under various atmospheric conditions. Methods for prediction of trajectories are also needed.

Techniques are to be developed for estimating effect on air motions from diabatic conditions such as are produced by precipitation, surface heating, terrain effects, and radiational heating and cooling. These must be tested against observations of contaminants, tracers or conservative properties of the atmosphere. From these results fallout models can be modified to produce a procedure for predicting transport and areas of anomalous dosages at the surface. These improved techniques will lead to a general macroscale fallout model including some mesoscale effects which can follow and predict the path and deposition of debris under various atmospheric and terrain conditions.

Results: A case study of Phoebus IB EP-IV, February 1967, was completed with the diabatic trajectories successfully describing the transport of radioactivity. A computerization of a radiation model has been completed and used both in calculations for a case study as well as for a comparison study with other models. Further studies on the identification of effects altering transport

has been made with the result that case studies included an attempt to estimate downward mixing layers from analysis of radiosondes.

SUPPORTED BY U.S. Atomic Energy Commission

1.0159, ATMOSPHERIC DIFFUSION, DEPOSITION, AND TRANSPORT PHENOMENA

P.W. NICKOLA, Battelle Memorial Institute, *Richland, Washington* 99352 (AT)

The study is directed toward understanding the behavior of gaseous and particulate material released to the atmosphere from atomic energy installations. The history of such materials as they are diffused by tubulent action, transported by various scales of atmospheric motions, and deposited on the ground and vegetation are investigated under various meteorological conditions and the influence of varying surfaces. An extensive field program is employed, in which atmospheric tracers are released and subsequently sampled simultaneously at hundreds of locations on a geometric grid extending to 26 km from the release point. Relationships between the diffusing materials and measurable atmospheric parameters are established. Findings are desirable to establish design criteria for effluent decontamination, for control of immediate and potential hazards arising from process operations, and as basic information for advisory groups in evaluating the adequacy of protective programs.

Results: Analysis of real-time data resulting from ground-level releases of Kr85 gas was undertaken during the past year. It was found that concentration fluctuations in diffusing plumes were greater in intensity and frequency than was expected. To distances of 800 m from the release point of puffs, it was found that regardless of stability, puff length sigma sub x was greater than puff width sigma sub y which in turn was greater than puff height sigma sub x.

SUPPORTED BY U.S. Atomic Energy Commission

1.0160, RADIOACTIVE FALLOUT RATES AND MECHANISMS

J.A. YOUNG, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The objectives of this study are to determine the distributions of radionuclides and trace elements in the atmosphere and the rates and mechanisms by which airborne particulates are transported to and deposited on the earth's surface. Studies of the chemical and radiochemical composition of atmospheric aerosols from ground level to maximum attainable altitudes are made to determine the rates and mechanisms by which airborne radionuclides become attached to the aerosol, the origin and chemistry of the host aerosol and the rates and mechanisms of the mixing and scavenging processes. Vertical profiles of concentrations are measured in the atmosphere and the sea near the surface. The data and the concentrations in precipitation are used with vertical profiles and variations of wind, temperature, and humidity to determine the effects upon the vertical flux of radionuclides, the flux across the sea surface, and the vertical flux in the surface layers of the oceans.

Results: The production rates of Cl-39, Cl-38, S-38, Cl-34m, Mg- 28, Na-24, and F-18 produced by spallation of Ar-40 with cosmic rays have been determined for the first time and used as tracers of precipitation and short-term atmospheric mixing processes. During the experimental phase of the Barbados Oceanographic and Meteorological Experiment, the concentrations of Be-7 and several nuclear-weapons- produced radionuclides were measured in air, seawater, and rain samples. Nineteen elements have been measured on filters and in rainwater to establish the gradient of several trace elements from troposphere through lower stratosphere.

SUPPORTED BY U.S. Atomic Energy Commission

1.0161, FLAME RETARDANTS AND AIR POLLUTION FROM SLASH BURNING

R.C. CORLETT, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

A research program is proposed for investigating the effect of flame retardants on air pollution due to burning of logging slash. With the cooperation of the U.S. Forest Service, a matrix of controlled field scale experimental fires will be held at a site near Bend, Oregon in the Deschutes National Forest.

Because of the difficulties inherent in achieving scientific control in field burning experiments, a major objective is the development and evaluation of experimental procedures. In addition, it is expected that there will be obtained substantive new data relating to the quantity of pollutant formed, the mechanism of its formation in the fire, and its short range dispersion in the atmosphere. This new information will be compared with suggestions based on laboratory scale research and will be sharpened by new laboratory scale experiments as appropriate.

This research program will suggest improved procedures for minimizing air pollution due to slash burning. A rational and efficient research program will be formulated for execution on a longer time scale than this proposed one year program.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0162, THE CONTRIBUTION OF FOREST FIRES TO ATMOSPHERIC POLLUTION

L.J. FRITSCHEN, Univ. of Washington, School of Forestry, *Seattle, Washington* 98105 (WO2102)

OBJECTIVE: Determine the amount of fuel consumed in the burning of logging slash and the combusion products that contribute to air pollution. To determine the atmospheric and fuel moisture conditions affecting efficiency of combustion and the distribution of gaseous and particulate pollutants.

APPROACH: Determine the weights of different kinds and sizes of fuel components. Measure moisture contents at time of burning. Measure residual weights and moisture contents after the fire. Develop sampling designs to distinguish between ambient air conditions and those induced by the fire itself. Determine vertical and horizontal wind components, degree of stability and wind shear. Determine the kinds, densities, fallout patterns and horizontal and vertical trajectories of various pollution components.

PROGRESS: Investigated the relationships between slash burning and air pollution with broadcast, and laboratory fires. Tested hypothesis that incomplete combustion and greater pollutant emissions result from low temperature, broadcast fires. Investigated burning characteristics and the gaseous hydrocarbon and particulate emissions from the three types of experimental fires. Results suggest that broadcast fires can be modeled in the labortary with respect to burning characteristics and gaseous and particulate emissions from different fuel density, packing quality and method of ignition. These experiments indicate that the air pollution from slash burning can be minimized with a high energy fire under conditions favorable for rapid atmospheric dispersion. Also, results showed that the concentration of gases and hydrocarbons dilluted rapidly to ambient values. Particulate emissions in the smoke plume were high, but decreased in 20 km. to values found over Seattle. Additional significant findings and developments are: flight tested the airborne version of the integrating nephelometer; developer air samplers, capable of operating without power, to collect air samples over a period of time; and found the peak frequency of flame speeds to be 3 m. sec.

SUPPORTED BY U.S. Dept. of Agriculture

1.0163, KINETICS OF NITROGEN-OXIDE AUTOMOTIVE POLLUTION

A. HERTZBERG, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

A sequence of processes in the Automotive Pollution Shock Tube closely simulates automotive engine cylindar operation. We are investigating the formation and decomposition of oxides of nitrogen in this apparatus.

A gasdynamically actuated endwall sampling system with time resolution of 0.1 msec has been developed. This technique, in conjunction with absorption spectroscopy will be used to monitor nitrogen oxide concentration in the test section. An advanced chemical monitoring technique, utilizing a frequency selective carbon monoxide laser is also under development.

This system will be used to make decisive measurement of nitrogen oxide production as a function of operational variables appropriate to engine design and adjustment.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0164, CHEMISTRY OF SULFUR IN HOT COMBUSTION GASES

C.B. MEYER, Univ. of Washington, School of Arts, *Seattle, Washington* 98105

Study of the oxidation and reaction of SO2 and other combustion gases in pure form and in mixture. Reactions of hot combustion gases with atmospheric gases. Absorption of SO2 and NXOY on solid catalysts. Recovery reactions to re-activate catalyst and transform SO2 and sideproducts into useful or harmless, non-polluting chemical compounds. A second goal is the study of chemical reactions of SO2, NO2 and CO2 in their lowest excited triplet states Tl.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0165, INFRARED SPECTROSCOPIC ANALYSIS OF TRACE POLLUTANTS

C. KARR, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia*

Purpose: Identify and determine the amounts of the individual minerals and inorganics in various coals burned for electric power generation and burned in experimental fluidized-bed combustion equipment, using low-frequency and vacuum far infrared spectrometry. Similarly analyze the mineral and inorganic particulate pollutants emitted to the atmosphere from industrial equipment, using limestone injection with these coals, and from fluidized-bed equipment burning these coals. Correlate the kinds and amounts of mineral and inorganic pollutants with the minerals and inorganics in the various coals, and with the various operating conditions used during combustion of these coals.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0166, COMBUSTION PROCESS ANALYSIS

H.K. NEWHALL, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

There are two broad objectives for the proposed research. These are stated as follows: 1. It has been established that the formation and subsequent emission of nitric oxide and carbon monoxide by automotive combustion processes are controlled by chemical kinetics of the combustion and post combustion processes. One of the objectives of the proposed research is the continuing investigation of the basic kinetic mechanisms responsible for formation of these undesirable chemical species under conditions of combustion in automotive propulsion systems. 2. Results of basic investigations performed during the preceding period of this project have resulted in a concept in combustion chamber design which holds promise for reduction of air pollutant emissions from automotive power plants. It is proposed to continue study of this concept with the objective of systematic optimization of chamber design from the standpoint of exhaust emissions and engine performance.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel - P.H.S.

1.0167, RADIATIVE PROPERTIES OF AEROSOLS IN THE STRATOSPHERE

J.A. WEINMAN, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The objective of the research is to continue to study the radiative properties of the stratospheric aerosol by means of theoretical studies, experiments and the analysis of observational data. The program is divided into several problem areas: (1) flights of several radiometersondes with simultaneous hygrometersonde ascents to check if the aerosol contains significant quantities of water; (2) measurement of the spectral dependence of the infra-red complex index of refraction of solutions expected in the stratospheric aerosol; (3) analysis of the spectral radiance of the stratospheric aerosol using data obtained in (2); (4) compilation of data describing the global aerosol distribution and (5) simultaneous aerosol measurements by lidar and radiometersonde at various latitudes in both hemispheres aboard ships enroute to the Antarctic.

SUPPORTED BY U.S. National Science Foundation

B. EFFECTS - HUMAN

Medical and Epidemiological Studies; Laboratory Animal Studies and Other Biological Effects Research Relating to Effects of Air Pollution on Man.

1.0168, COLLECTION OF AEROMETRIC, METEOROLOGIC, BIOMETRIC OR OTHER HEALTH INFORMATION IN BIRMINGHAM, ALABAMA.

UNKNOWN, Univ. of Alabama, School of Medicine, *Birmingham, Alabama* 35233

Air pollution measurements and information on specific health parameters must be collected in the cities included in the HESN by people located in the area. Collection sites are determined by NAPCA staff and instruments are checked and calibrated routinely but periodic collection according to a prescribed regimen are made under contract. Information relative to selected health parameters are likewise collected by contractors with regular review of activities by the project officer.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0169, CHRONIC LUNG DISEASE IN NEW GUINEA POPULATIONS

C.R. BLACKBURN, Univ. of Sydney, *Sydney, Australia*

The prevalence and incidence of chronic non-tuberculous lung disease in some native populations in Papua and New Guinea is being determined by epidemiological methods. Complete subpopulations, clans or village groups, are surveyed by standard methods at intervals of 1-3 years and particular emphasis is being placed on serial changes in peak expiratory flow rates. The subpopulations selected are relatively isolated, with little urban contact, and in both coastal and highland districts. The elucidation of the nature of the disease and its relationship to chronic cor pulmonale is being sought by studying the clinical course, changes in respiratory function and pathological changes in the lungs of selected natives with chronic lung disease. Respiratory function studies include measurement of lung volumes, blood gas tensions, diffusion capacities, and ventilatory function. Etiological factors, such as infection, air pollution, and sensitization to fungal products or visceral larval migrans, are being studied. The elucidation of this disease in New Guinea may lead to its prevention there as well as in other non-industrialized Asian countries. The etiological factors of the disease are relevant to chronic non- tuberculous lung disease in industrialized countries, such as the U.S.A., U.K. and Australia, especially since air pollution is an entirely different problem in New Guinea.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0170, BIOLOGICAL EFFECTS OF GASEOUS IONS

A.P. KRUEGER, Univ. of California, School of Public Health, *Berkeley, California* 94720

The general research objective of this project is to assess the biological activities of gaseous ions. During the past 13 years we hve developed methods and facilities which make it feasible to expose bacteria, protozoa, higher plants, insects and small animals to predetermined concentrations of small air ions in controlled and monitored microenvironments. We have demonstrated a series of physiological changes in experimental subjects directly attributable to inhalation of these ions.

We wish to continue this work with particular attention to the effects of air ion depletion, unipolar ionized atmospheres and air containing various ratios of positive to negative air ions on: 1. the biogenic amines of the mouse brain. 2. the blood levels of serotonin in the mouse. 3. the nucleic acid metabolism of higher plants. 4. host-virus models including (a) the honey moth-Chile irridescent virus, (b) the mouse-influenza virus. 5. longevity of Drosophila melanogaster. 6. genetic phenomena in Drosophila melanogaster.

Items 1 and 2 will provide some insight into the relations between air ion imbalance associated with naturally occurring meteorological conditions and alterations in mood, affect and soma of exposed subjects. Items 3, 4 and 5 will extend our work to other areas of basic concern in which mechanisms of air ion action hopefully may be deciphered.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0171, TOBACCO SMOKE AND LUNG BIOCHEMISTRY
C.E. CROSS, Univ. of California, School of Medicine, *Davis, California* 95616

The lung, the principal organ for external gas exchange, is exposed to various effete inhalants including bacteria. Pulmonary alveolar macrophages (PAMs) constitute the major cellular host defense apparatus that protects the lung from these noxious inhalants. The interactions of tobacco smoke with the lung are reported to cause pathophysiologic manifestations, but little is known concerning the underlying biochemical mechanisms. The study will provide information concerning the effects of tobacco smoke lung cells. Using PAMs and other lung cells as models, cigarette smoke effects will be expressed in terms of biochemical malfunctions. These effects presumably underlie early events that are manifest by overt pulmonary pathological changes.

The rationale of our approaches is that (i) cigarette smoke may directly affect lung cells and interfere with their energy metabolism, leading to impairment of pulmonary gas exchange and pathological cellular changes; (ii) Respiratory disorders may occur from cigarette- induced impairment of PAM phagocytic functions; and (iii) cigarette smoke may interact with other noxious environmental inhalants so as to cause addative insults to lung cellular biochemical machinery.

The studies undertaken may lead to the establishment of precautionary and possible therapeutic measures relevant to a better definition of the biochemical hazards of cigarette smoke exposures.

SUPPORTED BY Amer. Med. Assn. Educ. & Res. Foundation

1.0172, EFFECTS OF CIGARETTE SMOKE ON THE PULMONARY LYMPHORETICULAR SYSTEM
C.E. CROSS, Univ. of California, School of Medicine, *Davis, California* 95616

The effects of cigarette smoke on the renewal rates of pulmonary alveolar macrophages will be studied utilizing the Es-2 marker enzyme system of inbred RF/Al mice. The effects of cigarette smoke on pulmonary macrophage cellular kinetics will be compared to the effects of a wide variety of other exogenous and endogenous agents such as air pollutants and corticosteroids.

SUPPORTED BY Council for Tobacco Res. - New York, N.Y.

1.0173, PULMONARY EFFECTS OF ENVIRONMENTAL OXIDANT POLLUTANTS
D.L. DUNGWORTH, Univ. of California, School of Veterinary Medicine, *Davis, California* 95616

Rats and non-human primates will be exposed to oxidant air pollutants of a photochemical type, primarily ozone and nitrogen dioxide, at concentrations approximating high ambient levels. Structural-functional correlates of the effects will be assessed by integrated physiologic, morphometric and biochemical studies. Specific pathogenetic relationships to be sought, by determination of appropriate parameters, are: 1) Between changes in pulmonary function and morphometry of airways, alveoli and the blood-air barrier. 2) Between decreased resistance to infection and enzymatic defects and lipid peroxidation in pulmonary alveolar macrophages. 3) Between morphometry of the blood-air pathway and lipid peroxidation.

Other hypotheses to be tested concern the concept of oxidant lung damage as an acceleration of lipid peroxidation-molecular damage and the possible prophylactic effect of diets with increased content of vitamin E and other antioxidants.

The integration of functional, morphologic and biochemical observations from exposures to realistic levels of pollutants will allow more confident predictions regarding possible long-term effects in man. Comparisons between rats and non-human primates will substantiate the validity of extrapolating from experimental animals to man. One outcome will be the establishment of rational tolerance limits for concentrations of oxidant pollutants in ambient air.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0174, EFFECT OF POLLUTANTS ON PULMONARY BACTERIAL DEFENSE
E. GOLDSTEIN, Univ. of California, School of Medicine, *Davis, California* 95616

The proposed studies are designed are to: 1) delineate the effect of atmospheric exposures of various concentrations of nitrogen dioxide on murine pulmonary anti-bacterial defense mechanisms; 2) evaluate the combined effect of ozone and nitrogen dioxide on murine defenses; and 3) develop a biological model which can be used to establish air quality control standards. Investigations performed during the first year of this grant demonstrated that short term exposures to relatively low levels of ozone O.62 ppm inhibited murine ability to kill inhaled bacteria (1, 2). We plan to investigate the effects of nitrogen dioxide and nitrogen dioxide in combination with ozone in a like manner using murine pulmonary bactericical activity as the test parameter. Mice will be exposed to combinations of the two pollutants using an isobologram type of experimental design. Pulmonary bactericidal activity will be measured by previously published aerosol techniques. Ozone and nitrogen dioxide will be monitored continuously using equipment which minimizes cross-interference. If ozone and nitrogen dioxide manifest an additive or synergistic result, we expect to observe an adverse effect of the combination at concentration levels which are less than those necessary to cause impairment by each agent alone and which in some instances will approximate atmospheric pollutant levels. The demonstration of murine bactericidal dysfunction at ambient oxidant levels could be used as an air quality control measurement.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0175, ANATOMY OF THE RESPIRATORY SYSTEM IN HEALTH AND DISEASE
W.S. TYLER, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-V0-ANA-2150)

OBJECTIVE: Determination of structure and function of resporatory system in health and disease. Compare and correlate the structure and function of respiratory system in animals and man.

APPROACH: Application of as many methods as possible to lungs from a variety of animals will be made. Cardiac pulmonary function tests will be applied to a number of normal and diseased animals.

PROGRESS: Our comparative studies of chronic pulmonary emphysema have been summarized and brought to publication (87 below). Additional studies, using scanning electron microscopy in addition to transmission electron microscopy and histochemistry, are in progress. We hope to reveal the basic nature of pores in the interalveolar septum and their relationship to the various cell types. Several experiments designed to reveal the reaction of the respiratory system to known air pollutants, specifically ozone, have been conducted and the results are being analyzed. Some of the analyses will be deferred until the quantitative image analyzing computer, which has been funded, is received. Additional experiments will be conducted during 1970. We have continued our studies of the avian lung by applying scanning electron microscopy, transmission electron microscopy, and histochemistry to lungs from chickens and Japanese quail. We have developed new procedures to prepare pulmonary tissues for scanning electron microscopy and will present results of our studies at three scientific meetings this year. Our most important observations concern the nature of the atria, the epithelium of the atria, and the manner of communication between the tertiary bronchus, atria, and air capillaries.

1. AIR QUALITY

SUPPORTED BY California State Government - Sacramento

1.0176, CHEMICAL ELEMENTS OF BIOLOGICAL FLUIDS AND TISSUES
L.R. ANSPAUGH, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

Essential information is lacking on the normal occurrence and distribution in man of most of the elements, even though there have been many studies on those presently known to be essential or highly toxic. Variations with age, sex, health state, and dietary levels are virtually unknown as are the homeostatic control processes. As man is increasingly exposed to various less familiar elements, whether by fallout, industrial contamination, or other means, such information becomes essential if the hazards of exposure to stable or radioactive isotopes are to be intelligently evaluated and controlled.

The long-range objectives of this program are (1) to fill in these gaps of knowledge as far as possible within the limits of our presently established techniques of x-ray spectrography and optical emission spectroscopy, and (2) to pursue other methods to answer specific questions raised by this and other prediction programs. Basically our present methods are applicable to the study of 73 elements from atomic number 3 to 92. The unique contribution of this program is its ability to analyze for many elements, of which a great number have not been studied previously.

A secondary objective is to compile and organize the available published information on the concentration of all elements in the various human tissues, and to tabulate them using a single, consistent set of units.

Results: Advanced capabilities have been established in x-ray spectrography and optical emission spectroscopy. Studies on the elemental content of brain regions and livers are nearly complete. An interesting finding is that approximately 15 percent of the samples from mentally retarded individuals contain unusually high amounts of heavy metals indicating that the incidence of metallic poisoning may be considerably higher than anticipated.

SUPPORTED BY U.S. Atomic Energy Commission

1.0177, INTERACTION OF ELECTRON ACCEPTORS WITH CHLORPROMAZINE
H. KEYZER, Calif. State College, School of Letters, *Los Angeles, California* 90032

Recent studies in our laboratory have indicated that electron acceptors such as sulfur dioxide and nitrogen dioxide, major components of polluted air, interact with chlorpromazine to form a product which alters the effect of this drug in terms of hypothermia and sedation in white mice.

It is proposed to study in detail the exact nature of the above interaction product by resonance techniques, spectroscopic methods and electrochemical means.

It is further proposed to inject the interaction product (in which the molar concentration of the electron acceptor is varied from 0 to 10) into statistically significant populations of mice and to observe the effect of the modified drug on a comparative basis with the pure drug, pure acceptor and controls in terms of the physiological indicators, hypothermia and sedation.

The objectives of this study are: to discover what the precise nature is of the modification induced in chlorpromazine by the action with specific electron acceptors, whether CPZ activated by extraneous electron acceptors is consonant with the primary event of 'in vivo' activation of the drug; whether 'in vitro' activation can provide a new technique to understand the basic action of the drug.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0178, SMOG EYE IRRITATION - EXPERIMENTAL AND CLINICAL STUDIES
A.T. SAPSE, Univ. of California, School of Letters, *Los Angeles, California* 90024

The aim of this study is the assessment of harmful effects of air pollutants on the eye after short and long term exposure to smog, artificial smog and smog components. The principal components of the eye presumably exposed to the action of smog, i.e., tears, cornea conjunctival area and the lacrimal gland system will be examined.

The results of studies performed so far clearly indicate that the problem of smog eye irritation is not just a transient irritation of the eyes. Apparently significant changes are taking part as a result of long-term exposure.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0179, INHALATION OF WHOLE SMOKE, SYNTHETIC SMOG, & AMBIENT AIR ON THE RESPIRATORY TRACT & OTHER ORGANS OF PATHOGEN-FREE MICE (ABBREV)
C.G. LOOSLI, Univ. of Southern California, School of Medicine, *Los Angeles, California* 90033

Studies are being continued to determine the effect of synthetic smog on the lungs of pathogen free male and female mice. Synthetic smog consists of NO2 (0.4 to 0.8 ppm), 03 (0.2 to 0.4 ppm), SO2 (0.8 to 1.2 ppm), and CO (4.0 to 6.0 ppm). These are levels found in Los Angeles ambient air. It does not contain particulates. Control animals of similar age will be housed in filtered air rooms. Four groups of animals will be studied. Group one will be subjected to long term exposure to synthetic smog. Group two will be exposed to synthetic smog and cigarette smoke. Group three, living in filtered air, will be exposed daily to fresh cigarette smoke alone. Group four will serve as control and be housed in filtered room air. Periodically, mice from the four groups will be sacrificed and comparative studies of the lung changes in the four groups will be made. Sufficient animals will be used to make observations over a twenty-four months' period.

SUPPORTED BY Council for Tobacco Res. - New York, N.Y.

1.0180, RESPIRATORY TRACT AIR POLLUTANTS AND BIOLOGICAL AGENTS
C.G. LOOSLI, Univ. of Southern California, School of Medicine, *Los Angeles, California* 90033

Studies begun last year will be continued. They are concerned with the role of certain known air pollutants, nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3) and carbon monoxide (CO), airborne inorganic particulates, and biological agents (Staphylococcus aureus and influenza PR8-A virus), alone and in combination, on the health and particularly the lungs of pathogen free mice. Comparable control groups of mice of similar age and strain will be housed in filtered air rooms. Pathogen free mice will be exposed for 24 months to a 'synthetic smog' (SS) composed of NO2, SO2 and CO in amounts found in ambient Los Angeles air. Similar groups of mice will be housed in a filtered air room (FA). Sufficient animals will be exposed so that smaller groups of SS and FA exposed mice can be sacrificed for detailed study of the lungs by histological, histochemical, biochemical and electron microscopic procedures. Mice living in SS and FA will also be exposed to particulates collected from the Los Angeles atmosphere. Likewise, mice in SS and FA will be subjected to airborne influenza virus or Staphylococcus aureus to assess the role of these biological agents in producing changes in respiratory tract structure. The above studies are designed to evaluate the respective roles of gaseous, inorganic particulates, and biological agents in the production of lung lesions which might resemble chronic bronchitis or emphysema in man.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0181, ACUTE TOXICITY OF HEATED ASBESTOS
J. JAGATIC, U.S. Veterans Administration, Hospital, *Martinez, California* 94553

Purpose or significance of project (hypothesis): The desire of the Investigator is to establish firm evidence that 1) heated asbestos is acutely toxic for mice if it is injected intraperitoneally. 2) That mice fed with heated asbestos develop signs of acute toxicity. 3) Observation of mice exposed to breathing dust from heated asbestos. If these experimental observations are reproducible with accuracy and consistency comparison is obvi-

ous with the workers in the asbestos industry, steel mills, shipping yards, brake lining and many other occupations. Preventive measures should be introduced to help many veterans from becoming seriously ill.

Plan of approach (design): Experimental animals (mice) should be divided into 4 groups. Each group should be composed of 100, 2 month old white female mice from the same breed. 1) First group of 100 mice should be injected with 1cc emulsion of 50% heated asbestos in N/saline. 2) Second group should have mixed in the daily food heated asbestos in powdered form without being diluted and offered to the animal daily. 3) Dust chamber (closed box without ventilator) should be used 2 hours daily to expose the animal to dust. 4) Fourth group should be controlled animals applying on them the same technique as above but instead of heated asbestos, talcum powder as a media.

Technique: 1) Each animal will be autopsied and tissue examined by light and electron microscope. 2) Blood of these animals will be examined by micro method for the chemistry.

SUPPORTED BY U.S. Veterans Administration

1.0182, CARBON MONOXIDE AND HUMAN INFORMATION PROCESSING

R.R. BEARD, Stanford University, School of Medicine, *Palo Alto, California* 94305

The aim of the proposed research is to examine the effects of exposure to low concentrations of carbon monoxide (CO) on several levels of human performance within the context of information search, selection and manipulation. CO effects on information processing in both visual and auditory modalities will be evaluated. This will include tests which are an extension of ongoing research in our laboratory on vigilance, simple discriminatons (including temporal discrimination), as well as further work on memory and more complex tests of cognitive processes.

Multiple measures will be used to evaluate the effects of CO within this framework of information processing by human subjects. These measures will include behavioral responses, electrophysiological activity (EEG and evoked potentials), and eye movements, when each is applicable to the testing situation. The amount of CO present in the blood will be determined by estimating the carboxyhemoglobin (COHb) levels present during all testing using both blood samples and breath samples. Testing equipment and methodology developed in our behavioral toxicology laboratory over the past eight years will continue to have direct application and use in the current proposed studies. The reserch is directed toward the practical objective of understanding the extent of impairment of human performance (both psychological and physiological) from exposure to CO and thus aid in the establishing of air quality standards relevant to environmental conditions. The methods which are being developed are applicable to a wide variety of toxic agents, both industrial and pharmacological.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0183, BIOCHEMICAL EFFECTS OF AIR POLLUTANT OXIDANTS

J.B. MUDD, Univ. of California, School of Agriculture, *Riverside, California* 92502

It is proposed that studies of the reaction of ozone with reduced nicotinamide adenine dinucleotides be continued. The nicotinamide ring is cleaved but it remains to identify the products. The importance of this oxidation under physiological conditions is to be studied first by comparing its oxidation with that of glutathione, both compounds being exposed to ozone simultaneously.

Reaction of ozone with lipoprotein systems: Earlier studies with pure preparations of amino acids, proteins and fatty acids have now led to a study of ozone on more complex lipoprotein structures, in particular the membranous structures of cells. Ozone reacts both with unsaturated fatty acids and with certain amino acids. The question is whether the protein or the lipid of the lipoprotein system is first affected by ozone. We propose to measure the reaction of ozone a) with unsaturated fatty acids in the presence and absence of glutathione; b) with pure lecithin in the presence and absence of glutathione and c) finally with subcellular organelles in the presence and absence of glutathione. Glutathione is normally oxidized by ozone. The above studies use glutathione as a competitor with the unsaturated fatty acids. Oxidation of the unsaturated fatty acids will be measured both by assay of malonaldehyde and peroxide.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0184, AN EVALUATION OF THE HEALTH EFFECTS OF AIR POLLUTION IN ALBERTA

S. GREENHILL, Univ. of Alberta, *Edmonton, Alberta, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

1.0185, EFFETS DES POLLUANTS ATMOSPHERIQUES SUR LES ENZYMES ANTIPROTEOLYTIQUES ET NEUROHUMORAUX

S. JEGIER, Univ. of Montreal, *Montreal, Quebec, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

1.0186, EFFECTS OF ENVIRONMENTAL POLLUTION ON THE EYE

P.K. BASU, Univ. of Toronto, School of Medicine, *Toronto, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

1.0187, BIOCHEMICAL AND HISTOCHEMICAL INVESTIGATIONS OF ENZYME SYSTEMS IN MAMMALIAN LUNG

A.E. VATTER, Univ. of Colorado, School of Medicine, *Denver, Colorado* 80220

In this project, we propose to locate precisely the site of enzyme- substrate reactions in the cells of pulmonary tissue by electron microscopic cytochemical methods. The findings will be correlated directly with biochemical studies of isolated systems or cell fractions containing similar enzymatic activities. The initial approach is to find synthetic substrates which will undergo an enzymatic reaction such that one of the products of hydrolysis forms an insoluble compound rendering the site of reaction electron-opaque. The substrate will be designed so that the product can also be determined spectro- photometrically. Once the reaction has been detected in a specific organelle of the cell, biochemical preparations will be made of these organelles and similar reactions followed using the same substrates. These subfractions will be examined by electron microscopy as a further control. Studies of the effects of inhibitors and thermal denaturation of these enzymes in whole tissues and after isolation, and to study the kinetics of the purified enzymes using a variety of substrates under various experimental conditions are planned. Enzyme preparations, tissue slices and animals will be treated with substances found in polluted air (noxious gases and irritants) to determine any effect upon such enzyme-substrate reactions.

SUPPORTED BY Amer. Med. Assn. Educ. & Res. Foundation

1.0188, PROPERTIES OF PARTICULATE POLLUTANTS

M.L. CORRIN, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

Research is continuing on the extent of adsorption of gaseous pollutants such as sulfur dioxide on atmospheric particulates and simulants. Isotherms will be obtained at several temperatures for the adsorption of pure sulfur dioxide; surface areas of the solids will also be measured. Heats and entropies of adsorption will be calculated. Isotherms for the adsorption of sulfur dioxide from air at several temperatures and relative humidities will also be determined and the desorption rates at high temperatures and relative

humidities (lung conditions) will be measured. The concentrations of sulfur dioxide (and the corresponding pressures) will be in the range of 0.05 to 10 ppm. From this information a model for sulfur dioxide transport via the particulate adsorption and desorption route into the lung will be developed. The adsorption of pure sulfur dioxide will be measured with the aid of a sensitive pressure transducer and a volumetric adsorption system. The adsorption of sulfur dioxide from air will involve a volmetric system with determination of sulfur dioxide in small volumes of air with a microcoulometer.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0189, IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD
H.W. EDWARDS, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

The major purpose of this proposed research is to develop and test an interdisciplinary mechanism for studying environmental contamination problems using a system approach. The purpose of the system approach is to provide the kind of broadly based information concerning the movement of a contaminant through the environment which will be useful in evaluating the nature and extent of a possible environment hazard. Examples of such contaminants include heavy metals such as lead and mercury, combustion-produced carcinogens, pesticides, etc.

The selection of lead for the model system offers several advantages in that it occurs in demonstrable amounts in the environment, has known deleterious health effects, and can be traced in its movement by newly-developed isotope-ration measurement techniques. The proposal has been well developed and the scientific staff is qualified to conduct the proposed research. Arrangements have been made for interactions between Colorado State University and other institutions interested in similar problems.

SUPPORTED BY U.S. National Science Foundation

1.0190, EFFECTS OF DENTAL AEROSOLS ON OPERATORY AND SUBMARINE ENVIRONMENTS
M.A. MAZZARELLA, U.S. Navy, Submarine Medical Center, *Groton, Connecticut* 06340

Technical Objective: Develop corrective methods for reduction or elimination of contamination hazards associated with airborne dissemination, transfer, or reentrainment of microorganisms and toxic products resulting from dental procedures and naso-oral manipulations in submarine, dental clinic, and underwater habitat environments.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0191, EFFECT OF EXPOSURE TO THE TOTAL SUBMARINE ATMOSPHERIC ENVIRONMENT ON PHYSIOLOGICAL FUNCTIONS
K.E. SCHAEFER, U.S. Navy, Submarine Medical Center, *Groton, Connecticut* 06340

Technical Objective: Determine physiological effects of atmospheric contaminants in submarines and to carry out controlled experiments on physiological effects of CO2, CO, ions and aerosols.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0192, ATMOSPHERIC POLLUTION AND RESPIRATORY DISEASE
R.E. SNELL, Hospital for Sick Children, *Washington, District of Columbia* 20017

The long term goal of studies carried out under this project is to describe the concentration - time relationships necessary to produce a change in respiratory function when an individual with pulmonary disease is exposed to specific agents associated with air pollution. In the initial years of support, the investigators were concerned with the systematic evaluation of various tests of function in children with asthma and in the design of an Environmental Control Unit where it would be possible to carefully control and monitor barometric pressure, temperature and humidity. Studies are currently being carried out in the unit to determine whether there is any improvement in function when the asthmatic child is removed from the usual urban environment to one that is pollution-free. By this approach, it is hoped to better define the sub-acute and chronic effects of exposure to various gaseous and particulate agents and to acquire data necessary to establish rational air quality standards.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0193, FURNISHING NOTICE OF RESEARCH PROJECTS RELATIVE TO ALL BIOLOGICAL INFORMATION
UNKNOWN, Smithsonian Institution, *Washington, District of Columbia* 20560 (EHSD-71-529)

The Contractor shall furnish all personnel, material and equipment necessary to perform the following: Furnish notice of research project relative to all biological information (exclusive of vegetation effects) concerning the following air pollutants: SOx, particulate oxidants, O3, NOx, Pan, CO, polynuclear organics, carcinogens, mutagen, teratogens, asbestos, aeroallergens, odors, H2S, HCl, Cl2, Pb, F, Cd, V, Mn, Zn, As, Ni, Cr, Cu, Ba, Se, Hg, B Be, auto exhaust, diesel exhaust, industrial emissions, or any additional material of future interest. On a quarterly basis, during the period from date of award through June 30, 1971.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0194, TOBACCO SMOKE CONTAMINATION IN AIR TRANSPORT AIRCRAFT
E.A. RICHARDSON, U.S. Dept. of Transportation, Federal Aviation Agency, *Washington, District of Columbia* 20590 (000573)

Frequent complaints have been received by the Federal Aviation Administration from airline passengers who alleged that cabin smoke levels are achieved on some flights which are harmful to health. An editorial in Science, December 22, 1967, has highlighted the adverse effects of air pollution by tobacco smoke. Some have contended that cabin tobacco smoke may compromise airmen flight performance.

Measurements will be made of the cabin environmental levels of tobacco smoke products during typical air transport flights. Carbon monoxide will be measured with a MSA CO indicator and chart recorder. Polycyclic benzopyrene type compounds will be determined with a battery operated pump and charcoal tubes. In addition, particulates will be obtained for analysis with a pump, charger and filter-paper device. Aldehydes, ketones, and aromatic hydrocarbons will be obtained by pump and charger, plus charcoal filter. Oxides of nitrogen and sulfur may also be determined. In a number of instances, passenger blood samples will be obtained just prior to the flight, during, and immediately after, so that carbon monoxide blood levels can be correlated with environmental levels. Also, smokers and nonsmokers will serve as subjects and a record will be maintained of the type of smoking done by each subject (cigarette, pipe, cigar) and how much, in order that a proper correlation and analysis can be made.

Coordination is effected with the U.S. Public Health Service in Cincinnati with respect to measurements, and with the U. S. Air Force regarding Military Air Transport flights during which cabin air samples are obtained.

Document provided by Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

1.0195, LUNG ALVEOLAR SURFACTANT - PHYSIOLOGICAL, BIOCHEMICAL, AND THERAPEUTIC ASPECTS IN CARDIOPULMONARY DISEASE
L.T. ELLISON, Medical Coll. of Georgia, School of Medicine, *Augusta, Georgia* 30902

The purpose of this project is (1) to determine the role of lung alveolar surfactant in a variety of cardiopulmonary diseases, (2) to establish the mechanism (s) of alteration, and (3) to correlate this information in the anticipation that it may be used to prevent or treat conditions in which surfactant is abnormal.

Surfactant will be determined in lung biopsies obtained in patients undergoing thoracotomy and in patients at postmortem, an attempt being made to obtain tissues from both normal and abnormal appearing areas. Data from the clinical record will be carefully recorded in order that it may be correlated with the surface tension measurements. Factors suspected of having some influence on surfactant will be especially noted.

The effect of various concentrations of oxygen and the effect of ozone and other air pollutants on surfactant will be studied in animals.

The alveolar bubble method will be used to evaluate surfactant.

SUPPORTED BY Georgia Heart Association

1.0196, ENVIRONMENTAL RADIOACTIVITY AND TRACE ELEMENTS IN MAN

R.B. HOLTZMAN, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-38)

The concentration of Ra 226, Pb 210, Po 210, stable lead and other stable trace elements in food, water, air, and excreta are being correlated with the concentrations of these same elements in human tissue. Material has been obtained from three geographic areas for which human exposure to lead and Pb 210 differs markedly. Materials from the Eskimos and Indians in Canada and from Puerto Rico show a high and low rate of exposure to Pb 210, Po 210 and Pb, respectively. In addition, a complete metabolic balance study for Pb 210, Po 210 and Pb in man has been initiated with Herta Spencer at Hines Hospital. From these and other studies studies, the relative contribution of food and air to the lead content of man under normal environmental conditions of exposure can be derived. Similar relationships can be derived for other trace elements from these same materials.

SUPPORTED BY U.S. Atomic Energy Commission

1.0197, AIR POLLUTION MEDICAL RESEARCH CONFERENCE

F.W. BARTON, Amer. Medical Association, *Chicago, Illinois* 60610

The objectives of the American Association in conducting this project are: (a) to encourage scientific investigation of the effects of air pollution on health; (b) to critically examine the present status, needs and goals in air pollution measurements in order to achieve better correlation of physical, chemical and biomedical data; (c) to present original research findings and to explore application of these findings to air pollution control efforts and to medical care.

It is felt that the scientific results of research are not reaching the medical profession and other interested persons who are most involved in the use of those results in a form they could best understand and take appropriate action. There is a little too much of the 'researcher speaking to other researchers.' While this in itself is valuable, it is believed that the program should try to answer questions by interested physicians and others as to what they should do about what research shows to be true.

To more effectively implement the goals of this project, therefore, the Conferences will be organized around specific problems which not only enable the speakers to present their current research, but will effectively reach physicians, the allied professions and even the general public. To aid in this attempt to reach and activate an audience which can implement action in this field, Summary sessions will attempt to tie together all the presentations in a manner most conducive to practical use. The AMA expects that not only will the program be sophisticated, but that the long-range accomplishments will be great.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0198, STUDIES OF ENVIRONMENTAL AIR POLLUTANTS

G.T. OKITA, Northwestern University, School of Medicine, *Chicago, Illinois* 60611

The objective of the proposed investigation is to obtain information on the biological and biochemical effects of environmental air pollutants on experimental laboratory animals. More specifically, we are interested in investigating the following two problems: 1) The locus of action of aromatic polycyclic hydrocarbons and 2) in vivo metabolic effects of environmental noxious gases.

For studies concerned with the site of action of polycyclic aromatic hydrocarbons (PAH), we are interested in determining the molecular nature of the carcinogenic action of PAH. Nonplanar endosuccinate derivatives of dimethylbenzanthracene and dibenzanthracene are being synthesized and tested for their carcinogenic activity. Preliminary findings indicate that both derivatives are carcinogenic in mice and rats. Radioactive derivatives are also being prepared for drug metabolism studies to determine whether they are broken down to parent compounds. If these non-planar compounds are confirmed to be carcinogenic and are not broken down to PAH, these findings may invalidate the current hypothesis that PAH acts by intercalating between base pairs of DNA.

For studies concerned with investigating in vivo metabolic effects of environmental noxious gases, we are interested in determining the type of biochemical lesion induced by SO2. In vivo biochemical studies are being conducted to compare differences in oxidation of select C14- labeled biochemical intermediates between control animals and animals exposed to SO2. Both acute and chronic exposure to varying concentrations (0.1 to 20 PPM) of SO2 will be tested. Histologic examination of pulmonary tissue will also be performed to determine whether biochemical changes can be detected before pathological changes. Similar studies also are planned for NO and NO2.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0199, THE EFFECT OF INFLUENZA VIRUS AND NICOTINE ON THE NUCLEAR STRUCTURE OF CILIATED HUMAN EPITHELIUM

J.J. BALLENGER, Evanston Hospital, *Evanston, Illinois* 60201

The general objective of the project here proposed is to investigate the effects of various air pollutants upon the structure and function of the muco-ciliary cleansing system of the respiratory tract of man and also of possible nuclear changes in the cells so exposed. The rotating explant method will be used in the investigations since it provides an isolated epithelial (ciliated) 'organ' which performs work and which can be subjected to quantitative experimentations and analysis. A lower animal model will be actively sought in order to make the method more flexible. It is also our aim to determine whether or not there is a possible relationship of air pollutants and/or viruses working separately or in concert to the appearance and progression of respiratory malignancy.

Other avenues of study include: further elucidation of the action of substance such as nicotinamide-adeno-dinucleotide upon muco-ciliary function, effect upon ciliary activity of the induced allergic states, the effect upon this system of corticosteroids and other hormonal substances.

We will also, as time permits, observe the effects of certain crude phenols and tobacco tars on the muco-ciliary cleansing system.

Finally, if the epithelial cells survive and grow they will be examined every five to seven days for nuclear pattern shifts. Time-lapse photography will be used to record growth changes where feasible.

SUPPORTED BY Amer. Med. Assn. Educ. & Res. Foundation

1.0200, STRUCTURE AND FUNCTION IN TRANSPORTING EPITHELIA

J.L. OSCHMAN, Northwestern University, School of Arts, *Evanston, Illinois* 60201

Recently much has been learned about the biophysical basis of membrane transport. One of the most significant contributions is the standing gradient hypothesis, which can account for the structural and functional characteristics of fluid transport by both absorptive and secretory epithelia. Our work concerns the validi-

ty and implications of this important hypothesis. The main emphasis is on the structure and function of specializations of the cell surface, such as microvilli, basement membrane intercellular spaces, basal infolds, and canaliculi. The epithelia chosen for study have particular advantages for study of transport mechanisms, and for considering the general mechanisms of absorption and excretion in animals. The latter aspect of the study has relevance to the problem of the effects of environmental pollution on biological systems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0201, NEUTRON ACTIVATION OF BIOLOGIC SPECIMENS
Y.T. OESTER, U.S. Veterans Administration, Hospital, *Hines, Illinois* 60141

Progress: Emission spectroscopy (spark), neutron activation, and atomic absorption techniques continue to be employed in the studies of urine, serum, finger nails, aortic and myocardium. Collaborative study with the World Health Organization (WHO) has been implemented on the possible role of trace elements in cardiovascular function. This collaborative venture was extended to Argonne National Laboratory (reactor facilities) and to Loyola University Chemistry Department (emission spectroscopy facility). Specimens continue to be collected and are being received from different regions of the world (New Zealand, Jamaica, etc.). During this period of time a second major study was initiated. This study is on a possible relationship of trace elements normally found in the atmosphebe of metropolitan Chicago area to elements observed in inhabitants with normal lungs and lungs with various functional disorders. In addition to lungs, the following organs are also collected: spleen, liver and mediostinal lymph nodes. These organs may be used in future studies.

SUPPORTED BY U.S. Veterans Administration

1.0202, O3 & NO2 TOXICITY IN NORMAL & ANTIOXIDANT-FED ANIMALS
A.S. CSALLANY, Univ. of Illinois, School of Agriculture, *Urbana, Illinois* 61801

Experiments will be conducted to determine the chronic effects of small concentrations of the pollutant gases NO2 and O3 on the metabolism of rats and mice. Animals will be exposed continuously throughout their life span to one of the following concentrations of these gases: 0.05 ppm NO2 , 0.15 ppm NO2, 0.15 ppm O3, 0.45 ppm O3. The following parameters of response will be determined: (a) gross and histopathology of tissues and organs (b) growth rate (c) reproductive performance (d) longevity (e) concentrated of lipofuscin pigments in the tissues (f) levels of conjugated dienes in the tissue lipids (g) amounts of carbonyl compounds associated with tissue lipids (h) rate of oxidation of vitamin E in vivo (i) peroxidase activity in the tissues. The effect on the susceptibility of the animals to these oxidants of depriving them of the natural lipid antioxidant vitamin E, of providing them with high levels of this vitamin and of administering the synthetic antioxidant DPPD, also will be determined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0203, EXPERIMENTAL INFECTIVE PNEUMOCONIOSIS
S.H. ZAIDI, Industrial Toxicology Res. Ct., *Lucknow, Uttar Pradesh, India*

The objective of the study is to determine the role of infection and immune reactions in the development of asbestosis and other dust related pneumoconioses.

In the pathogenesis of dust related pneumoconiosis one widely held view has been that the dust itself acting alone and unaided in the lung tissue is the initiating agent of the disorder e.g., silicosis. In other dust related pneumoconioses, such as asbestosis, byssinosis, talcosis, and coal miners pneumoconiosis, the possible role of infective organisms is not clear except in pulmonary massive fibrosis among coal miners. That an infection can exaggerate or modify the form of dust induced pneumoconiosis requires further investigation and documentation. It may be the case that there are two processes involved in dust pneumoconiosis working together which augment the effects of each separately - the dust and the infective agent.

A study will be made of the combined action of the different dusts which are common contaminants of the air in asbestos and coal mining and processing and the various strains of suspected pathogens present in the mines, processing plants and lungs of the exposed workers. The respirable dust will be collected from various coal and asbestos mines and processing plants. The organisms will be isolated from the respiratory tract of mine and processing plant workers.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0204, THE EFFECTS OF ENVIRONMENTAL POLLUTANTS IN GERMFREE RODENTS
M. POLLARD, Univ. of Notre Dame, School of Arts, *Notre Dame, Indiana* 46556

This is a collaborative research program with the Laboratory of Toxicology and Pathology, Cincinnati, Ohio, for the purpose of delineating the role of environmental pollutants in disease. Germfree rats will be the experimental subjects because of the controlled environment in which they live and the absence of complicating influences, such as injection, which would confuse the interpretation of experimental results.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0205, BIOCHEMICAL EFFECTS OF SIMULATED AIR POLLUTANTS
F L. ESTES, Gulf South Research Institute, *Baton Rouge, Louisiana*

A dependable system for the delivery of trace components in a gas stream has been developed and appropriate assay procedures for the biochemical systems have been validated. These developments should provide for the valid comparison of the relative effectiveness of differing pollutant mixtures on biochemical reaction. In addition, the responses of the various biochemical systems should give indication of those biochemical changes that may be significant in the subsequent development of pathologic changes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0206, ENVIRONMENTAL TOXICANTS AND PERINATAL DEVELOPMENT
R.D. HARBISON, Tulane University of Louisiana, School of Medicine, *New Orleans, Louisiana* 70118

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Life Ins. Med. Res. Fund - Hartford, Conn.

1.0207, RESPIRATORY FINDINGS AND URBAN LIVING
G.W. COMSTOCK, Johns Hopkins University, School of Public Health, *Baltimore, Maryland* 21205

Standardized surveys of respiratory findings among telephone employees were done in rural Westchester County, Baltimore, Washington, and southern Manhattan, and repeated 5 years later. Exposure to an urban environment at home and at work is used as the index of air pollution exposure of these men. Their response to this exposure will be measured by changes in respiratory symptoms between surveys among men with no change in place of work or residence.

SUPPORTED BY National T B & Resp. Dis. Assn. - New York

1.0208, A PROGRAM IN ENVIRONMENTAL PHYSIOLOGY AND TOXICOLOGY
R.L. RILEY, Johns Hopkins University, School of Public Health, *Baltimore, Maryland* 21205

The major objective of this program is to pursue a variety of investigations related to the maintenance of human health in the face of environmental hazards. We shall approach this objective

by elucidating mechanisms of action on body tissues and will concentrate on studies in the following areas where members of the department have greatest competence: A) Responses of the respiratory system to airborne agents; B) Physiological and behavioral evaluation of carbon monoxide hazards; C) Toxic effects of trace metals; D) Synergistic and antagonistic mechanisms responsible for changes in toxicity of environmental agents; and E) Cooperative prospective study of a human population with reference to the incidence of cerebral vascular disease. Because of the wide variety of disciplines required, we shall cooperate with other departments and where possible coordinate activities in order to bring the full potential of the School of Hygiene and the entire University to bear upon problems of the environment.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0209, ENVIRONMENTAL FACTORS AND CHRONIC BRONCHITIS
H.D. KERR, Univ. of Maryland, School of Medicine, *Baltimore, Maryland* 21201

The research objectives are to identify the relationships between respiratory health and environment. Interrelated investigation of human response by variation and patterns of respiratory function will describe in part the relationshps between specific significant environmental factors and agents as causing and/or influencing th course of chronic obstructive respiratory disease.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0210, FUNCTIONAL ADAPTATIONS TO ATMOSPHERIC CONTAMINANTS
W.H. TEICHNER, Amer. Inst. for Res. Behv. Sc., *Silver Spring, Maryland* 20910

This research is concerned with two problems: (1) The development of methods for evaluating the functional effects of air contaminating agents, and (2) the study of functional adaptations to such agents with a particular interest in adaptations to low level, long-term exposures. The approach is through both behavioral and physiological dependent measures. Containants to be studied will be nitrogen dioxide, formaldyhyde, and carbon monoxide.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0211, USSR LITERATURE ON AIR POLLUTION AND RELATED DISEASES
M.Y. NUTTONSON, Amer. Inst. of Crop Ecology, *Silver Spring, Maryland* 20910

The research goals for the coming year is to proceed with the survey, selection, and translation of USSR's technical air pollution literature as it relates: (a) to the nature of air pollution in the different industrial regions of the country, (b) to the effect of the specific physical environments of the various industrial regions of the Soviet Union on the propagation and dispersal of air pollutants as well as on the level of air pollution (c) to the biological effects of air pollutants, and (d) to methods of control of air pollution.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0212, AUTOMOBILE EXHAUST AND CHRONIC RESPIRATORY DISEASE
F.E. SPEIZER, Boston Dept. of Hlth. & Hosps., *Boston, Massachusetts* 02118

Epidemiological investigations into the factors relating to the occurrence and development of chronic non-specific respiratory diseases have, in general, followed a pattern of retrospective point prevalence studies. Increased levels of cigarette smoking and air pollution have been associated with the increased prevalence of chronic respiratory disease. Few prospective studies on the early stages of these diseases have been conducted. Until factors relating to susceptibility to chronic respiratory diseases are understood, it is unlikely that the increasing morbidity and mortality from these diseases can be controlled. To try to relate factors associated with these diseases to the development of disease, this study is designed to follow a selected segment of the population over an extended period of time and to record the rate of change of signs and symptoms associated with the development of chronic respiratory disease. Intense exposure to automobile exhaust and cigarette smoking are the major environmental agents to be evaluated. The assessment of the population will include interview by standard questionnaires, measurements of ventilatory capacity, evaluation of sputum production, both qualitatively from a bacteriological standpoint and quantitatively in amount, and an evaluation of the host response mechanisms by relatively detailed immunological analyses. Exposure to the environment will be assessed by several techniques. These will include environmental sampling as measured by standard monitoring equipment and personal sampling devices. In addition, measures of biologically incorporated constituents of automobile exhaust, particularly carbon monoxide and lead, will be determined. By studying prospectively a relatively healthy segment of the population, it is believed that factors related to susceptibility to chronic respiratory diseases in high risk individuals can be identified.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0213, PHYSIOLOGICAL RESPONSE TO ATMOSPHERIC POLLUTANTS
M.O. AMDUR, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

The changes in the mechanical behavior of the longs of unanesthetized guinea pigs are used to assess the response to respiratory irritants. Emphasis continues to be on the effect of inert aerosols on the degree of response to irritant gases, with special attention to sulfur dioxide. The problem of the potency of irritant aerosols of different particle sizes will also remain an area of consideration.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0214, RESPIRATORY DISEASE AND ENVIRONMENTAL EXPOSURES
B.G. FERRIS, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

Studies of various population groups are being made to determine whether specific airborne materials are factors in the causation of chronic respiratory disease. The ultimate purpose is to try to determine what constitutes safe or reasonably safe levels for exposure of populations. Populations studied to date have included samples of general populations - adults and children, asbestos workers, welders, and men exposed to toluene diisocyanate. Studies of the children involved absences from school and simple tests of pulmonary function. School absences even when corrected for non-sickness absences or examining only those due to respiratory illness did not seem to be adequately sensitive to demonstrate any effect of air pollution. Tests of pulmonary function, however, did indicate that the children in the more polluted area had poorer pulmonary function. Studies of the asbestos workers, welders, and pipe fitters showed impairment of diffusing capacity in the asbestos workers and more shortness of breath than in the other two categories. Analysis of these data is continuing. A repeat survey of a sample of the population from Berlin, N.H. has been made and is in the process of being analyzed. Preliminary results indicate that the levels of air pollution have not changed significantly since 1961 but the prevalence of respiratory disease when standardized for age, sex, and cigarette smoking has decreased slightly.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0215, FACTORS AFFECTING EXCRETION OF INDUSTRIAL POISONS
H.B. ELKINS, State Dept. of Labor & Indust., *Boston, Massachusetts* 02202

Fluoride Excretion in Workers Exposed to Freon - The relationship between urinary fluoride excretion and trichlorotrifluoroetane exposure will be studied in workers exposed to this solvent (perhaps other freons also) by urinalyses and air tests.

1. AIR QUALITY

Mercury Loss in Aged Urine - A study will be made to determine the effect of storage on mercury content of urine. Mercury loss through volatilization by bacteria found in aged urine has been reported. The practical significance of this finding will be investigated in urine samples from workers exposed to this element.

Relationship Between Urinary delta Aminolevulinic Acid and Lead Excretion - We will continue to perform lead and delta aminolevulinic acid analyses in urine from lead exposed workers to determine any useful correlation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0216, AEROBIOLOGY PROGRAM

W.S. BENNINGHOFF, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan* 48104

This integrated research program of the International Biological Program is designed to meet problems of airborne diseases, allergenic substances and biologically harmful pollutants of the air. It will organize, integrate, and extend present investigations of airborne spores, pollen, microbes, insects and other small organisms, and biologically significant nonliving materials such as toxic gases. It will identify critical problems not yet under investigation and will initiate new projects to meet those needs. The program will include segments for research technology, phytopathology, allergenic particles, transport of genetic materials, human and animal disease microbes, wind carried insects and other small animals, and gases toxic to organisms. The aerobiology programs will share efforts with several other IBP programs as well as various federal agencies, scientific societies, and private university laboratories. It is designed to increase the quantity and improve the quality of research on atmospheric dispersal of biologically significant materials, by emphasizing coordination of on- going activities in divergent areas.

SUPPORTED BY U.S. National Science Foundation

1.0217, TRACE AMOUNT SUBSTANCES IN ENVIRONMENTAL HEALTH

C.J. MARIENFELD, Univ. of Missouri, School of Medicine, *Columbia, Missouri* 65201

The sixth year of the study. The computer generated birth defect maps are being correlated with descriptive geographic maps characterizing the State of Missouri. It is apparent that geographic differences of statistical significance are present in both human and swine birth defects. In-depth studies of the high and low rate areas are being designed and several 'epidemics' of birth defects in swine have been investigated and reported. A geochemical census of the state is being conducted by the National Geologic Survey in collaboration with the University of Missouri Environmental Surveillance Center.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0218, TOXIC EFFECTS OF AIR FORCE CHEMICALS AND MATERIALS

L.E. LOVELESS, Lab. for Exptl. Biology., *Saint Louis, Missouri* (F33615-68-C-1492)

Technical Objective: Air Force operations involve the handling and use of chemicals and materials that can produce adverse effects. Toxic effects are established by exposing experimental animals to known concentrations of toxic chemicals and materials and determining what effects occur. Many effects occur internally and require the examination of tissue from the experimental animals. This data can then be used to estimate the effect on Air Force personnel.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0219, AIR LEAD POLLUTION - EFFECT ON THE G6PD DEFICIENT NEGRO

M.S. MCINTIRE, Univ. of Nebraska, School of Medicine, *Omaha, Nebraska* 68105

The purpose of this study is to demonstrate by several methods, increased hemolysis of the glucose-6-phosphate dehydrogenase deficient erythrocyte of negroes in the presence of increased blood lead due to air pollution. A survey will be made for G-6-PD deficiency and hematocrit in a negro population, in an area of high and of low air lead. Subjects with low G-6-PD activity by micro methemoglobin reductase screening will be investigated for blood lead, serum iron, G- 6-PD activity as measured by TPN reduction, and reticulocytes. Supplemental studies of auto hemolysis, potassium loss from rbc, ATP stability, and glutathione reductase activity will be carried out in samples of G-6-PD deficient negroes with 'high' and 'low' blood lead. It is postulated that lead affects sulfhydryl stability in the hexose monophosphate shunt as well as in the rbc membrane and that this would be more evident in a system characterized by an already decreased generation of TPNH, one of the two phosphophyridine systems concerned with maintenance of glutathione and other cellular thiols in their reduced state. Such evidence would be an original demonstration of an environmental hazard affecting, at the cellular level, approximately 13 percent of the negro population as well as a significant number of other persons with genetically determined deficiencies in red cell enzymes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0220, EFFECTS OF CARBON MONOXIDE INDUCED ARRHYTHMIAS

D.E. HUTCHEON, New Jersey Coll. Med. & Dent., School of Medicine, *Jersey City, New Jersey* 07304

Experiments have been designed to study the influence of carbon monoxide inhalation on the vulnerability of the ventricles to catecholamine-induced arrhythmias. The effects of carbon monoxide exposure on the incidence and severity of ventricular arrhythmias produced by epinephrine and petroleum ether will be determined in dogs under pentobarbital anesthesia. The relationship of the electrocardiographic changes induced by epinephrine and petroleum ether to carboxyhemo-globin levels and oxygen saturation of the arterial blood will be investigated in animals exposed to carbon monoxide and in controls exposed to low oxygen concentrations in the inspired air.

SUPPORTED BY Bergen County Heart Assn. - New Jersey

1.0221, ETIOLOGIC SYNERGISMS IN DISEASES OF THE LUNG

R.L. SOPHER, U.S. Veterans Administration, Hospital, *Albuquerque, New Mexico* 87108

Most studies have been purely qualitative or crudely quantitative. Studies of a quantitative nature will be absolutely required if the earliest induced alterations in tissues are to be detected and differentiated from 'normal' aging effects. It is our aim to develop some quantitative data so that the very earliest changes in pulmonary structure after exposure to atmospheric contaminants may be found. At the same time, classic means of study such as light and electron microscopy as well as histochemistry will be used to determine the origin of those quantitative changes and, perhaps, to determine where the problem may be best attached to prevent the occurrence of such changes. The changes to be measured will include lung volume, alveolar volume, tissue volume, alveolar surface area, capillary surface area and volume, blood-gas barrier thickness expressed as arithmetic mean and expressed as harmonic mean.

Specifically, we hope to be able to differentiate pulmonary structural changes associated with air contamination from those occurring with aging at a level where conventional means of study would be fruitless. In this way the earliest morphological manifestations of air pollution may be determined. By applying other means of morphologic study such as histochemistry we shall try to determine the cause of differences in morphometric data. At a later stage in our program, we wish to study the combined effects of air pollution and pulmonary resistance to infection and mechanisms of such pulmonary resistance can be studied. Basic mechanisms of pulmonary injury and repair may be quantified and a better understanding of them acquired. This project has had significant re-direction since it was taken over by Dr. Sopher. We are now mainly inderested in quantitating the morphologic changes which occur in pulmonary anatomy in the lungs of animals normally aging, as a control group, and comparing these to a similar group of animals exposed chronically to low levels of pulmonary irritants. In this way we hope to determine if common

atmospheric contaminants play a significant part in the development of acceleration of chronic pulmonary disease. At this time we have decided to use the Mongolian Gerbil as an experimental animal since it has been shown to spontaneously develop emphysema and chronic bronchitis in old age. Gerbils have been acquired and are being bred so as to develop a usable colony.

SUPPORTED BY U.S. Veterans Administration

1.0222, PULMONARY REACTIONS TO GASEOUS ENVIRONMENTS
M. WITTNER, Yeshiva University, School of Medicine, *Bronx, New York* 10461

This research compares the pulmonary alterations resulting from exposure to irritant gas systems (O2, O3, NO2, SO2) with reference to alterations in structure and function of the gas-blood barrier at the ultrastructural level. Emphasis is on chronic exposures at low concentrations and on mechanisms underlying development and maintenance of tolerance and cross-tolerance to the toxic effects of these gases. Pathology will be interpreted in terms of structural and functional defects using electron microscopic cytochemistry and autoradiography. In addition, a cell model system will be studied in order to assess gaseous environments on macormolecular synthesis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0223, A MODEL OF MUCOCILIARY FUNCTION AND VISCOELASTICITY
M.J. DULFANO, U.S. Veterans Administration, Hospita *Brooklyn, New York* 11209

The development of an experimental model in a. imals to study tracheal mucous clearance through the analysis of the relative contributions made by such participant variables as mucous viscosity, elasticity, depth of the mucous blanket and ciliary function, both under physiological conditions and after challenge by air pollutants.

SUPPORTED BY U.S. Dept of Hlth. Ed. & Wel. - P.H.S.

1.0224, URBAN CHRONIC DISEASE EPIDEMIOLOGICAL STUDY PROGRAM
W. WINKELSTEIN, State University of New York, School of Medicine, *Buffalo, New York* 14214

The objectives are to study 1) the relationships of social, environmental, and personal factors to blood pressure variability; 2) the relationships of environmental factors to the occurrence of chronic respiratory disease; and 3) coronary artery disease, particularly in women, and arteriosclerosis, including cerebrovascular disease. The personal and social data derived from the Erie County Air Pollution- Respiratory Function Study will be utilized to explore possible associations between pulmonary function and respiratory symptoms and such independnet variables as exercise, residence, ethnic background, and socio-economic status as well as to test specific hypotheses related to smoking, air pollution, and occupation. Collaboration with other groups will continue in order to utilize methodologies and competence unavailable within the Division. Continued emphasis will be directed toward studying the familial aggregation of conditions of interest and increasing concern will be placed on social and psychological factors. Retrospective studies of patients with particular conditions and appropriate controls will be utilized to explore selected hypotheses. Samples will be interviewed in the field; however, facilities are available for clinical examinations of selected individuals or appropriate population samples.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0225, EVALUATION OF CARCINOGENIC AGENTS IN CIGARETTE SMOKE
UNKNOWN, Amer. Health Foundation, *New York, New York* 10028 (NIH-70-2087)

The Contractor will exert its best efforts to perform research concerned with tobacco smoking and health.

Define the relative tumorigenic activity of tobacco smoke condensates obtained from tobaccos of the same grade and origin, but differing in contents of nicotine and smoke condensate yield. As a particular varient of the experiment, a cigarette made entirely of cellulose fiber will also be tested.

Define the relative tumorigenic activity of smoke condensate from cigarettes made of reconstituted tobacco sheets.

Develop more sensitive bioassay methods for a better understanding of the carcinogenic potential of cigarette smoke.

Cigarettes and tars will be subjected to physical and chemical analysis as follows: a. Physical parameters of cigarettes: Weight (g), Length (mm), Circumference (mm), Porosity (cms H2O), Pressure drop (cms H2O). b. Smoking data; Number of puffs, Rate of burn (mm/min.). c. Smoke delivery (mg/cig.): Smoke solids, Water, Dry smoke solids, Nicotine, Dry nicotine-free smoke. d. Smoke chemical data: Hentriacontane and total paraffin content, Nicotine and other alkaloids, Acetaldehyde, Acrolein, Formic acid, Phenol, HCN, Pyrene, Benz(a)Anthracene, Benzo(a)pyrene, Other analyses as indicated.

Perform epidemiological studies in man with the aim of identifying means of disease prevention. These studies will attempt to formulate answers to the following questions. a. Is there a dose relationship between risk of disease and extent of smoking habits? b. Is the risk of disease affected by different smoking habits such as inhalation, partial inhalation, etc? c. Is the risk of disease correlated with particular characteristics of the product smoke? d. Is the risk of disease dependent on the individuals susceptibility as a smoker? e. Is the risk of disease dependent on specific environmental factors?

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0226, ASBESTOS EXPOSURE-RISK IN DEFINED HUMAN POPULATIONS
I.J. SELIKOFF, City University of New York, School of Medicine, *New York, New York* 10029

This cluster of studies is designed to provide information concerning the community risk of asbestos-related disease by investigation of several defined human populations with related but different exposures. We have already defined the risk of direct occupational exposure in one industrially-exposed group; we are now obtaining data on the experiences of other populations associated with but distinguished from the defined group. Their asbestos exposures will have been derived from: 1. Indirect occupational exposure 2. Intimate personal environmental exposure 3. Neighborhood environmental exposure of general community group.

These studies are also intended to provide data with regard to three important variables not easily defined in studies among group with direct occupational exposure: effect of interrupted exposure, effect of age at onset of exposure and effect of minimal exposure.

The information derived from these studies is being correlated with other data currently being obtained concerning asbestos exposure in the general population (age, residence, occupation and disease being taken into account), to assist in the estimation of the overall risk resulting from asbestos exposure.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0227, AIR POLLUTION AND EMERGENCY ROOM VISITS
R.M. ALBRECHT, Columbia University, School of Public Health, *New York, New York* 10032

The purpose of this study is to examine the usefulness of statistics of visits to emergency rooms in two hospitals in New York City over the course of one year in surveillance of health effects of air pollution. Data to be analyzed consist of statistics of visits to emergency rooms for selected causes, and hourly measurements of pollutants and selected weather variables reported by the aerometric network of the New York City Department of Air Resources.

By use of the appropriate multivariate statistical techniques, the investigator expects to answer three questions: 1. Holding weather constant, is there a relationship between air pollution and

emergency room visits by cause? 2. Holding air pollution constant, is there a relationship between weather and emergency room usage by cause? 3. What combination of pollution and weather variables yield the best predictors of emergency room usage by cause?

SUPPORTED BY U.S Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0228, RED CELL DEFENSE MECHANISMS AGAINST AIR POLLUTION
R. BENESCH, Columbia University, School of Medicine, *New York, New York* 10032

The main purpose of this project is to ascertain to what extent a recently discovered mechanism, whereby certain organic phosphates of the red cell control and promote oxygen release to the tissues, might operate as a compensatory factor in protecting against the respiratory handicap associated with air pollution. Research will be concentrated in the first place on carbon monoxide intoxication, not only because it is a major air pollutant, but also because much previous work on its interaction with hemoglobin and erythrocytes provides a solid basis for studies of the kind described in this project.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0229, COLLECTION OF AEROMETRIC, METEOROLOGIC, BIOMETRIC OR OTHER HEALTH INFORMATION IN NEW YORK CITY, NEW YORK
UNKNOWN, New York City Hlth. Res. Coun., *New York, New York*

Air pollution measurements and information on specific health parameters must be collected in the cities included in the HESN by people located in the area. Collection sites are determined by NAPCA staff and instruments are checked and calibrated routinely but periodic collection according to a prescribed regimen are made under contract. Information relative to selected health parameters are likewise collected by contractors with regular review of activities by the project officer.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0230, PULMONARY DEPOSITION AND CLEARANCE OF DUST IN MAN
R.E. ALBERT, New York University, School of Medicine, *New York, New York* 10016

The overall purpose of this study is to characterize deposition and clearance in the respiratory tract of healthy humans and donkeys, and to determine the effects of various types of lung disease and impairment on these processes. Experiments are being carried out to extend the characterization of the physical and physiological parameters which control deposition in man for both nose and mouth breathing, especially the particle parameters: size, shape and electrical charge; and the respiratory variables: respiratory flow, tidal volume, state of chest expansion. The dynamics of normal and bronchial clearance are being investigated in both humans and donkeys. In the human studies the major effort is directed toward the characterization of normal bronchial clearance, the departures from normal resulting from exposure to cigarette smoke, and urban and occupational air contamination, and the deviations from normal characteristic of various lung diseases. Additional insight into the nature of the abnormalities will be obtained by comparing the clearance abnormalities observed in man with those which can be produced in donkeys following the inhalation of cigarette smoke and irritant gases.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0231, EFFECT OF AIR POLLUTION ON OBSTRUCTIVE LUNG DISEASE
E.H. BERGOFSKY, New York University, School of Medicine, *New York, New York* 10016

This project is designed to determine the effect of air pollution on lung function in patients with chronic and subacute obstructive lung diseases, such as chronic bronchitis and emphysema, by selectively removing the various airborn constituents, viz., particles, gases, and carbon monoxide in different experimental combinations, while relating the levels of these pollutants to studies of airway resistance, lung volume, blood gases and other parameters of lung function. When compared with previous studies, the present project will have the advantage of 1) selective removal of each pollutant or pollutant group from the ambience of a specially constructed environmental room, 2) the use of more precise measurements of lung function which may be made several times daily and require little disturbing intervention with the patient, and 3) maintenance of patients for periods up to one month in an area where levels of air pollution are constantly monitored.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0232, RESEARCH IN THE ENVIRONMENTAL HEALTH SCIENCES
N. NELSON, New York University, School of Medicine, *New York, New York* 10016

This grant provides core support for a broad program in the Environmental Health Sciences. The research under way and proposed is broadly relevant to adverse health effects from Environmental factors. The general objectives of the research are to define the nature and extent of such effects with the aim of instituting appropriate preventive or control procedures where required. Interests range from acute to chronic health effects including, in the latter, cancer and the degenerative diseases.

The research encompasses laboratory studies on the biochemical mode of action of environmental toxicants, exploratory studies aimed at improving the reliability and efficiency of predictive toxicological tests, improvement of diagnostic procedures for diseases possibly related to environmental factors, epidemiological investigations and field studies on the distribution of pollutants.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0233, MODE OF ACTION OF ALKYLATING CARCINOGENS
B.L. VANDUUREN, New York University, School of Medicine, *New York, New York* 10016

The purpose of the proposed research is to study the mechanism of action of alkylating carcinogens such as epoxides, beta-lactones and their nitrogen analogs and of aromatic hydrocarbon carcinogens. Studies will be aimed at the elucidation of the mode of action of aromatic hydrocarbon carcinogens by the synthesis and biochemical studies of possible proximal carcinogens of these agents. The aromatic compounds of interest are hydroperoxides, peroxides and epoxides. Metabolic studies will be carried out to determine whether these possible proximal carcinogens occur as metabolites on mouse skin. The 'in vivo' interaction of alkylating carcinogens with nucleic acids and proteins will be explored. 'In vitro' studies will be concerned with purines, protein precursors and other relevant model compounds.

Both of these groups of compounds occur widely as environmental contaminants and some of them are possible occupational hazards. Studies on the structure-activity relationships and mode of action of these agents are, therefore, relevant to cancer induction in man.

SUPPORTED BY Amer. Cancer Society Inc. - New York, N.Y.

1.0234, CHRONIC LUNG DISEASE RESPONSE TO POLLUTION FREE AIR
S.M. AYRES, Saint Vincents Hosp. Med. Ctr., *New York, New York* 10011

Over an eighteen month period residency in a controlled environment has been studied as to its effects on pulmonary function in patients with chronic airway obstructive disease. Outside air entering the unit is passed through high efficiency particulate and activated charcoal filters. This pre-filtered air is then refiltered in a unit directly over the beds of the patients. The particle counts from this over the bed filter is 400, 390, 10, less than 10

for particle size of less than 0.3, 0.3-2, 2-6, and greater than 6 respectively as compared to an adjacent room where the particle counts were 10,500, 9,800, 585, and 114 for the same respective particle size. Temperature, humidity, and particle size were controlled however carbon monoxide was not. Fifty patients with a variety of diagnoses were measured daily on selected pulmonary function tests. Maximum flow averaged 113 L/min; FeV1, 1.03 L; FEV2, 1.38 L; and vital capacity 1.74 L in the 50 patients studied. On the average, there was an initial improvement following 24 hours within the unit. Pulmonary function then decreased or leveled off for 1-2 days. Gradual improvement throughout the remaining six days was then observed. Analyses of variance was performed between individual days and the observed changes were found to be statistically significant. The critical question which still needs to be answered is whether similar levels of improvement would be observed during residence in other areas of the hospital without the controlled environmental conditions.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0235, INFLUENCE OF AIRBORNE FACTORS ON LUNG CLEARANCE

J. FERIN, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)49)

The alveolar clearance of particles is determined by the physico- chemical properties of the particles (solubility, size, amount) and by a physiological mechanism in which phagocytosis is considered to be an important step. This study should not only increase our knowledge of the mechanism of penetration of particles from the alveoli into the lung interstitium, but should also allow an appraisal of the deleterious effects of a variety of air pollutants on clearance and, therefore, yield a more complete description of the potential hazards associated with airborne particles and gaseous air pollutants. In the experimental procedure the animals (mostly rats) are exposed to TiO2 aerosol and clearance of these particles is measured at different time intervals as the difference between deposition and retention of TiO2 by chemical analysis of the lungs. The clearance rate of the TiO2 particles serves as a test in animals inflicted, experimentally either with defined pathologies or with chronic exposures to air pollutants such as asbestos, SO2, NO and others.

RESULTS: Experimental facts to date are: The relationship between the deposition of TiO2 particles in the lung and the species of animals (lung weight), concentration of TiO2 in the experimental atmosphere and the time of exposure respectively, can be expressed as D equals 2.0105 W.728 C.8405 T.8197 where D equals deposition, W equals lung weight, c equals concentration of TiO2 in inhaled air and T equals exposure to time. Further, the clearance rate of TiO2 particles in animals with experimental emphysema is decreased.

SUPPORTED BY U.S. Atomic Energy Commission

1.0236, CHARACTERIZATION OF EXPOSURE AEROSOLS

T.T. MERCER, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)-49)

A complete definition of the inhalation toxicity of a given aerosol requires a thorough characterization of its particles with respect to their physical and chemical properties. Moreover, the definition must be compatible with methods employed in practice to evaluate environmental hazards. The project is intended to provide details of the physical properties (electrostatic charge, solubility, aerodynamic characteristics) of exposure aerosols in sufficiently general terms that the results may be applicable to past inhalation studies to establish experimentally the relationships which are required in comparing size distributionns based on different types of measurement; and to determine the relative importance of various mechanisms involved in sampling processes in an effort to develop better instrumentation and more accurate methods of data interpretation. Aerosols are produced by the methods commonly used for inhalation studies including some tagged with radon decay products, their activity distributions as a function of aerodynamic diameters are measured with casade impactors and their charges with a parallel-plate charge spectrometer. Shape factors of irregular particles are measured by means of a conifuge. Factors affecting the efficiency of particle collection by jet impactors are assessed by means of special test impactors.

RESULTS: The charges on droplets produced by nebulization have been measured as a function of initial droplet size for sodium chloride- uranine solutions of 0.1, 1.0, and 10.0% by weight. The average number of elementary charges, n, was found to be related to the initial droplet diameter D, in the following way: n equals aDb. The observed values of a and b for the different solutions were: For 0.1% solution, a equals 4.80 and b equals .65 For 1.0% solution, a equals 4.80 and b equals .65 For 10.0% solution, a equals 18.7 and b equals .89

SUPPORTED BY U.S. Atomic Energy Commission

1.0237, INVESTIGATIONS INTO THE TOXICOLOGY OF FLUORIDE

F.A. SMITH, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT-30-1-49)

The threshold limit value (TLV) for an air born contaminant to which industrial workers may be exposed is derived from past experience in the field and from experiments in which animals and occassionally human volunteers are exposed under carefully controlled conditions to the agent of interest. To more adequately understand the nature of the hazards of using a given material, it is helpful to know the nature and the magnitude of the biological response to different atmospheric concentrations of the agent, and to know as much as possible about its mechanisms of action, but such data frequently are meager indeed. This project is intended to determine the lethal concentration 50 (LC50) for hexafluoroacetone, a gaseous chemical potentially useful as an intermediate in organic its mode of action, and to investigate the biotransformations, if any, which it may undergo. The results are expected to permit a more realistic and meaningful assessment of the hazards associated with the compound.

Results: A bench top exposure chamber (Rochester pickle' jar) has been set up, together with the necessary hardware to permit production of hexafluoroacetone-containing atmospheres, and one trial exposure of 4 rats to approximately 300 ppm for 4 hrs. has been made. This concentration proved lethal. Work presently is beeng done on setting up a gas chromatographic method for analysis of the exposure chambers atmospheres.

SUPPORTED BY U.S Atomic Energy Commission

1.0238, LARGE IRRADIATION CHAMBER STUDIES TO EVALUATE USE OF REACTIVITY SCALES FOR PREDICTING CHEMICAL REACTIVITIES OF HC-NOX MIXTURES

S.L. KOPCZYNSKI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Complex mixtures of paraffins, olefins, and aromatics and NO in air are irradiated with ultraviolet light under controlled conditions and the ensuing photochemical reaction is followed via chemical analyses. Analyses are performed for some 15 individual hydrocarbons, NO, NO2, total oxidant, ozone, aldehydes and peroxyacyl nitrates. Eye irradiation measurements are obtained for each mixture after 6 hours irradiation. The initial reactant concentrations and the effects of subsequent dilution of reactants are related to various measures of photochemical reactivity, such as production of total oxidant, ozone, NO2, aldehydes, eye irritation, and aerosol formation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0239, LARGE IRRADIATION CHAMBER STUDIES TO EVALUATE REACTIVITY OF BENZALDEHYDE-NO AIR MIXTURES

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Mixtures of benzaldehyde and NO in air will be prepared in a large irradiation chamber at various concentration levels and in various proportions. The mixtures will be irradiated with ultraviolet light and the ensuing photochemical reaction followed via chemical analyses. The inter-relationship between production of eye irritation, aerosol formation, total oxidant, ozone, NO2,

and other products, and reactant concentrations will be defined. An evaluation of the reactivity of benzaldehyde will be obtained from the preceding measurements.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0240, COMPLETE ANALYSES OF DATA & PREPARE A REPORT OF A STUDY OF PHILADELPHIA IN RELATION TO SOX & PARTICULATE AIR POLLUTION LEVELS

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Mortality data for 1960-1969 have been assembled and analyses initiated relating total deaths and deaths from particular causes to the SOX and Particulate air pollution levels in the area of residence . These studies will be completed and a report prepared during the current fiscal year.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0241, COMPLETE ANALYSIS OF DATA & PREPARE A REPORT ON THE RELATIONSHIP OF SOX & PARTICULATE AIR POLLUTION LEVELS TO SCHOOL ABSENCES IN CINCINNATI

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

During the school year 1967-68, aerometric and meteorological information were collected in Cincinnati together with absence records for all students in 11 schools. Objectives of the study were (1) to determine if absence rates were independent of long-term average pollutant levels or (to determine if absence rates were independent of acute air pollution episodes. Analyses of this data will be completed and a report of prepared during the current fiscal year.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0242, CONTINUE STUDIES TO DETERMINE THE THRESHOLD AT WHICH LEAD AND MERCURY PRODUCE HEMATOLOGIC IMPAIRMENT

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The large quantities of lead and mercury among other metals, that are emitted into the air by several basic industrial operations in Yugoslavia offer an exceptional opportunity to study the health effects of these types of air pollution. Through the mechansim of PL-480, a contract with the Institute for Medical Research and Industrial Hygiene in Yugoslavia, has proven to be a most efficient method for obtaining good information concerning these effects. Current studies are determining the lowest levels of chronic atmospheric exposure at which significant hematologic aberrations can be demonstrated.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0243, PLAN, DEVELOP AND IMPLEMENT STUDIES DESIGNED TO IDENTIFY AND QUANTIFY THE EFFECTS OF CO AIR POLLUTION ON HUMAN HEALTH

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Present and prior studies results will be reviewed routinely and together with considerations of current ambient air pollution levels will be utilized to indicate the additional investigations needed to provide convincing evidence for maximum levels of air pollution that can be tolerated in a chronic exposure situation relative effects of total exposure vs. peak exposure and the significance of combination of pollutants or their decay products. These reviews will form the bases upon which subsequent program plans will be developed.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0244, COMPLETE A MANUSCRIPT DESCRIBING THE EFFECTS ON HUMAN HEALTH OF CHRONIC EXPOSURE TO LOW LEVELS OF CO

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Pertinent research relating chronic low levels of CO exposure to altered cellular metabolism and resultant decrements summarized in manuscripts suitable for publication in a medical journal. This publication should serve as a source of information for health officials, practicing physicians and other interested individuals.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0245, COMPLETE A STUDY, ANALYZE RESULTING DATA AND PREPARE A REPORT ON THE EFFECTS OF EXPOSURE TO LOW LEVELS OF CO ON EYE-HAND-FOOT COORDINATION

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

A mechanism designed by NASA to test coordination in astronauts is to be utilized to determine possible decrements in human behavioral performance as a function of low level Carbon Monoide exposure.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0246, BIOLOGICAL EFFECTS OF CO ON DOGS WITH EXPERIMENTALLY INDUCED MYOCARDIAL INFARCTS (ABBREV)

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The relative incidence of cardiac arrhythmias will be measured in dogs experiencing myordial infarction and exposed to various levels of CO. CO exposure will be initiated 3 days prior to the infarction and extend for 6 weeks post infarction. Results will be determined on the basis of surveillane in relation to intensity of exposure.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0247, INITIATE A STUDY AND BEGIN COLLECTION OF DATA ON THE EFFECTS OF IN-VIVO EXPOSURE TO CO ON ERYTHROCYTE METABOLISM

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

A laboratory study is to assess the effects of CO on adult and fetal erythrocyte metabolism. The effects of graded exposure on O2 content, CO2 content, pH and 2,3-diphosphoglycerate will be determined.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0248, EFFECT OF AIR POLLUTANTS ON DEVELOPMENT AND PERSISTENCE OF HEMAGGLUTINATING ANTIBODIES AGAINST INFLUENZA VIRUS (ABBREV)

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Oxidant air pollutants are know to inhibit natural defense mechanisms by which animals, including humans, combat other invasive organisms. One possibly significant measure of this impaired defense could be the development and persistance of antibodies produced in response to an exposure to an infective agent. This study will measure antibody response in populations which occur as a result of natural endemic or epidemic exposure to influenza virus. The study and report will be completed during the current fiscal year.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0249, INITIATE A STUDY AND COMPLETE COLLECTION OF DATA RELATING EXPOSURE TO O3 AIR POLLUTION TO ALTERATIONS IN THE BIOCHEMICAL NATURE OF LUNG LIPIDS

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The biochemistry composition of lung lipids is known to change as an organism ages. Similar alterations have been observed in laboratory animals exposed to oxidixing air pollutants. In this study sufficient animals will be exposed to O3 air pollution and then examined and tested for alterations in the biochemical

nature of lung lipids. When changes occur their reversibility will be studied as well as their relations to other evidences of aging.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0250, COLLECTION OF AEROMETRIC, METEOROLOGIC, BIOMETRIC OR OTHER HEALTH INFORMATION IN CHARLOTTE, NORTH CAROLINA
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Air pollution measurements and information on specific health parameters must be collected in the cities included in the HESN by people located in the area. Collection sites are determined by NAPCA staff and instruments are checked and calibrated routinely but periodic collection according to a prescribed regimen are made under contract. Information relative to selected health parameters ar likewise collected by contractors with regular review of activities by the project officer.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0251, A REPORT ON THE RELATIONSHIP BETWEEN NO2 AIR POLLUTION & LOWER RESPIRATORY TRACT INFECTIONS (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Nitrogen dioxide air pollution and lower respiratory tract infection data collection was completed in May 1970 in Chattanooga, Tennessee. The final report of this feasibility study will be prepared by September 15, 1970.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0252, DETERMINE THE VARIABILITY OF REPORTING OF ILLNESS & USE OF HEALTH CARE FACILITIES AS RELATED TO PERCEPTIONS OF ILLNESS (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

A questionnaire prepared in conjunction with Sociologists will be used to identify the factors influencing illness perception and predictions of illness behavior regarding the consultation with physicians and use of health care facilities. This information is necessary because consultation with physicians and use of health care facilities are being used as health parameters being related to air pollution levels.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0253, A REPORT OF SEVERAL AIR POLLUTION PARAMETERS AND THE INTENSITY OF SYMPTOMS IN A PANEL OF ASTHMATIC PERSONS (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

In June 1970 data collection of sulfur oxides and particulate air pollution levels, of meteorological factors and the daily symptoms of asthmatic patients was completed. The final report of this feasibility study that presents the interrelationship of the data will be prepared by October 1970.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0254, COMPLETE ANALYSES OF DATA PREVIOUSLY COLLECTED AND PREPARE A REPORT ON THE RELATIONSHIP BETWEEN SCHOOL ABSENCES AND AIR POLLUTION LEVELS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Data collection on school absences and air pollution levels was completed in April 1970 in the three cities chosen for particulate levels, namely; Birmingham, Alabama and Charlotte and Greensboro, North Carolina. The final report of this initial project will be completed by January 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0255, ALTERATIONS IN MYOCARDIAL VASCULATURE IN RELATION TO AMBIENT CO LEVELS AS INDICATED BY CARDIOMORPHOMETRIC TECHNIQUES (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

This study will be undertaken to utilize the cardiomorphometric technique for identifying the subtle alterations in the distribution and calibre of myocardial vasculature as they are effected by exposure to CO. These studies should provide a useful method for indicating the effects of CO on humans.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0256, CONTINUE QUANTITATIVE STUDIES OF RAGWEED POLLEN IN SARATOGA SPRINGS, NEW YORK IN RELATION TO DIURNAL VARIATIONS, LOCATION AND OTHER CONDITIONS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Concentrations and distributions of ragweed pollen were determined during 1968 and 1969. These studies will continue to obtain additional data on diurnal variations in relation to temperature, relative humidity and other meteorological factors. This program is also designed to evaluate the accuracy of various types of collecting equipment.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0257, CONTINUE COLLECTION OF DATA ON THE EFFECT OF CHRONIC EXPOSURE OF BEAGLE DOGS TO SULFUR OXIDES AND PARTICULATE AIR POLLUTION
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Dogs have been exposed to low levels of sulfur oxide pollution on a continuous schedule for a period in excess of 3 years. Studies are designed to determine the effects of this exposure on: a) physiological status of the lungs. b) incidence of myocardial arrhythmias. c) incidence of ischemia as demonstrated by exercise stress. d. incidence of hematological dyscrasias. e) adrenal cortical response (stress adaptation) f) stress response. g) immune competency.

Since the test subjects have just attained full maturity, it is anticipated that detrimental effects of the exposure should become evident within the next year or two. All subjects including suitable controls will be given a series of test in which stress will be induced to facilitate the detection of aberations in the respiratory or circulatory functions. These tests will be conducted twice during the current fiscal year.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0258, PULMONARY FUNCTION IN SCHOOL CHILDREN IN RELATION TO AMBIENT AIR POLLUTION LEVELS (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

This task is a continuation of the effort to identify three cities with a gradient of sulfur oxides levels that are similar in other respects and are amenable to participation in the special studies of the Health Effects Surveillance Network. Busing of students, civil turmoil, and non-cooperativeness of either local health departments or schools have delayed the initiation of this task.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0259, PLAN, DEVELOP EFFECTS OF SOX AND PARTICULATE AIR POLLUTION ON HUMAN HEALTH
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Present and previous study results will be reviewed routinely, and together with current ambient air pollution levels were to be

used to determine the additional investigations needed to provide convincing evidence for the maximum tolerable levels in a chronic exposure situation, relative effects of total exposure vs. peak exposure and the significance of combinations of pollutants or their decay products. These reviews will form bases upon which subsequent program plans will be developed.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0260, COMPLETE A STUDY AND PREPARE A REPORT ON THE EFFECT OF CO ON MYOCARDIAL FUNCTION
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The effects of exposure to low levels of CO on myocardial function will be studied by measurements of systolic time intervals, six-lead simultaneous EKG's and echocardiographic determinations of left ventricular function before, during and following near maximum treadmill exercise. Healthy and ill subjects of various ages will be studied.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0261, PLAN, DEVELOP AND IMPLEMENT STUDIES DESIGNED TO IDENTIFY AND QUANTIFY THE EFFECTS OF AMBIENT LEVELS OF AIR POLLUTION ON HEALTH
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The HESN now includes three cities chosen for a gradient of particulate levels and one conurbation. During FY '71 the Network will be expanded into three additional cities chosen for sulfur oxide levels and into one additional conurbation. This type of investigation should give evidence of particular cause and effect relationships in the cities and give essential baseline data in the conurbations upon which the health effects of improving air quality will be determined in subsequent years.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0262, CONTINUE ACQUISITION OF INFORMATION & COMPLETE DEVELOPMENT OF ASSEMBLY FORMAT OF A MONOGRAPH ON THE HEALTH CONSEQUENCES OF AIR POLLUTION
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The acquisition of relevant bibliographic material will continue and pertinent items will be selected and cataloged. Drafts of three chapters will be completed.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0263, IMMINENT AND SUBSTANTIAL ENDANGERMENT TO HEALTH
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Prepare a report that recommends ambient air levels of a pollutant never to be reached to serve as the basis for the air pollution episode plans. Reports for nitrogen oxides, lead, fluorides, and polynuclear organics will be prepared in FY-1971.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0264, CARCINOGENIC AND MUTAGENIC STUDIES ON ATMOSPHERIC POLLUTANTS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

To determine the carcinogenicity of fractions of the airborne hydrocarbon as measured in neonatal mice to obtain information needed for determination of air quality criteria and to be used for background for exposure of mature animals to airborne carcinogens by inhalation procedures to be carried on by direct operations.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0265, COLLECTION OF DATA RELATED TO THE CARCINOGENIC POTENTIAL OF HYDROCARBONS & ASSOCIATED POLLUTANTS COLLECTED DIRECTLY FROM THE AIR (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Aromatic polynucleated materials concentrated and removed from air are used in studies of their carcinogenicity. The materials may be painted on test subjects, injected into various tissues, instilled into the nasal passage, or injected into the air they breathe. Young animals may be exposed on several occasions or older animals may be used. Then animals are followed throughout their lives to determine the rates at which cancerous processes develop.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0266, STUDIES DESIGNED TO IDENTIFY AND QUANTIFY THE EFFECTS OF AROMATIC POLYNUCLEATED MATERIALS ON MAN'S HEALTH AND HIS ENVIRONMENT (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Present and previous study results will be reviewed routinely and together with current levels of aromatic polynucleated pollution in the ambient air will be used to determine the additional investigations needed to provide convincing evidence for the maximum levels that can be tolerated in a chronic exposure situation, relative effects of total exposure vs. peak exposure, and the significance of combinations of pollutant or their decay products. These reviews will form the bases upon which subsequent program plans will be developed.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0267, INITIATE A STUDY & BEGIN COLLECTION OF DATA ON PHYSIOLOGICAL MECHANISMS BY WHICH PB, CD, OR AS POLLUTANTS AFFECT METABOLIC PROCESSES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Prison inmates will be exposed to significant quantities of lead or other trace materials following which balance studies will be conducted. The influence of the relevant exposure material on various clinical laboratory findings will be ascertained. This study is conducted in cooperation with API and ILZRO.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0268, COMPLETE A STUDY AND PREPARE A REPORT ON THE EFFECTS OF EXPOSURE TO OXIDANT AIR POLLUTION ON LUNG DEFENSIVE MECHANISMS OF ANIMALS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Animals will be exposed to oxidant pollutants and determinations made of the effects on cells of the various segments of the air-way, on non-cellular components on the surface active material and in mucociliary mechanisms. The influence of oxidants on the mumber, function and enzyme competence of pulmonary macrophages will be evaluated.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0269, COLLECTION OF DATA ON THE BIOCHEMICAL CHARACTERIZATION OF LUNG SURFACTANT AS IT IS AFFECTED BY EXPOSURE TO AIR POLLUTANTS (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Alterations of lipid profiles in alveolar washings from animal exposed to oxidants will continue to be studied as a prelude to

similar studies in human autopsy material. Profiles will be established also on pulmonary surfactant from humans who volunteer for lung lavage.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0270, COMPLETE A STUDY AND PREPARE A REPORT ON THE IMMUNOLOGIC CHARACTERIZATION OF LUNG SURFACTANT USING IMMUNO-ASSAY TECHNIQUES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The alveolar lining layer constitutes the greatest interface between man and his environment and consequently, alterations in its composition and function should be one of the earliest effects of exposure to air pollutants. Immuno-assay techniques now being developed in the Medical Research Branch will be applied to animal models and humans as a means of assessing the effects of oxidants on the tissues.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0271, CONTINUE COLLECTION OF DATA ON THE EFFECTS OF CHRONIC EXPOSURE OF BEAGLE DOGS TO NITROGEN OXIDES AND/OR AUTO EXHAUST
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Otfice, *Durham, North Carolina* 27709

Dogs have been exposed to low levels of nitrogen oxides pollution on a continuous schedule for a period in excess of 3 years. Studies are designed to determine the effects of this exposure on: (a) physiological status of the lungs; (b) incidence of myocardial arrhythmias; (c) incidence of ischemia as demonstrated by exercise stress; (d) incidence of hematological dyxcresias; (e) adrenal cortical response (stress adaptation); (f) stress response level; (g) immune competancy)

Since the test subjects have just attained full maturity, it is anticipated that detrimental effects of the exposure should become evident within the next year or two. All subjects including suitable controls will be given a series of tests in which stress will be induced to facilitate the detection of aberations in the respiratory of circulatory functons. These tests will be conducted twice during the current fiscal year

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0272, A REPORT ON THE INFLUENCE OF EXPOSURE TO LOW LEVELS OF OZONE ON THE STRUCTURAL INJURY PRODUCED BY BACTERIAL INFECTIOUS AGENTS (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

This study uses thin sectioned tissue from the lungs of animals exposed to various levels of oxidant air pollutants and then to pathogenic bacteria to determine by light and electron microscopy, the pathology produce by the exposure.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0273, INITIATE A MORBIDITY STUDY OF ALTERATIONS IN LUNG STRUCTURE ASSOCIATED WITH EXPOSURE TO AIR POLLUTANTS AS INDICATED BY LUNG MORPHOMETRY
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

This study will be concerned with determining early changes in structures compatible with those found with chronic bronchitis or emphysema which can be found and associated in a significant fashion with air pollution exposure history.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0274, A STUDY OF ACUTE RESPIRATORY ILLNESS IN RELATION TO NITROGEN OXIDES AIR POLLUTION LEVELS IN CHATTANOOGA, TENNESSEE
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Illness data and aerometric data have been collected to determine the relationships between acute respiratory illness in the local population and the ambient level of nitrogen oxides produced by emission from a munitions producing plant.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0275, STUDIES DESIGNED TO IDENTIFY & QUANTIFY THE EFFECTS OF OXIDANT, NOX AND HYDROCARBON AIR POLLUTANTS ON HUMAN HEALTH (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Previous and present study results will be reviewed routinely and together with current levels of Oxidant pollution in the ambient air will be used to determine the additional investigations needed to provide convincing evidence for the maximum levels that can be tolerated in a chronic exposure situation, relative effects of total exposure vs. peak exposure and the significance of combinations of pollutant of their decay products. These reviews will form the bases upon which subsequent program plans will be developed.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0276, CONTINUE COLLECTION OF DATA ON THE EFFECTS OF CHRONIC EXPOSURE OF BEAGLE DOGS TO CARBON MONOXIDE
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Dogs have been exposed to low levels of CO pollution on a continuous schedule for a period in excess of 3 years. These studies are designed to determine the effects of exposure on: (a) physiological status of the lungs; (b) the incidence of myocardial arrhthmias;(c) the incidence of ischemia as demonstrated by exercise stress (d) incidence of hematological dyscrasias (e) adrenal cortical responses (stress adaptation) (f) stress response level (g) immune competency.

Since the test subjects have just attained full maturity it is anticipated that detrimental effects should become evident within the next year or two. All subjects including suitable controls will be given a series of tests into which stress will be introduced to facilitate the detection of aberrations in the respiratory or circulatory function. These tests will be conducted twice during FY 71.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0277, ALTERATIONS IN DISTRIBUTION & CALIBRE OF MYOCARDIAL VASCULATURE EXPOSED TO CO DETECTED BY CARDIOMORPHOMETRIC TECHNIQUES (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Subtle alterations in lung structure and in cardiac structure may be expected to occur as a result of exposure to air pollution. Techniques for quantitation of such alterations are not available; however, it is expected that alterations in distribution and calibre of myocardial vasculature could be measured by cardiomorphometric techniques.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0278, A REPORT ON THE RELATIONSHIPS AMONG O2 UPTAKE, CO EXPOSURE, O2 CARRYING CAPACITY OF BLOOD AND EXERCISE (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The effects of CO exposure on blood oxygen carrying capacity will be determined at graded leveds of exercise in normal subjects. These data will enable one to calculate and predict hypoxic insult on an individual once the extent of exercise and exposure history are known.

1. AIR QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0279, COMPLETE COLLECTION OF ANALYSES OF DATA ASSOCIATING HEALTH EFFECTS WITH EXPOSURE TO PB, AS, OR CD EMISSIONS FROM SMELTERS IN MONTANA & IDAHO

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

A number of trace metals are emitted into the atmosphere from non- ferrous smelters. This study is designd to determine the ambient levels of some of these mate.ials and indications of health effects in people exposed to them.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0280, COLLECTION OF AEROMETRIC, METEOROLOGIC, BIOMETRIC OR OTHER HEALTH INFORMATION IN GREENSBORO, NORTH CAROLINA

UNKNOWN, Guilford Co. Health Department, *Greensboro, North Carolina*

Air pollution measurements and information on specific health parameters must be collected in the cities included in the HESN by people located in the area. Collection sites are determined by NAPCA staff and instruments are checked and calibrated routinely but periodic collection according to a prescribed regimen are made under contract. Information relative to selected health parameters are likewise collected by contractors with regular review of activities by the project officer.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0281, AIR POLLUTION AND RESPIRATORY INFECTIONS

Q.N. MYRVIK, Wake Forest University, School of Medicine, *Winston Salem, North Carolina* 27103

The research project is directed towards a study of the effect of selected air pollutants on naturally occurring respiratory infections which are of a low grade chronic nature. It is postulated that low grade chronic respiratory infections can lead to pathologic changes which are an important component of air pollution disease. It is further postulated that air pollutants lower the resistance of the respiratory tract which in turn leads to infections by normal flora microorganisms and organisms in the immediate environment. Experiments will be carried out by exposing rabbits and squirrel monkeys to acute and chronic exposure patterns of air pollutants. The qualitative and quantitative aspects of the respiratory flora will be studied with respect to associated pathologic changes.

The following topics represent the specific aims of this research proposal. 1. Determine Respiratory Flora and Index of Respiratory Infections in 'Normal' Rabbits and Squirrel Monkeys. 2. Effect of Selected Air Pollutants on the Quantity of the Microbial Flora of the Respiratory Tract of Rabbits and Squirrel Monkeys. 3. Effect of Selected Air Pollutants on the metabolism, Phagocytic Activity and Hydrolase Levels of Alveolar Macrophages. 4. Effect of Selected Air Pollutants on the Capacity of Alveolar Macrophages of Rabbits and Squirrel Monkeys to support Viral Replication and Capacity to Produce Interferon.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0282, PHAGOCYTOSIS AND BACTERIAL KILLING BY ALVEOLAR MACROPHAGES

C.L. VASSALLO, U.S. Veterans Administration, Hospital, *Cincinnati, Ohio* 45220

The aim of this program is to establish a method whereby bacterial killing and bacterial entry can be determined simultaneously in R.A.M. This method will then be used to investigate the rate of killing of bacteria by alveolar macrophages and to compare this rate with that noted in leukocytes. The effect of alcohol, nitrogen dioxide ion, nitrogen dioxide gas, aminotriazole, and other agents that have been demonstrated to alter peroxide metabolism and by virtue of this might be expected to impair bacterial killing will be noted. Other air pollutants such as sulfur dioxide and drugs suspected of impairing defense mechanisms will also be investigated.

Progress has been limited to the acquisition of the equipment necessary and the recent hiring of a technician whose primary job will be to work on this project. Laboratory space also has been renovated and it is estimated that work will begin prior to the end of June 1970.

SUPPORTED BY U.S. Veterans Administration

1.0283, EYE IRRITATION RESPONSE MEASUREMENTS FOR EVALUATION OF PHOTOCHEMICAL REACTIVITIES OF HYDROCARBON-NO-AIR AND BENZALDEHYDE-NO-AIR MIXTURES

S.L. KOPCZYNSKI, Univ. of Cincinnati, School of Medicine, *Cincinnati, Ohio* 45221

This contract will provide appropriate medical supervision for eye irritation studies carried out as an integral part of the large irradiation chamber studies under tasks 03 and 04. An evaluation of eye irritation as a measure of photochemical reactivity and smog intensity will be made.

The studies involve reactants and reaction products found in the atmosphere and include various hydrocarbons, aldehydes solvents, nitric oxide, nitrogen dioxide, sulfur dioxide, peroxyacylnitrates, and oxidants.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0284, CONTINUE STUDIES OF HUMAN BLOOD LEAD LEVELS IN RELATION TO ATMOSPHERIC LEAD LEVELS

UNKNOWN, Univ. of Cincinnati, Graduate School, *Cincinnati, Ohio* 45221

In cooperation with the American Petroleum Institute and the Automobile Manufacturers of America through the auspices of CRC-APRAC, this cooperative study is designed to determine the relationship between blood lead levels, and extent of exposure to automobile exhaust products.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0285, GAS-OFF STUDIES ON NONMETALLIC MATERIALS USED IN AIR FORCE SYSTEMS

D.L. GEIGER, U.S. Air Force, Aerospace Med. Res. Lab. 6570, *Dayton, Ohio* 45433

Technical Objective: Detect, characterize, and quantitate the volatile contaminants that evolve from nonmetallic materials of interest to the Air Force, provide chemical data and generation rates of contaminants for use in establishing the toxic potential of materials used in habitable portions of aircraft, and other restricted environments such as launch control centers and missile silos.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0286, EFFECTS OF AIR FORCE PROPELLANTS ON THE METABOLISM AND BIOCHEMISTRY OF BODY ORGANS

M.E. GEORGE, U.S. Air Force, Materials Laboratory, *Dayton, Ohio* 45433

Technical Objective: Air Force function - fueling operations with hazardous materials. Deficiency - human tolerance criteria and limits for new toxic chemicals. Research - mechanisms of toxicity of compounds in body tissues and fluids. How research contributes - provides toxicological definition for formulation of safe and habitable aeronautical and ballistic weapon systems. To determine the effects of altered atmospheres, atmospheric contaminants, and various propellants on the metabolism and biochemistry of various organs in experimental animals. Animals will be exposed to potentially toxic compounds and atmospheres by injection. The metabolic and biochemical effect will be evaluated by determining the functional integrity of target organs, principally liver, kidney and brain. Finally, basic mechanisms of action of the toxicant on the organs will be evaluated.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0287, OCCUPATIONAL HEALTH HAZARDS OF RUBBER DUST
C.A. NAU, Univ. of Oklahoma, School of Medicine, *Oklahoma City, Oklahoma* 73104

The purposes of the proposed investigation are to: A. To continue the ongoing chronic inhalation studies in order to have a realistic and significant duration of total exposure by inhalation. B. Evaluate the developmental effects of chronic exposure to respirable rubber tire dust by exposing Rhesus Monkeys from birth to maturity. C. Elucidate the physiological effects of ingestion of rubber tire dust. D. Determine if any 3,4 benzpyrene (absorbed on the carbon black which is a component of the rubber tire dust) can be detected and/or quantitated in the excreta or urine of rats eating rubber tire dust. Consideration will also be given to the deposition of this carcinogen in some organ or tissue. Metabolites of 3,4 benzpyrene will also be considered.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0288, EFFECTS OF AIRBORNE FLUORIDES ON ANIMAL NUTRITION AND METABOLISM
F.W. ADAMS, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00919)

OBJECTIVE: Determine effects of chronic airborne HF gas upon lungs, growth, reproduction, tissue fluoride storage, trace element metabolism and enzyme activity in small animals. Examine possible interaction between HF and other air pollutants. Improved method of soil fluoride analysis and HF sampling, and provide capability for fluoride analytical service.

APPROACH: Several generations of experimental animals will be continuously exposed to airborne HF contamination of themselves and their environment, drinking water excepted. Lungs will be histologically examined, whole body x-rays taken, and tissue fluoride analyses run at appropriate growth stages. Tissue levels of some trace elements and ceruloplasmin activity to be determined following HF exposures.

PROGRESS: Two generations of a continuing series of hamsters have been born and raised to adults in 1 ppm HF atmosphere. Distilled drinking water is ad lib while food is exposed to HF. Growth rates appear normal. Decay and mottling of incisor teeth prevalent in F(1) generation adults did not appear in young F(2). F(1) adults examined at 13 and 26 wks had femur fluoride contents of 3376 and 3750 ppm dry weight respectively, compared to controls of 243 ppm. Femur fluoride contents of F(2) generation were 2516, 2000, and 2125 ppm at 3, 5, and 7 wks. Food pellets increase their F content by 20 ppm during a 72 hour exposure period in the chamber. Femur fluoride contents of 855 ppm were found in 6 adult hamsters exposed to 3 ppm HF for 30 days. Whole body x-rays of normal various experimental animals are being examined. Lung and bronchial tissue have been obtained for histological examination.

SUPPORTED BY Oregon State Government

1.0289, EXPLORING STATISTICAL RELATIONSHIPS BETWEEN AIR POLLUTANTS AND CERTAIN CHRONIC DISEASE MORTALITY RATES
UNKNOWN, Univ. of Pennsylvania, Graduate School, *Philadelphia, Pennsylvania* 19101

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Resources for Future Inc. - Wash., D.C.

1.0290, ABSORPTION OF POLLUTANTS IN THE RESPIRATORY TRACT
M. CORN, Univ. of Pittsburgh, School of Public Health, *Pittsburgh, Pennsylvania* 15213

The absorption of pollutant gases (SO2, NO2, C2H4O, and oxidant) in the respiratory tracts of anesthetised, artificially ventilated cats is being measured by means of a retrograde catheter technique. An automatic sampling system permits gas sampling prior to entry into the respiratory tract and from the catheter during inhalation or exhalation. Variables being investigated are pollutant concentration (0.1 - 20 p.p.m.) respiratory frequency (15 - 30 cps) and tidal volume (25 - 75cc in cats). Results should permit one to estimate the dosage of inhaled pollutants to different segments of the respiratory tract and thus assist with interpreting receptor responses and disease sites.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0291, BRITISH-NORWEGIAN MIGRANT STUDY
J. CORNFIELD, Univ. of Pittsburgh, School of Public Health, *Pittsburgh, Pennsylvania* 15213

The primary objectives of the parent study based in the London School of Hygiene with Donald Reid as Principal Investigator are: 1) to determine the relative frequency of morbidity and mortality, especially from various forms of cardiorespiratory disorder, among British and Norwegian migrants in the United States, their siblings still living in their native countries, and the native-born populations living in those areas in which the migrants lived either before or after migration; 2) to relate the disease experience of these groups to both personal factors, such as smoking and occupation, and general factors, such as air pollution levels in the area of residence; 3) to establish time relationships between disease experience and date of migration, changes in habits, or occupations; and 4) to identify possible explanations for the major differences in national death rates.

Present proposal is concerned with rounding off the mortality experience, particularly with respect to chronic respiratory disease, for which it is felt that 2 additional years of experience are required.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0292, STUDY OF UPPER RESPIRATORY TRACT CLEARANCE IN RATS
J.A. WATSON, Univ. of Pittsburgh, School of Public Health, *Pittsburgh, Pennsylvania* 15213

Studies in this laboratory resulted in the development of an esophageal collection procedure in rats which permits the serial collection of all material (particles, phagocytes, mucous, etc.) removed from the lungs via the tracheal orifice and swallowed. Based on this procedure we have developed techniques for measuring: (1) the tracheobronchial clearance rates of particles from the lungs, (2) the density distribution functions of particles along the trachea, (3) the velocity of the mucociliary escalator in the trachea, (4) the numbers of pulmonary macrophages leaving the lungs via the tracheal orifice, and (5) the functional role of pulmonary macrophages in transporting particles from the lungs to the oropharynx. These methods provide in vivo data in the rat without requiring surgery on any portion of the pulmonary system.

Our research objectives are to characterize these parameters and their interrelationships under normal conditions and under various conditions of stress (dusts, noxious gases, bacteria and metabolic stimuli) to be pulmonary system. We hope to achieve an understanding of the basic physiological and homeostatic mechanisms which apply in mammals to the clearance of particulates from the lungs and to utilize this information in the realistic appraisal of the hazard associated with the inhalation of respirable dusts and air pollutants in mane.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0293, BIOLOGICAL EFFECTS OF AIR POLLUTANTS ON MAMMALS
R.A. RHOADES, Penn. State University, Inst. of Science & Engineering, *University Park, Pennsylvania* 16802

Our primary objective was to determine whether or not known low level concentrations of air pollutants, singularly or in combination, can cause biological damage to animals exposed for prolonged periods under known environmental conditions.

Accordingly, a large group of mice (N equals 400) and rats (N equals 100) were continuously exposed for 9 months in stainless steel exposure chambers. Temperature and relative humidity were controlled between 72-74 degrees F and 40-65%, respec-

tively. Water and food were supplied ad libitum. Under the above conditions, one group of animals was exposed to an average concentration of 545 micrograms/m super 3 (plus or minus 193 SOD) particulate (carbon black). The mass median diameter was 1.8mu. A second group was exposed to NO2 with an average concentration of 2.9 parts per million (plus or minus sub 71 S.D.). The third group received NOsub 2 plus carbon particulate averaging 3.1 parts per million (plus or minus 0.81 S.D.) and 532 micrograms/m super 3 (plus or minus 219 S.D.), respectivtely. A fourth group serve as controls, and received ambient air.

From our exposure regimen, the data analyzed thus far indicates that: 1) exposure to NO super 2 and to NO super 2 plus carbon appears to increase the incidence of early lung tumors in AJ mice after 80-100 days; 2) carbon and carbon plus NO super 2 affects the immune response of Balb/c mice with very pronounced immuno-suppressive effects occurring after long periods of exposure; and 3) elastic properties of lungs were not significantly altered when rats were exposed to NO super 2 and carbon singularly, but were markedly affected when the pollutants were in combination.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0294, EFFECTS OF LOW LEVELS OF LEAD ON PROTEIN SYNTHESIS

W.R. FARKAS, Univ. of Tennessee, Memorial Res. Center & Hosp., *Knoxville, Tennessee* 37920

Lead has been shown to inhibit protein synthesis by rabbit reticulocytes concentrations as low as 1.0 mu. Although a great deal has been learned about the steps involved in protein synthesis, the precise point in this process which is so sensitive to lead, has not yet been determined. The objective of this proposal is therefore to uncover the mechanism of the inhibition of protein synthesis by lead.

The depolymerization of RNA by lead in vitro has been demonstrated. There is no knowledge, however, as to the effects of lead on RNA in vivo. In order to determine the effects of lead on the different types of RNA in vivo, the integrity of polyribosomes, the molecular weight of RNA, and the acceptance of capacity of transfer RNA will be compared for RNA obtained from normal cells and for cells exposed to low levels of lead.

Cells other than reticulocytes may also be sensitive to lead. Furthermore, nothing is known about the sensitivity of human erythroid cells and other human cell types to this substance. Lead is a component of most gasolines and an atmospheric contaminant. Therefore, this study could also give some indication as to the degree to which cellular RNA is degraded and protein synthesis is impaired by atmospheric lead.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0295, AIR POLLUTION TRAINING PROGRAM

H.G. APPLEGATE, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01417)

OBJECTIVE: This program will be to train personnel within general field of air pollution. Primary academic and research training will be in the biological and meterological aspects of air pollution.

APPROACH: Training and research will be conducted in areas of long-term chronic injury. Much of the training and research in air pollution in the biological area is concerned with pollutant concentrations high enough to induce visible injury. Work with pollutant concentrations which may induce physiological and genetical disorders without inducing visible injury.

PROGRESS: This program is being phased out. Three trainees remaining in the program are in the Departments of Plant Sciences, Wildlife Science and Biochemistry and Biophysics. Their research interest are on the effect of fluoride on anthocyanins, the effect of pesticides on wildlife and the effect of SO(2) on polynuclear aromatic hydrocarbons, respectively.

SUPPORTED BY Texas State Government - Austin

1.0296, PUBLIC HEALTH ECOLOGY

C.M. BARNES, U.S. Natl. Aero. & Space Adm., Manned Spacecraft Center, *Houston, Texas*

The Public Helth Ecology Program is designed to determine through several pilot studies the usefulness of aircraft and ultimately satellite remote sensing in defining public health problems and suggesting remedies through a gross geopathologic analysis. Specifically, NASA multispectral sensing data will be used in determining environmental pollution of water and air and how these pollutants affect the health of the local populace. Insect growth as related to local climatological conditions will be studied and plans developed for assisting eradication officials in combating these plagues. The investigator shown above is the Project Monitor whose telephone is 713-483-4251.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0297, BIOCHEMICAL EFFECTS OF SIMULATED AIR POLLUTANTS

F.L. ESTES, U.S. Veterans Administration, Hospital, *Houston, Texas* 77031

Of necessity to the further exploration of the biochemical effects of simulated air pollutants, efforts have been directed to 1) development and evaluation of a synamic gas mixing system for the delivery of known concentrations of trace components in a carrier gas stream (presented 156th Meeting Am. Chem. Soc., Atlantic City, Sept. 1968), and 2) the development of valid analytical procedures for the direct determination of components in biochemical systems. Quantification of lactic and pyruvic acids from biological samples has been presented (Southwest Regional Meeting, Am, Chem. Soc., Austin, Texas, Dec. 1968). The analysis of mixtures of glutamic and alphaketoglutaric acids by infrared spectroscopy is quantitative in the micromole range (J. Applied Spectroscopy).

The development of these techniques, along with those previously established, should provide for valid comparison of relative effectiveness of pollutant mixtures, as well as indicate those biochemical changes that may be significant in the subsequently developing pathologic changes.

SUPPORTED BY U.S. Veterans Administration

1.0298, PERFORMANCE, RECOVERY, AND MAN-MACHINE EFFECTIVENESS

R.A. DUDEK, Texas Technoiogical University, School of Engineering, *Lubbock, Texas* 79409 (DAAD05)

To determine man's ability to perform for long periods of time and to recover from such performance. Environmental, task and organizational variables affecting several conceptualized man-machine systems will be studied. Means of sustaining performance and speeding recovery will be investigated. Basic data on human performance and recovery will be used to evolve criteria for insuring efficient performance in small military units-also used in implementing a doctrine of continuous operations.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0299, ESR STUDIES OF BIOCHEMICAL EFFECTS OF ATMOSPHERIC POLLUTANTS

J.R. ROWLANDS, Southwest Research Institute, *San Antonio, Texas* 78228

This study is aimed at studying effects of cigarette smoke upon biological systems by electron spin resonance spectroscopy and optical spectroscopy. During the initial year, results have included the detection and characterization of an in vivo reaction between cigarette smoke and hemoglobin, and the detection and characterization of four free radicals produced by the interaction of NO2 and various biological lipids. Those results have been described in two separate publications (J. R. Rowlands, R. M. Estefan, E. M. Gause, and D. A. Montalvo, Environmental Research 2, 47-71, 1968; R. M. Estefan, E. M. Gause, and J. R. Rowlands, 'Electron Spin Resonance and Optical Studies of the Interaction between NO2 and Unsaturated Lipid Components', in press, Environmental Research, 1969). In addition, studies have been made of the effects of cigarette smoke and nitrogen oxides upon the respiratory chain component, cytochrome c.

A new line of experimental effort is being initiated with the beginning of the second year of research. Thus study is designed to observe short-lived free radicals present in cigarette smoke and

the fate of these radicals and other smoke components upon contact with the lung/blood system. A unique L-bank ERS spectrometer built in-house by SwRI will be utilized for this work.

SUPPORTED BY Council for Tobacco Res. - New York, N.Y.

1.0300, TRACE CONTAMINANTS ASSOCIATED WITH MAN IN AIR FORCE SYSTEMS
J.P. CONKLE, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: Closed cycle environmental control systems, requiring no direct contact with the surrounding atmosphere, provide one approach to sustaining life in advanced aircraft and in selected phases of retaliatory missile weapon systems operations. Closure of an environment necessitates monitoring and removing atmospheric contaminants which arise from materials, equipment and from body metabolism. Failure to remove the contaminants will result in shortened effective mission duration or crew performance decrements coupled with impaired health. Since man himself is one of the major sources of contaminants, a comprehensive study of the gaseous constituents associated with man is requisite to the design of effective environmental control systems. This effort will measure human generated trace contaminants.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0301, PERFORMANCE DECREMENTS IN AIR CREWS EXPOSED TO CONTAMINATED LIFE SUPPORT GASES
R.L. MILLER, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: Contaminated breathing oxygen is frequently used as an excuse for terminating flying missions, and occasionally as an explanation for aircraft accidents when no other causative factor can be found. In both cases, unit commanders and flight surgeons have subjective criteria upon which to base decisions with regard to continued flying operations. The purpose of this work unit is to examine the physiologic effects and determine objective performance decrements caused by exposure of mammalian systems to common oxygen contaminants at concentrations above use limits. This study will provide flight surgeons with definitive data regarding the probability of pilot malfunctions due to exposure of certain contaminants.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0302. ENVIRONMENTAL ASSESSMENT OF AIRBORNE COTTON AND FLAX DUSTS
M.H. NOWEIR, Alexandria University, *Alexandria, United Arab Republic*

Byssinosis is a lung disease prevalent in the cotton and flax industries. Control of the disease requires that exposure of workers to vegetable dust be maintained at a safe level. To date it has been impossible to establish direct relationships between total dust concentrations and the incidence or absence of the disease. There is evidence that only certain parts of cotton and flax plants contain a biologically-active material (capable of releasing histamine from lung tissue) which may be causally related to the disease.

This research will attempt to isolate and identify the hygienically significant biological activity of fractions and sub-fractions of the dusts in the cotton and flax industries. The biological activity will be related to the physical, chemical and aerodynamic characteristics of the air-borne dust, as well as to the incidence and severity of byssionosis as measured from periodic medical examinations on new, regular and retired employees. If significant relationships can be established, it will be possible to utilize meaningful criteria for evaluating the environment to control and prevent this lung disease.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0303, A LONGITUDINAL CORRELATION OF PULMONARY FUNCTION STUDIES WITH PATIENTS HISTORY
L.G. MAY, U.S. Veterans Administration, Center, *Hampton, Virginia* 23367

Purpose of this study is to determine the relationship, if any, to pulmonary function tests including the use of body plethysmograph for airway resistance and the history and duration of exposure to pollutants in the atmosphere.

A special type of pulmonary history and physical has been devised and will be used by the investigator in patients referred for routine arterial blood gases and pulmonary function studies.

An attempt will be made to find by history, any exposure to toxic material which occurred 20 years or so ago.

50 patients will be used at first, the duration of the study will be less than one year. Unselected patients will be used in sequence from ward consults and outpatient requests.

The history and physical examination will be done during the time the patient is resting prior to the pulmonary function procedure.

The cost of this study will be the investigator's time and the cost of printing 100 copies of the 'Respiratory System Questionnaire'.

SUPPORTED BY U.S. Veterans Administration

1.0304, AIR POLLUTION EFFECTS ON AIRBORNE RESPIRATORY DISEASE
J. MCCARROLL, Univ. of Washington, School of Medicine, *Seattle, Washington* 98105

Studies are now underway in the Division of Environmental Health on the effect of common urban air pollutants on airborne respiratory disease, using specially designed controlled environment animal exposure chambers. Support is requested for two related objectives: first, to continue the studies on the role of air pollutants in modifying susceptibility to infection, and, second, to determine the interrelationships between air pollutants and other environmental factors (temperature and relative humidity) on the pathogenesis of airborne respiratory infection.

The studies on the role of air pollutants in acute respiratory disease use the mouse-influenza airborne infection model developed by Schulman and Kilbourne. Exposing colonies of mice to nebulized influenza virus, the number infected can be shown to be related directly to the concentration of aerosolized virus when temperature and humidity are held constant. Using this model, animals will be exposed to common urban air pollutants, such as sulfur dioxide, particulates, nitrogen dioxide, and ozone, either before or during virus aerosol exposure, to determine the effects of pollutants singly and in combination on infection rates and parameters related to virulence of infection. The roles of cold, heat, and humidity will also be studied in relation to the various pollutant combinations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0305, HUMAN ADAPTATION OF CARDIO-PULMONARY FUNCTION TO HYPOBARIC, AQUATIC AND INDUSTRIAL ENVIRONMENTS
J.A. DEMPSEY, Univ. of Wisconsin, School of Medicine, *Madison, Wisconsin* 53706

It is the purpose of this project to determine the interrelationship of cardiac respiratory homeostatic control mechanisms during man's adaptation to hypobaric, aquatic and industrial environments. Underlying this application is the aim of revising a method (inert gas technique) we have already established for simultaneous measurement of cardiac out-put, pulmonary capillary blood volume and alveolar-capillary diffusion. Specifically the aims are as follows:

1. Hypobaric Environment. (a) To determine the time course of cardiovascular and ventilatory acclimitization over 8 to 10 hours of exposure to simulated altitudes of 2000 to 3000m i.e. levels of hypoxia where acute exposure of 20 to 30 minutes produces no measurable cardiovascular adaptation. (b) To determine the contribution of changes in total blood volume, cardiac

output and stroke volume with hypoxic exposure to increases in resting and exercise pulmonary diffusing capacity and capillary blood volume. 2. Aquatic Environments. To assess departures from linearity in the relationship of cardiac output to metabolic rate which occur with the relative bradycardia of water immersion and work, with separation of postural and aquatic influences. As stated above in 1.(b) for hypoxic environments, contributions of a changing cardiac output to pulmonary capillary bed expansion with immersion (rest and work) will also be determined. 3. Industrial Environments. To determine the relationship of ventilatory and cardiovascular adaptations to manual, semi-skilled work in the industrial environment, including laboratory and 'on the-job' analyses of work with varying muscle groups, work under varying environmental (seasonal) temperatures, effect of work 'shift' change on cardio- pulmonary diurnal variations, and of work under both acute and chronic effects of industrial air pollutants.

SUPPORTED BY Wisconsin Heart Association

C. EFFECTS - ANIMAL, PLANT, AND GENERAL ENVIRONMENT

Studies of Air Pollution Effects on Livestock, Vegetation, Crops, Materials, and Structures. Includes Deterioration, Corrosion, and Other Deleterious Effects.

1.0306, EFFECT OF ATMOSPHERIC POLLUTANTS UPON DISEASE SUSCEPTIBILITY IN CHICKENS AND QUAIL

R.N. BREWER, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00292)

OBJECTIVE: Determine the effects of different concentration of atmospheric gases and particles common to poultry houses on susceptibility of birds to poultry pathogens.

APPROACH: Germfree Trexler units will be used to provide controlled environment for study. Chickens and quail will be subjected to measured quantities of gaseous pollutants under germfree and gnotobiotic conditions. Histopathological and physiological techniques will be used to measure the effects of these adverse environmental conditions on the health of the bird.

PROGRESS: Three separate trials using artificial and contact exposure to the G(A) isolate of Marek's disease (MD) have indicated a direct influence of B blood group allelee on mortality from MD. In a large trial involving 1,800 birds, 46% of all birds inoculated intraabdominally died of Marek's disease by 18 weeks of age compared to 31% of naturally infected birds. In this trial MD mortality ranged from 20% to 61% among blood types. Attempted sterilization of the incubator environment with ultra violet rays did not influence the rate of MD mortality. A germfree laboratory has been developed to study disease- environment interrelationships. Plastic Trexler units will be used in conjunction with modified Horsfall-Bauer units in an attempt to establish definite levels of atmospheric pollutants and control the spread of specific disease agents. Level of atmospheric pollutants will be achieved by use of flowmeters and monitoring of exhaust gasses.

SUPPORTED BY U.S. Dept. of Agriculture

1.0307, ACOUSTIC RADAR INVESTIGATION OF ARCTIC RADIATION INVERSIONS AND ICE FOG

C.R. WILSON, Univ. of Alaska, School of Mathematics, *College, Alaska* 99735

The rapid growth and development of the community of Fairbanks has brought with it many of the problems inherent in typical industrial communities throughout the world. Air pollution is one such problem. At Fairbanks, as in other industrial communities in the Arctic, air pollution during the winter months manifests itself primarily as ice fog. These fogs are troublesome, as well as distinctly disagreeable to human comfort, because they frequently reduce visibility sufficiently to hamper both aircraft and automobile operation. The meteorological situations of extreme cold (below -40degrees C) and great air stability which allow the formation of ice fog also permit stagnation and high concentration of other pollutants, such as combustion products, in the lower atmosphere over Fairbanks. The proposed research will take advantage of recent research which has shown that acoustic echoes can be rapidly obtained from the natural occurring temperature eddies and velocity fluctuations existing in the boundary layer of the atmosphere. Two acoustic sounders will be used to study the structure and motions of the inversions layer over Fairbanks. The research will be undertaken by the University of Alaska and National Oceanic and Atmospheric Administration (NOAA) Environmental Research Laboratories, Boulder, Colorado. An interagency agreement will cover the NOAA participation.

SUPPORTED BY U.S. National Science Foundation

1.0308, BIOLOGY AND CONTROL OF DISEASES OF CONIFER FORESTS OF CALIFORNIA AND HARDWOOD FORESTS OF HAWAII

R.V. BEGA, U.S. Dept. of Agriculture, Pac. Sw. For. & Rg. Expt. Sta., *Berkeley, California* (PSW2301)

OBJECTIVE: Determine the epiphytology of the biotic and abiotic agents causing diseases of forest tree seeds, seedlings, and both young and mature trees.

APPROACH: Develop controls for mistletoes parasitizing conifers on timber producing and recreational areas in California; determine recreation site pathology and hazard control needs on forested sites west of the Mississippi River; determine the biology of and develop controls for the major root diseases of California conifers and Hawaii hardwoods; calibrate western conifers for susceptibility to air pollution.

PROGRESS: An aerial survey of the San Bernardino National Forest showed that 1.3 million ponderosa pine trees encompassing 160,000 acres are being killed or injured by air pollution. A multi-stage probability sampling design and large-scale color aerial photographs were used. Cost of the survey was about 3 cents per acre. Continuous air monitoring at 6,000 feet elevation near Lake Arrowhead, California, showed average high readings of 0.30 ppm ozone with one daily high reaching 0.52 ppm. The standard set for plant damage is 0.10 ppm, and 0.50 ppm is the standard for a smog alert in Los Angeles. A survey of the major air basins of California shows smog injury to forest trees is quite widespread. The most severe injury was found in the south coast air basin and parts of the southeast desert basin. Slight injury was found in the north central coast, San Francisco Bay, San Diego, and San Joaquin Valley air basins. A study of the rate of spread of the forest tree root disease Fomes annosus was conducted on seven National Forests and one State Forest throughout the State. Average linear extension of the damage within infection centers was found to be 3.5 feet/year except on the San Bernardino National Forest, where spread was 8.4 feet/year. The largest infection centers found were on the Cleveland National Forest. Some were over 100 acres in size. The study will enable pathologists to predict losses in an area in a given time period.

SUPPORTED BY U.S. Dept. of Agriculture

1.0309, STRUCTURES AND EQUIPMENT TO MINIMIZE STRESS ON BEEF CATTLE

T.E. BOND, Univ. of California, Agricultural Engin. Res. Div., *Davis, California* 95616 (312-020-B225)

OBJECTIVE: Develop design criteria for structures and related equipment that will minimize environmental stress of beef cattle.

APPROACH: In air conditioned research barn at the University of California Experiment Station at El Centro obtain basic bioengineering data relating the influence of various environmental factors to the physiological responses and growth of beef cattle. In beef cattle pens at Davis and El Centro, investigate the effects of mud, wind, rain, dust, temperature, humidity, etc. on growth of beef cattle and develop methods of management and equipment that will minimize stress from these environmental factors and maximize productivity. Measure and map radiant fluxes from sky, ground and surroundings and investigate their effects on design and orientation of beef cattle shelters.

PROGRESS:

SUPPORTED BY U S. Dept. of Agriculture

1.0310, ULTRAVIOLET RADIATION IN A POLLUTED ATMOSPHERE
K.L. COULSON, Univ. of California, School of Agriculture, *Davis, California* 95616

This is a continuation of an investigation of the effects of atmospheric pollutants on the ultraviolet radiation regime of the atmosphere. Measurements of the polarization and intensity of ultraviolet radiation have been made in the polluted atmosphere of Los Angeles and in carefully selected clear atmospheric conditions at Davis. These two sets of measurements are being compared with each other and with results obtained from the application of radiative transfer theory to appropriate atmospheric models. The main effort during this grant period will be on analysis and interpretation of the results which have been obtained from the measurement program.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0311, EFFECT OF SO2 ON METABOLIC PATHWAYS IN HIGHER PLANTS
M. MAZELIS, Univ. of California, School of Agriculture, *Davis, California* 95616

Studies on the effect of SO2 and its hydrated forms on the amino acid metabolism of higher plants has continued. A new enzyme, L-proline dehydrogenase, has been found in extracts of peanut cotyledons. This enzyme uses NAD as an electron acceptor in the oxidation of proline. This enzyme is very sensitive to the presence of bisulfite ion. In the presence of 1 mM bisulfite, the conversion of radioactive L-proline to its product is completely inhibited. The purification of this enzyme is underway so that the mechanism of this inhibition can be more clearly understood.

Future experiments call for the feeding of radioactive amino acids concurrently with low concentrations of bisulfite to isolated leaves. The metabolism of the labeled amino acid will be examined by determining the distribution of label among various classes of compounds and within each class. These will be compared with control leaves to which bisulfite will not be given.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0312, BIOCHEMICAL EFFECTS OF SULFUR DIOXIDE ON HIGHER PLANTS
S.F. YANG, Univ. of California, School of Agriculture, *Davis, California* 95616

The present proposal is aimed at determining the biochemical mechanism by which SO sub 2 causes metabolic disturbance and tissue injury in plants and the biochemical mechanism by which plants may detoxify or tolerate the pollutant. The O sub 2 super minus and OH. radicals, which are generated during the aerobic oxidation of sulfite are particularly suspect as toxic agents. We shall examine the oxidation of certain biological molecules by this sulfite-oxygen system. Sulfite oxidase is suspected to be the key enzyme responsible for the detoxification of sulfur dioxide. The relationship between the relative sulfite oxidase activity and the relative plant susceptibility among various plants and plant parts will be examined. It is assumed that the inhibition of photosynthetic CO sub 2 fixation by SO sub 2 occurs through interaction of SO sub 2 with ribulose-1,5-diphosphate. We shall study this interaction using isolated chloroplasts and purified carboxydismutase. In addition, the possible mutagenic action of sulfite in plant tissues, the fate of SO sub 2 in plant tissues and a possible interaction of sulfite with certain coenzymes will be studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0313, EFFECT OF AIR POLLUTANTS ON TEXTILE FABRICS
S.H. ZERONIAN, Univ. of California, School of Agriculture, *Davis, California* 95616

To establish the effects of exposure to air pollutants, individually and in combination, on textile fabrics made from natural or man-made fibers.

To correlate these effects with variations in light, humidity and temperature.

To study the soiling and launderability of fabrics exposed to air pollutants.

To establish the limit placed on the useful life of textiles by air pollutants.

To explore potential methods for minimizing the undesirable effects of air pollutants on textile fabrics.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0314, VARIABLE TOXIC RESPONSE AS A MEANS OF OBTAINING SMOG-RESISTANT PLANTS
E.A. BALL, Univ. of California, School of Biological Sciences, *Irvine, California* 92664

Methods to obtain smog-resistant plants will be developed in two ways: (a) by the use of tissue cultures, and (b) by the use of soil- grown plants and the employment of established genetic procedures. Snapdragon plants, the test objects, will be grown in conditions of atmospheric pollutants, and those that show the minimum damage as judged by killed tissue, and inhibition of growth, will be used for inocula. Where possible, inocula will be taken immediately adjacent to lesions, thus starting with tissues having some resistance. Callus tissues will thus be estabished in vitro which have in their genes the desired characteristic of smog-resistance. After several growth periods in (1) pure air, or (2) polluted air, they will be used to regenerate whole plants. In the first case, it will be assumed that the original exposure to smog killed the susceptible tissues and left the resistant, which was later perpetuated. In the second, the repeated exposure to smog will restrict the growth to the most highly resistant tissue, and will also institute habituation of the tissues to grow in this unfavorable environment. Regeneration will be brought about, resulting in the formation of buds, shoots and roots; these plantlets will be transferred to soil where they will grow to maturity and sexual reproduction. In the second proposed method, snapdragon plants will be grown in smog, and those showing minimum lesions and inhibition of growth will be utilized as the seed-producers of the next crop. Recognizing that this selection by phenotype is not the best genetic practice, selection by genotype will also be instituted. Pure lines of plants will be obtained by continual self-pollination, and they will then be crossed, seeking in the hybrids the character of smog- resistance. Once establised in a hybrid line, procedures will be followed to produce seeds in commercial quantities. These standard genetic methods, especially the latter, will require a number of years to achieve results. In this exploratory research the ground-work will be established for future work.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0315, WIND TUNNEL INVESTIGATION OF MICROPHYSICAL PROCESSES IN SUPERCOOLED CLOUDS
H.R. PRUPPACHER, Univ. of California, Graduate School, *Los Angeles, California* 90024

The proposed research using the cloud tunnel and the Walk-in Chamber will include: (1) A determination of the freezing temperature and mode of freezing of water drops as a function of their size, purity and the purity of the air stream in which they are floating; (2) A determination of the activation energy for self diffusion of water molecules in supercooled liquid water; (3) A determination of the rate of evaporation of ice spheres and ice crystals of various shapes; (4) A theoretical study of the rate of mass transfer from a rigid sphere moving at its terminal velocity for Re 0's between 0.01 and 1000; (5) An investigation of the rate of growth from the vapor of an ice sphere and ice crystals of various shapes suspended on fine fibres in a saturated air stream; and (6) An investigation of the rate of growth of an ice sphere and ice crystals of various shapes, suspended on fine fibres, by collision with supercooled water drops and ice crystals.

In addition an investigation to determine the effect of man made pollutants on the ice formation in atmospheric clouds in the Los Angeles area will be continued.

SUPPORTED BY U.S. National Science Foundation

1.0316, STUDY OF EFFECT OF ATMOSPHERIC TURBIDITY ON SATELLITE SOUNDINGS
Z. SEKERA, Univ. of California, Inst. of Geophys. & Pla. Phys., *Los Angeles, California* 90024 (011751)

Conduct a research study to determine the effect of atmospheric turbidity on temperature and water vapor soundings from satellites.

(1) Investigate in detail the contribution of aerosol scattering in the infrared regions of interest for a particular aerosol model. Extend or modify the theories of radiative transfer to the case of internal sources to provide the theoretical relationship between the emerging radiation from an ideal atmosphere and from a turbid atmosphere with aerosol scattering. From this relationship attempt to derive the possible connections due to atmospheric turbidity to the measurements of temperatures and other atmospheric parameters. (2) Investigate in detail the polarization characteristics of the infrared radiation scattered by the aerosols for the particular model assumed and the feasibility of the determination of aerosol content from the polarization measurement in the infrared.

Progress: Numerical computation of the scattering source function has been more difficult than anticipated. These difficulties have now been largely resolved and the final computations can soon be made. Polarization properties have have not yet been considered, since they must be computed last. To complete this vital phase of the research, it is likely that an extension of the contract, with added funds, will be required. Preparation of a proposal is in progress.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0317, A BIOLOGIC INDICATOR FOR AIR POLLUTION
R.P. SHERWIN, Univ. of Southern California, School of Medicine, *Los Angeles, California* 90033

A recently developed biologic index for air pollution, based on the exposure of guinea pigs to low levels of NO2 (1$ ppm) and an increase in the number of alveolar wall cells (lactic acid dehydrogenase positive) per alveolus, will be applied in a series of experiments to determine the sensitivity, specificity, and time distribution of the test. Once reference baselines are established, the relative influence on the index of a variety of gases, singly and in combination, will be investigated. Data will be obtained in the important areas of a) minimum ambient levels of air pollutants (singly and in combination) that will produce an elevation in the response, b) synergism and antagonism of air pollutants, c) patterns of response according to the time and level of exposure, d) the role of suspended particles (carbon) as a vehicle for focal deposition of high levels of air pollutants, and e) variations of the index in five different ambient atmospheres (major cities and rural areas) over a period of 40 weeks. The study will ultimately be extended to comparisons of species differences and, in particular, the relationship of the index in human lungs (accidental deaths and operations) to major residential location, cigarette smoking, occupation, age, and sex.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0318, STUDY TO DETERMINE THE FATE OF CO IN THE ATMOSPHERE
R.D. ENGLERT, Stanford Research Institute, *Menlo Park, California* 94025

Stanford Research Institute is to investigate reasonable methods for carbon monoxide consumption by selected plants. Two species of plants will be investigated, one from the sub-kingdom Embroyophyta (seed plant), and these will be screened for their ability to remove carbon monoxide from the atmosphere. The contractor will hermetically seal the above species of plants with a given carbon monoxide concentration for a reasonable period of time. Three types of plant species will be screened: (a) Seed plants, (b) Aquatic plants, and (c) Microorganism.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0319, EFFECTS OF FLUORIDES IN AIR, WATER, AND SOIL ON GROWTH, QUALITY, AND YIELDS OF TREE, FIELD, AND VEGETABLE CROPS
R.F. BREWER, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-RO-SSE-1633-B)

OBJECTIVE: Determine effects of F accumulation on plant growth, crop yields and product quality. Determine interrelationships between F and other plant constituents such as Ca, P, Zn, Mn, and Al. Investigate the feasibility of protecting F-sensitive crops from F-polluted air by modification of cultural practices. Study the physical and chemical effects of F-containing irrigation waters on western soils.

APPROACH: Test plants will be exposed to known concentrations of HF in the air or will be sprayed with dilute NaF or HF sprays to study effects on growth, yields, fruit quality and nutrient content. Calcium sprays will be applied to greenhouse and field plants exposed to F to determine feasibility of obtaining protection. Western soils irrigated with F-containing waters will be examined for physical and chemical changes.

PROGRESS: The effects of fluoride accumulation during or after blossoming has been studied under field conditions using dilute HF sprays applied weekly to introduce the fluoride. Preliminary results of these studies indicate the fruit yields were depressed significantly by both the post and pre-fruit set applications, but the accumulation of F following fruit set had the greater effect. Fruit quality, particularly fruit size and taste, were also detrimentally influenced by the accumulation of fluoride after the fruit was set on the trees. Pine trees grown in soil to which various amounts of N, P, K, Mg and Ca were added were exposed to measured amounts of HF and SO(2) gases alone and in combination. Results indicate no synergistic effects of the combination of the two gases, but influences of the gases were strongly affected by the inorganic nutrient supply, particularly by nitrogen.

SUPPORTED BY California State Government - Sacramento

1.0320, EFFECTS OF DUSTS ON VEGETATION
E.F. DARLEY, Univ. of California, Air Pollution Research Center, *Riverside, California* 92507

This research project is a continuation of a study to determine the effects on vegetation of settleable industrial dusts. The primary emphasis at present is on dusts emitted from cement-kilns. Dusting experiments are conducted in special chambers wherein experimental dusts settle uniformly on plant leaves at rates of 0.5 to more than 3 grams per square meter per 8-hour dusting day. One set of chambers provides for short term experiments (2-3 days dusting) and a second set is used for long term experiments (up to 60 days) to provide for dusting to harvest stage of certain annual test plants. The factors of dust deposit being examined include particle size, chemical composition and degree of dust loading. Criteria for reponses of vegetation to various dusts include changes in apparent photosynthesis, visible injury, growth rate, and, where applicable, yield and quality of product.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0321, AIR POLLUTION EFFECTS ON AMINO ACID METABOLISM AND MEMBRANE PERMEABILITY IN CITRUS
H.E. HEGGESTAD, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (0000-05-02(C))

OBJECTIVE: Determine the effects of atmospheric oxidants on amino acid metabolism water status of leaf tissue, and water permeability of plant membranes.

APPROACH: Citrus and cotton varieties will be exposed to atmospheric oxidants, principally ozone, and free amino acids determined with an automatic amino acid analyzer during different stages of growth. The amino acid pool of resistant and susceptible varieties will be compared. Based on these analyses, chromatographic methods will be used to study amino acid metabolism using C labeled amino acid tissues. The relation to carboxylation of CO(2) will be studied in control and ozone

treated tissue. Beta ray gauging techniques and transpiration resistance will be used to measure the effects of oxidants on water status of leaf tissue, including solute permeability of membranes.

PROGRESS: Studies were conducted with Rough Lemon to ascertain whether or not it would be possible to obtain acute damage with concentrations of ozone in the one part per million range. Even after several hours of ozone treatment there was no visible injury to leaves of any age. Young citrus leaves responded to ozone treatment by an initial increase in the concentration of free pool amino acids just as shown with cotton. (See Accession No. 0019388.) Preliminary data suggest that aspartate, lysine, and ornithine increased. Certain protein amino acids, such as leucine, isoleucine, tyrosine, and methionine decreased. This evidence of altered metabolism in citrus plants, even though no visible injury occurred, reveals that ozone can cause some significant subtle changes detectable only by laboratory procedures.

SUPPORTED BY U.S. Dept. of Agriculture

1.0322, AIR POLLUTION EFFECTS ON AMINO ACID METABOLISM AND MEMBRANE PERMEABILITY - COTTON

H.E. HEGGESTAD, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (0000-05-02(C)A)

OBJECTIVE: See Accession No. 0019387.

APPROACH: See Accession No. 0019387.

PROGRESS: A diurnal variation in sensitivity of cotton leaves to ozone was found. The free pool amino acids were at a minimum during the beginning of a normal light period (morning) when the leaves are most sensitive to ozone. The concentration of soluble and reducing sugars also reaches a minimum at about the same time. The immediate effect of ozone treatment of cotton was a dramatic increase in the concentration of free pool amino acids which are normally associated with proteins. After several days, the concentration of free pool amino acids in ozone- treated leaves dropped below that of the control. The nonprotein amino acids seemed to decrease after exposure to ozone. These results indicate that the major effect of ozone relative to amino acid metabolism is a blockage of protein synthesis. (See also Accession No. 0019387.)

SUPPORTED BY U.S. Dept. of Agriculture

1.0323, EFFECT OF AIR POLLUTANTS AND OF OTHER ENVIRONMENTAL FACTORS ON PLANT CELL AND TISSUE GROWTH

L. ODRIN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2231)

OBJECTIVE: Determine effect of growth-inhibiting concentrations of air pollutants and of other factors on various biochemical reactions known or suspected to be involved in growth of plant cells. Specifically, determine effects on cell wall component synthesis and breakdown in various plant tissues; determine effects on enzymes involved in wall metabolism.

APPROACH: After exposure of intact plants or tissue sections to factors such as ozone, peroxyacetyl nitrate or nitrogen dioxide, growth will be determined. Comparison of net amounts of wall components formed with de novo synthesis by use of high concentrations of C -sugar will be made. Phosphoglucomutase, pyrophosphorylases and polymerizing enzymes will be assayed in homogenates and cell fractions from treated tissues.

PROGRESS: Lecithin micelles partially restored oat cellulose synthetase activity initially decreased by mild detergent treatment. Treatment of tobacco plants with peroxyacetyl nitrate at levels ultimately causing leaf necrosis, resulted in decreased leaf cellulose synthetase activity which was detected early. Uridine diphosphoglucose pyrophosphorylase activity increased, apparently due to release of enzyme from subcell particles, only after necrosis was observed. Indoleacetic acid-2-14C was administered to tobacco plants before and after exposure to peroxyacetyl nitrate. At least 6 indolic metabolites were produced in control and treated plants. One, reported in the literature as indolelactic acid, has been termed pseudo indolelactic because of different structure. There was an indication that hydroxymethyl oxindole also was produced in treated plants only. Labeling of uridine diphosphoglucose from glucose-14C in oat coleoptile sections was decreased by fluoride pretreatment of tissue; sucrose labeling was unaffected at lower fluoride levels. Labeling of nucleotide glucose, sucrose and cell wall from glucose-14C in coleoptiles was decreased by peroxyacetyl nitrate pretreatment of tissue yielding 50 percent growth inhibition (with auxin); at lower levels of oxidant, no effect on intermediate or sucrose labeling was noted except that glucose-14C-6 phosphate to glucose-14C-1 phosphate ratio increased slightly.

SUPPORTED BY California State Government - Sacramento

1.0324, INFLUENCE OF ENVIRONMENT, CHEMICAL ADDITIVES AND AIR POLLUTANTS ON APPARENT PHOTOSYNTHESIS AND RESPIRATION

O.C. TAYLOR, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-PLS-2156-H)

OBJECTIVE: The objectives of the project are to study the effects of varied cultural practices, chemical additives, environment, and air pollutants on apparent photosynthesis and respiration by intact plant parts.

APPROACH: The CO(2) determinations will be made with appropriate infrared analyzers. The necessary equipment will be assembled to maintain the desired environmental conditions during the experiments. The most modern equipment available will be used to attain accurate measurements of the plant response to the varied treatments.

PROGRESS: Respiration (CO(2) release) increased sharply when tobacco callus tissue and small plants produced by tissue culture were exposed to ozone at concentrations up to 0.5 ppm. There was a lag of up to 30 minutes in respiration response time indicating that tissue injury preceded increased respiration. Ozone fumigations reduced the rate of photosynthesis but there was little, if any, measureable effect on CO(2) absorption when O(3) dosages were below the threshold required to produce visible injury. Ethylene is produced in automobile exhaust and by many industrial operations. Concentrations as high as 0.2 ppm are relatively common in ambient air. Extended exposure (5 to 10 days) to concentrations of about 0.5 ppm has produced excessive defoliation of many plants. One-hour exposures to high concentrations (5 ppm) caused no detectable defoliation, visible injury or change in CO(2) exchange. Eight-hour exposures of bean and tomato plants to concentrations of about 1.0 ppm ethylene caused significant reduction in photosynthesis and an increase in respiration. Emphasis is currently being placed on the identification of varieties of lettuce, tomato, radish, corn, barley and celery to ozone and PAN. Resistant varieties have been identified and will be used to determine effects of pollutants on photosynthesis and respiration.

SUPPORTED BY U.S. Dept. of Agriculture

1.0325, THE TOTAL EFFECT OF AIR POLLUTANTS ON BEARING CITRUS

C.R. THOMPSON, Univ. of California, Air Pollution Research Center, *Riverside, California* 92507

The broad objectives of this study are to extend the original project which was 'to determine under field conditions the effects of certain atmospheric phytotoxicants on agricultural crops grown in the upper Santa Ana Drainage Basin. The plan was to measure the effects of fluorides, ozone and other oxidants on plant growth, crop yield, longevity quality and keeping properties of fruits and other agricultural products.'

This will be done by extending and refining the present study of the effects of NO2 on navel orange trees so that the controlled exposure of the trees of this atmospheric toxicant is more in keeping with the varying diurnal levels which occur in the Los Angeles basin. Greenhouse and laboratory studies will be carried out to give basic biochemical information about the gross changes which are caused in the field by NO2.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0326, ENVIRONMENT - AIR POLLUTION INTERACTIONS ON PLANTS

D.P. ORMROD, Univ. of Guelph, *Guelph, Ontario, Canada*

1. AIR QUALITY

The overall objective is to precisely determine the relationship of the levels of environmental factors to the nature and severity of damage to plants by air pollutants. The effects of temperature, light intensity, atmospheric humidity and carbon dioxide levels before, during and after fumigation on responses to ozone and sulfur dioxide are currently being studied.

Several sensitive and tolerant plant species and cultivars are being evaluated. The results will be interpreted in relation to available data on outdoor weather conditions during plant damaging periods of air pollution.

The clarification of environment damage interactions will be followed by studies of the physiological and biochemical mode(s) of tolerance and susceptibility.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0327, ACOUSTIC RADAR INVESTIGATION OF ARCTIC RADIATION INVERSIONS AND ICE FOG

V.E. DERR, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. National Science Foundation

1.0328, ATMOSPHERIC TURBIDITY AND DIFFUSION

F.A. GIFFORD, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (001139)

Technical Objective: Study of the theory of the structure of energy transfer mechanisms of the planetary boundary layer. (This is a cooperative program with the Atomic Energy Commission and augments the larger programs sponsored by h m.)

Approach: Preparation of advanced mathematical models of the planetary boundary layer to analyze and predict wind and temperature profiles in adiabatic conditions. Incorporation, from first principles of energy transfer and radiation mechanisms that influence these profiles. The models will be tested via finite difference equation on high speed computers. A study of the changes in flow and energy transfers due to changes in surface roughness will be modelled and tested aginst existing observations, where available. Participation in advanced field programs to assist in their design to complement the model building will be carried out and data analysis from these programs will be a part of the overall research.

Prgress: Installation of an improved micro met system for two independent measures of energy dissipation was completed and initial field tests begun to verify the instrumentation and methodology. An approach to the planetary boundary layer problem through dimensional analysis and analysis of non-dimensionalized variables was undertaken. The results have led to the ability to formulte complete boundary layer models for testing. Considerable effort has gone into cooperative efforts with universities and state and local air pollution activities to transmit the accumulated information on the meteorological aspects of air pollution. A semester course was presented at Vanderbilt for scientists and engineers. An extensive series of seminars was presented at Syracuse.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0329, INADVERTENT MODIFICATION

UNKNOWN, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (001163)

Approach: The study of CO2 and O3 particulate matter and thermal radiation parameters will continue. New thermal radiation sensors, a new CO2 analyzer and automated recording equipment will be installed at MLO early in the fiscal year. The construction and instrumentation of a benchmark station on Niwot Ridge west of Boulder will be undertaken.

Progress: A detailed theoretical calculation of the depletion of available solar energy at the ground by solid atmospheric pollutants has shown that the initiation of climatic recession by such pollution is a distinct possibility.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0330, GEOCHEMICAL EXPLORATION TECHNIQUES IN ALPINE AND SUBALPINE ENVIRONMENTS

G.C. CURTIN, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

1.) To determine the physical and chemical factors that control the mobilization, transport, and deposition of metals in the zone of weathering in alpine and subalpine environments. 2.) To apply these factors to the development of favorable techniques in geochemical exploration for concealed ore deposits in alpine and subalpine environments. a) To evaluate the relative usefulness of sampling media, including rock, soil, humus, vegetation, stream sediment, and natural waters, for geochemical exploration in areas of varied geology and mineralogy, including areas of extensive surficial cover. 3. To evaluate, where applicable, the relationships between geochemical and geophysical data. 4. To develop criteria for determining the effects of surface contamination from mining, industry, automobiles, etc.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0331, GEOCHEMICAL SURVEY OF THE VEGETATION OF MISSOURI

H.T. SHACKLETTE, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: Missouri.

The principal objective of this investigation is to describe the chemical character of the major vegetation types and the important native and cultivated plant species and associated soils within the State in order to determine if regional patterns in the abundance of certain elements exist. The characteristic element content of vegetation will be compared with that of soils on which the plants grow, and the contributions of vegetation to element cycling in the rock-soil- plant system will be appraised. Regional patterns of biogeochemical abundance, if found, will lend support to studies of geographical patterns of human and animal diseases that are being conducted by health agencies. Other objectives include (1) determining geochemical relationships within and between the major vegetation types, (2) characterizing the element content of native and cultivated plant species that are important in the food chain, (3) studying the predominant tendencies in element concentration by plant groups in order to determine at which level of the taxonomic hierarchy plants can be grouped to best represent chemical affinities, (4) documenting seasonal variation in element content of selected plant species, and (5) evaluating highway contamination effects on nearby plants.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0332, EFFECTS OF PARTICULATES ON RADIOMETRIC MEASUREMENT OF SEA SURFACE TEMPERATURE & ON INFRARED COOLING RATES IN TROPOSPHERE (ABBREV)

W.E. MARLATT, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

The objective of this research is the further analysis of data taken during BOMEX which includes radiation measurements and particulate measurements, together with data on the meteorological situation at the time of those measurements. The research will address the following questions: 1) The effect of atmospheric particulates on the radiometric sea surface temperature. 2) The effect of atmospheric particulates on infrared cooling rates and the earth's heat budget. 3) The variation of these effects with particulate size, concentration and type. Existing computer programs will be used to investigate these problems using BOMEX data.

SUPPORTED BY U.S. National Science Foundation

1.0333, NATURE AND CONTROL OF OZONE INJURY TO PLANTS
S. RICH, Conn. Agric. Expt. Station, *New Haven, Connecticut* 06504

The formation of toxic lipid compounds in ozonated leaves will be studied and related to subsequent development of visible ozone injury. Toxic lipids of leaves will be analyzed qualitatively and quantitatively by thin-layer and gas-liquid chromatography. Specific emphasis will be placed on esterified steryl glucosides (ESG) and lysolipids. ESG formation will be studied by addition of radioactive solutions of glucose and fatty acids and by sulfhydryl binding reagents which affect symptoms of injury similar to those of ozone. The possibility of an equivalent relationship between increased levels of ESG and lysolipids will be determined by comparative fatty acid analysis of ESG and hydrolysed phospholipids.

Qualitative and quantitative increases in toxic lipids will then be related to ozone-uptake and the extent of subsequent leaf injury. These studies will be conducted on leaves which give a very similar response to ozone and on leaves which give very different responses to ozone based on selective breeding and maturation. Knowledge gained from measured toxic production and related to natural inhibition and tolerance will be used to inhibit ozone injury in more sensitive plants.

Ozone uptake data will also be used to measure the ability of plants to purify an ozone contaminated atmosphere.

Electron micrographs will be made to compare the internal structure of ozone-resistant and susceptible varieties of plants.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0334, NATURE AND CONTROL OF OZONE INJURY TO PLANTS
H. TOMLINSON, Conn. Agric. Expt. Station, *New Haven, Connecticut* 06504 (CONH00393-AP)

Progress: Tobacco and bean leaves became more resistant to ozone when treated with emulsions of various lipids and fatty acids which did not occlude or modify stomata. Untreated tobacco leaves exposed to ozone lost 50% of their saturated fatty acids but only 10% of their unsaturated fatty acids. Fatty acid content could be correlated with ozone-resistance of untreated leaves only when genetically similar tobacco plants were compared. We compared the stomatal conductivity of different tobacco varieties and found that their susceptibility to ozone could be correlated with the stomatal conductivity of the under surface of the leaves. The faster the exchange of gases through the under surface, the greater the ozone damage. A technique was devised to mark those few cells killed when bean plants are exposed to barely toxic levels of ozone. After exposure to ozone, the plants were kept in the dark for 2 days during which time the starch grains disappeared from all the living cells but not from the killed cells. The killed cells could then be clearly marked by staining the leaf tissue with the starch stain, I-KI.

SUPPORTED BY Connecticut State Government

1.0335, INFLUENCE OF SELECTED AIR POLLUTANTS ON PHOTOSYNTHESIS OF MATURE FOREST TREES UNDER NATURAL CONDITIONS
D. BOTKIN, Yale University, Graduate School, *New Haven, Connecticut* 06520

This project will initiate a pilot study to determine levels of SO2 and O3 that produce observable changes in photosynthetic rate. The research will be conducted at Brookhaven National Laboratory using growth chambers and automatic digital recording systems available. If Threshold levels of pollutants that influence carbon dioxide flux are established successfully during the first year, a pilot field plot study will then be undertaken. White pine will be the initial plant to be examined because of its high sensitivity. Several technical problems must be resolved before field measurements are practical including precisely metered introduction of pollutants. However, the results of this project could have considerable importance for design of monitoring projects for atmospheric pollution.

SUPPORTED BY U.S. National Science Foundation

1.0336, LEAD AND SODIUM CONTAMINATION OF TREES AND SHRUBS IN URBAN ENVIRONMENTS
W.H. SMITH, Yale University, School of Forestry, *New Haven, Connecticut* 06520

The specific objectives of this investigation are several: 1. To determine the magnitude of lead and sodium contamination of selected tree and shrub species in New Haven and Hartford, Connecticut. 2. To ascertain the position of lead on or within contaminated plants. 3. To estimate the pathological significance of the lead and sodium contamination. 4. To make recommendations with respect to species selection for planting in certain environments within the city, and also with respect to appropriate planting distances from roads. 5. To gain a preliminary impression of the capacity of plants to remove particulate contaminants from the atmosphere. 6. To conduct a preliminary screening of selected plant tissues for possible industrial mercury contamination (Walton 1969) on selected sub-samples.

Cation content of sample tissues will be determined by atomic absorption spectrophotometry.

SUPPORTED BY Connecticut State Government

1.0337, OZONE DAMAGE TO PLANTS
S. RICH, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONH00606)

OBJECTIVE: Determine conditions leading to ozone damage to plants; to observe which plants are damaged by ozone in Connecticut; and estimate extent of loss caused by ozone damage to plants. Find ways to protect plants from damage by ozone.

APPROACH: We monitor ozone in Connicticut air during summer months and relate ozone fluctuations to meteorological condition. We attempt to recognize and report instances of ozone damage to plants in Connecticut and estimate extent of loss. We search for plant varieties resistant to ozone, and for chemical treatments that would make plants more resistant to ozone.

PROGRESS: Periods during which concentrations of ozone were high enough to damage plants averaged once every 4 days during the 1963-1967 growing seasons in Connecticut. 80% of these periods occurred in the afternoon. Most lasted 1 to 6 hr. but a few lasted 7 to 9 hr. During the high-ozone periods the wind was usually from the southwest quadrant. There was no indication that pollution by ozone became progressively more severe during 1963-1967. During 1969, we exposed potato plants to ozone and produced symptoms identical to those we have seen on potatoes in the field. In July, 1969, necrotic blotches appeared on the foliage of Greening apples in many orchards in Connecticut. The leaves on the sunny side of the trees were most severely injured. We produced similar symptoms by fumigating branches with ozone, and suspect that the problem may be caused by air pollution. Tobacco plants treated with the systemic fungicide benomyl develop less fleck (ozone injury) than untreated plants. Dr. P.M. Miller reported that tobacco plants growing on soil previously treated with the nematicide Dasanit develop more fleck than plants growing on soil not so treated.

SUPPORTED BY Connecticut State Government

1.0338, AIR POLLUTION PROBLEMS IN THE NORTHEAST
D.J. FIELDHOUSE, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00125)

OBJECTIVE: Determine the impact of present air contaminants on the agriculture of the Northeast. Obtain information prerequisite for the development of air quality criteria as they relate to agriculture in the Northeast.

APPROACH: Research will deal with: establishment of the kinds of pollutants present, their concentration, their effects on plants and microorganisms in ambient air, and their relationship to local and area meteorological conditions; responses of plants and microorganisms to various concentrations and mixtures of pollutants in controlled environments; bioassay of pollutants by use of known indicator plants and a search for resistance/susceptibility in varieties, lines, and cultivars of various plant species and

in microorganisms; and the possible alleviation of damage to plants by selecting resistant lines, altering host nutrition, or the application of growth-regulating chemicals nd stomatal inhibitors.

PROGRESS: Total oxidant levels were recorded at two locations in Delaware during July and August of 1969. During this period, 5 pphm was the highest reading. This was lower than that recorded in 1968.//Tobacco plants (Bel-W3) were grown in Newark and Georgetown as indicator plants for recording oxidant damage. Damage was observed and recorded even though the oxidant readings were relatively low. Plant damage was also noted on beans and corn under field conditions.//Plants tested under growth chamber conditions for physical and chemical reduction in ozone damage have shown that Sunoco Folicote at a dilution of 1:25 to 1:100 and used as a spray or as a dip may be effective for reducing injury. This treatment showed very favorable results at ozone concentrations up to 20 pphm.//The plant growth regular succinic acid 2,2 dimethyl hydrazide (Alar) has been used on several species to reduce ozone injury. The short period required between application of the growth regulator and fumigation indicates that the material may be blocking entrance of the ozone rather than actually changing the susceptability of the tissue to injury.

SUPPORTED BY U.S. Dept. of Agriculture

1.0339, THE EFFECTS OF ATMOSPHERIC CONTAMINANTS ON THE DURABILITY OF BUILDING MATERIALS

UNKNOWN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

During this period studies have been mainly concerned with measurement of the effects of ozone (at 1.5 ppm level) on the photo degradation of paints and plastics.

Weathering devices were modified to permit the introduction of gaseous air contaminants directly into the machine without polluting the room or building air supply. Experiments showed that levels of ozone and sulfur dioxide could be maintained within plus or minus 10% of their nominal values of 0.5 and 2.0 ppm, respectively.

When materials were exposed to continuous light in these devices at 0.5 ppm ozone level (85% R.H. and 90 degrees F), only vinyl and acrylic- latex paints were found to be slightly sensitive to ozone. If an intermittent light cycle with 100% R.H. during the dark cycle was used, ozone appeared to affect all paints and some plastics.

In a cooperative program with the Public Health Service, a first step was taken to establish relative levels of air contamination at the six NBS exposure sites. Air pollution 'effects packages' have been placed at the Gaithersburg and Ft. Holabird sites. These have been designated as stations 272 and 273 in the air surveillance network of National Air Pollution Control Administration.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0340, EFFECTS OF AIR-BORNE FLUORIDES ON CITRUS

C.D. LEONARD, Citrus Agricultural Expt. Sta., *Lake Alfred, Florida* 33850 (FLA-CS-01395)

OBJECTIVE: Determine the effects of air-borne fluorides on growth and yield of citrus trees under exposure to fluoride air-pollution. Determine the effects of fluoride compounds applied to citrus foliage. Survey groves to determine whether fluorine problem is diminishing or intensifying.

APPROACH: Five sites will be selected in the polluted area and one outside for establishment of 'giant pot' experiments. At each site, trenches 29' x 76' will be dug, and refilled with soil from one location for uniformity. Uniform trees will be planted in these 'giant pots' and observed 5 years for growth and yield under the air-pollution prevalent at each site. Air-borne fluoride content will be measured continuously. Randomized block experiments will be set up on 6 or more groves where air-borne fluorides are absent. Fluorides will be applied in aqueous sprays applied to the foliage. Several concentrations will be used. Leaf fluorine content, yield, and fruit quality will be determined. Leaves from approximately 30 selected groves will be sampled 2 to 4 times per year for 5 years to determine whether leaf fluorine levels are becoming higher or lower in the area being studied.

PROGRESS: Some significant reductions in the 1969-70 crop yield were obtained from young orange, grapefruit, tangelo and tangerine trees set in 1967 in 'giant pots' measuring 76 by 29 feet at locations exposed to varying concentrations of air-borne fluorides (F). The average concentrations of F in the air during the bloom period from Feb. 24 to April 27, 1969, varied from 0.03 (control) to 0.38 parts per billion (PPB). The 1969 spring flush leaves from different varieties ranged from 1.0 to 42 PPB F when sampled in May, and from 1.1 to 138 PPB F when sampled in late September, 1969. There was little difference in trunk growth of the trees. Hydrofluoric acid (HF) spray experiments started in bearing citrus groves in 1967 were continued in 1968 and 1969. The 4 different HF concentrations of the sprays applied in 1968 varied from 0.005 to 0.016 normal. Some significant differences in yield and internal quality of fruit were obtained from the HF-sprayed trees as compared with the checks for the 1968-69 crop. These differences varied with variety. Some significant differences in yield and internal qua (Text Truncated - Exceeds Capacity)

SUPPORTED BY Florida State Government - Tallahassee

1.0341, EFFECTS OF AIR-BORNE FLUORIDES ON CITRUS

C.D. LEONARD, Univ. of Florida, Agricultural Experiment Sta., *Lake Alfred, Florida*

Two major experiments are being conducted. One of these involves growing young citrus trees in identical 'giant pots' measuring 76 x 29 feet. The trees were set in the pots in August, 1967. Five such pots are distributed within the area affected by air-borne fluorides emanating from phosphate manufacturing plants. Two more pots are located at the Citrus Experiment Station near Lake Alfred, Florida, which is exposed to very low levels of air-borne fluorides. One of the Station pots is designated as the check and the other is being used to apply dilute hydrofluoric acid sprays to build up different levels of fluorine in the leaves. The effects of different levels of fluorine in the leaves on tree growth and yield of fruit is being studied. Continuous air-sampling for fluoride content is being carried on at each giant pot site.

The other experiment involves application of dilute hydrofluoric acid sprays to commercial bearing citrus groves far removed from the area affected by air-borne fluorides. Four different concentrations of dilute hydrofluoric acid are being applied at different times of the year to study the effect of different leaf fluorine levels on yield and quality of fruit. Three orange varieties and one grapefruit variety are included in this test.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0342, ATMOSPHERIC OZONE AND WEATHER FLECK ON FLORIDA CIGAR-WRAPPER TOBACCO

C.E. DEAN, North Fla. Agric. Expt. Sta., *Quincy, Florida* 32351 (FLA-NF-01380)

OBJECTIVE: Study ozone-induced fleck and the reaction of varieties to abnormally high ozone concentrations. Study meteorological conditions which contribute to abnormally high concentrations of ozone and correlate fleck with ozone concentrations. Develop a procedure for predicting increases in ozone concentrations and fleck occurrences on Florida wrapper tobacco.

APPROACH: An electrochemical ozone sensor will be used to continuously record concentrations of ozone. Test plants will be grown to correlate leaf damage with ozone. Meteorological phenomena occurring before, during and after increases in ozone concentrations will be recorded and analyzed.

PROGRESS: Two Mast ozone recorders were operated continuously during the 1969 tobacco crop season. Ozone concentrations exceeded 4 pphm 15 times in May, 9 times in June, 3 times in July. Four parts of ozone per hundred millions parts of air is the threshold value at which susceptible varieties of tobacco will fleck under high soil moisture conditions. The highest concentration recorded during the crop season was 7 pphm on June 10. Rises were always associated with hazy conditions substantiating the observations of previous years that ozone is photochemically produced from air pollution near the surface. Increases above 4 pphm were also associated with continental polar air masses that covered the southeastern part of the country. Small increases in

ozone concentration were associated with some, but not all thunderstorms. Fleck damage was minimal considering the number of times ozone reached critical levels. Only the most susceptible varieties were damaged. Extreme drought conditions along with high daily water demand by the plants accounted for lack of fleck.

SUPPORTED BY Florida State Government - Tallahassee

1.0343, EFFECT OF FLUORIDE ON PLANTS

A.C. WIESE, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00293)

OBJECTIVE: Determine if there are important differences in the metabolic pathways of plant species which are susceptible or resistant to fluoride and investigate the nature of fluoride compounds in plants.

APPROACH: Gladiolus and alfalfa plants, representing susceptible and resistant species will be used. The effect of fluoride on enzyme systems obtained from these plants will be compared. The first enzyme will be phosphoglucomutase. Localize the effect of fluoride on enzyme systems to determine whether this is the cause of fluoride sensitivity. The enzyme studies will be correlated with other studies to determine how certain plant species accumulate abnormally high amounts of fluoride.

PROGRESS: Phosphoglucomutase (PGM) is inhibited by fluorine ion; 24 mumols causes 90 to 100% inhibition. Incubating the enzyme with histidine and Mg of activity. Enzyme preactivation was inhibited by F and F added after preactivation was equally inhibitory. Using specific ion electrodes it was found that the substrate glucose-1-phosphate (G-1-P) bound Mg ion, but that G-1-P did not bind F ion. Evidence was obtained for the formation of such complexes as MgF ion, (G-1-P)-MgF or PGM-MgF . The inhibition of PGM by F is probably due to the formation of one of these complexes.

SUPPORTED BY U.S. Dept. of Agriculture

1.0344, METEOROLOGICAL CONSEQUENCES OF THERMAL POLLUTION

J.E. CARSON, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

The objective of the study is to determine how the atmosphere will react quantitatively to the large amounts of heat energy and water vapor it will be forced to accept as a result of waste heat from nuclear power plants around the south rim of Lake Michigan. Nuclear plants with a capacity of 7000 MWe are being installed; most of the reject heat energy will enter the atmosphere as a result of evaporation, conduction, and radiation. The meteorological consequences of alternate heat sinks (cooling ponds and cooling towers) will be investigated.

To date, no evidence of weather or climatatic changes due to once- through cooling of power plants using water from a large, deep lake, such as Lake Michigan has been found. Meteorological equipment will be placed near the outfall on an existing 1100 MWE power plant and at a similar site far from any outfall. Climatological data will be examined for long-term temperature and snowfall trends. A program to measure fluxes of heat and water vapor over thermal plumes is being considered.

Results: This was a new project in FY 1970. Calculations show that the amount of nuclear energy added to the lake is extremely small compared to the imput via solar radiation; the heat added to the lake by the nuclear power plants during one year (assuming that they operated at 100% capacity for the entire period) is equivalent to the solar energy received at the lake in 2 hours in June. Observations at existing thermal plume sites show no significant (measureable) weather changes. Observations show that Lake Michigan has cooled by 2 degrees F in the past 40 years despite being used as a thermal sink by industry.

SUPPORTED BY U.S. Atomic Energy Commission

1.0345, ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS

L.C. MARSHALL, Southern Illinois University, Graduate School, *Carbondale, Illinois* 62901

The purpose of this work is to investigate the formation of constituents that comprise the atmosphere of terrestrial planets such as Earth, Mars, and Venus. This is a continuation of work that began under the direction of Drs. Lloyd Berkner and Lauriston Marshall. The continuing research will include the following areas: (1) further study of 02 stability in the earth's atmosphere using an E2 Oxygen Analyzer and the differential photometric technique; (2) measurements of atmospheric constituents using remote sensing methods such as lasers; (3) studies of the effect of oxygen deprivation on several pure strains of blue-green algae; (4) the effect of pollutants and pesticides on blue-green algae and other oxygen producing organisms; (5) the effect of high magnetic fields on blue-green algae and the chemicals that are important to their composition and functions; (6) studies of crystalline materials and molecular structures of biological systems at the molecular level; and (7) studies of the mechanisms of cyclic and noncyclic photosynthetic photophosphorylation.

SUPPORTED BY U.S. National Science Foundation

1.0346, EFFECT OF ATMOSPHERIC POLLUTION ON PRECIPITATION

S.A. CHANGNON, State Water Survey, *Urbana, Illinois* 61801

A review of research concerning urban-industrial effects on precipitation in the United States was made, and further research concerning urban effects on thunderstorms in the St. Louis and Chicago areas was performed. The general results showed that urban-industrial areas in the central United States produce increases in rainfall, thunderstorms, and hail that are 5 to 30 percent greater than that occurring in the unaffected rural areas. This research is continuing.

SUPPORTED BY Illinois State Government - Springfield

1.0347, CLIMATOLOGICAL ASSESSMENT OF URBAN EFFECTS ON PRECIPITATION

F.A. HUFF, Univ. of Illinois, State Water Survey Division, *Urbana, Illinois* 61802

This project is a two year study to obtain climatological information for eight specific urban locations in an attempt to assess the effects of urban sizes, industrial complexes, pollutants and thermal outputs upon the precipitation patterns of the city and its local sphere of influence. Historical climatological records will be examined to determine the existance of urban effects on precipitation, the likely causes of any detectable changes, and the differences in changes attributed to cities with a variety of industrial activity, physical size, population, and geographical location. It is expected that the effects of inadvertant weather modification by urban environments may have a greater bearing on local climatic changes than many of the intentional weather modification program now being contemplated for implementation.

SUPPORTED BY U.S. National Science Foundation

1.0348, INTERDISCIPLINARY STUDIES - QUANTUM ELECTRONICS IN LIFE SCIENCES

H. MERKELO, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

Techniques developed in quantum electronics for studying very fast processes in luminescent systems are applied to a study of the dynamics of inductive energy transfers in living cells. Such nonradiative migration of excitation-energy is, possibly, the most important and, certainly, the fastest reactions (10 to minus the 12th power sec) of the photosynthetic apparatus. Emphasis is placed on determining the rates of homogeneous and heterogeneuos inductive transfers, both in vivo and in vitro, and on establishing the effects of industrial by-products on the efficiency of the photosynthetic apparatus.

SUPPORTED BY Westinghouse Educational Fdn. - Pittsburgh

1.0349, EFFECTS OF CIGARETTE SMOKE ON PLANT CELLS IN TISSUE CULTURES

P.S. SABHARWAL, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (E5-3-72(C))

1. AIR QUALITY

OBJECTIVE: Develop a new bioassay method based on the effects of cigarette smoke on plant cells in tissue cultures.

APPROACH: Plant tissue cultures of Lemna gibba, Allium cepa, hybrid tobacco (Nicotiana langsdorffia X N. glauca), and callus tissue of Nicotiana tabacum will be maintained. These plant materials will be exposed to the following: standard puffs of tobacco smoke from the University of Kentucky smoking machine, smoke fractions at varying concentrations, and known amounts of individual smoke components such as dimethylnitrosamine, benz(a)anthracene, and methyl benzo(a)pyrene. Cell growth responses will be determined and documented photographically. Morphological, growth physiological, cytological and/or biochemical responses will be determined by comparison with suitable controls. Applicability of the test results to the development of a new bioassay method for cigarette smoke, and fractions thereof, will be appraised.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

1.0350, ENVIRONMENTAL REQUIREMENTS OF POULTRY

R.B. WILLIAMS, Univ. of Maine, Agricultural Experiment S *Orono, Maine* 04473 (ME00182)

OBJECTIVE: Determine the physiological responses of chickens to variations in light, dust and thermal environment.

APPROACH: Birds grown in a dust free environment will be exposed to sterile poultry house dusts and similar dusts innoculated with known microbial concentrations. Bird response will be determined by various physiological measurements. Determine feasible means for controlling harmful dust at a safe level.

PROGRESS: The dust insult chambers have been modified to allow insertion of only the bird's head; therefore the bird's body remains accessible for monitoring and sampling. Several types of dust sampling and estimating apparatus have been constructed which might be used in the field. Two different methods of microbial quantitation were successfully used in the laboratory: (1) Forced impingement on a nutritive coated plate (2) Chemical luminescence. Alteration of some hematologic areas were found during dust insult. Liquid crystals were not found to be a practical remote bird temperature sensing device. Electrocardiographic records have been made on several chickens of different ages before, during, and after dust insult. Results vary with technique and lead position but indicate that some pattern differences exist due to dust as a stress. Further refinement of technique is necessary.

SUPPORTED BY U.S. Dept. of Agriculture

1.0351, ACTION OF AIR POLLUTANTS ON PLANTS AND METHODS OF DAMAGE CONTROL ESPECIALLY THROUGH RESISTANCE

H.E. HEGGESTAD, U.S. Dept. of Agriculture, Plant Air Pollution Laboratory, *Beltsville, Maryland* 20705 (0000-05-01)

OBJECTIVE: Basic research directed toward better understanding of how air pollutants act on agronomic, horticultural and ornamental plants, and the development of methods for controlling air pollution damage including resistant varieties.

APPROACH: A wide spectrum of plants will be subjected to pollutants in ambient air and to one or more photochemical air pollutants under controlled conditions, differences in response will be studied and the physiological, morphological and biochemical basis of the effect established.

PROGRESS: Determined effects of photochemical oxidants on growth and yield of 8 potato (Solanun tuberosum) varieties. Plants were grown in a greenhouse supplied with air filtered through activated carbon to remove oxidants and in an adjacent greenhouse with ambient air. Haig and Norland had the most leaf injury. Tuber yields of Haig, Irish Cobbler, and Norland were about 50% lower in the ambient air. Yields of Avon, Superior, and Peconic were reduced 11, 20, and 24% respectively. Kennebec and Alamo produced about the same yield in both environments. Phenolic composition was significantly altered in Tempo bean leaves cultured in polluted ambient air. Fluorescent compounds were concentrated in the reddish-brown leaves. The level of caffeic acid in injured leaves was twice that detected in healthy leaves. Although anthocyanin is formed in leaves of Rumex Crispus after exposure to smog and ozone, it was not detected in the injured bean leaves. Discovered that mechanical wounding of the beans resulted in galls on plant parts. The response of major sites (chloroplast and cytoplasmic ribosomes) of protein synthesis to ozone were investigated with Pinto bean. Chloroplast polysome level was reduced more than the cytoplasmic polysome. RNA components of chloroplast ribosomes decreased more than those of cytoplasmic ribosomes. Results indicate that protein- synthesizing capacity is impaired by ozone.

SUPPORTED BY U.S. Dept. of Agriculture

1.0352, LITERATURE REVIEW ON THE EFFECT OF AIR POLLUTANTS ON LIVESTOCK AND POULTRY

R.J. LILLIE, U.S. Dept. of Agriculture, Animal Science Research Div., *Beltsville, Maryland* 20705 (032909390121)

OBJECTIVE: Conduct an exhaustive research, summarize and interpret the literature on air pollutants.

APPROACH: Conduct a comprehensive literature search and review of published information on the effects of air pollutants on livestock and poultry. It will include all experiments in which any of the pollutants were used or studied. The information will be compiled by chemical compounds, by class of livestock and poultry and by the type of physiological or pathological effect. Potential benefits from further experimentation will be described and evaluated.

PROGRESS: The literature review on the effect of air pollution on livestock and poultry which involved 1200 papers was completed. This review indicates that fluorides, arsenic and lead appear to be the most critical air pollutants for domestic animals. The rank of decreasing susceptibility among farm animals was demonstrated for cattle, sheep, horses, swine, rabbits and poultry exposed to fluorosis, but not clearly demonstrated for all classes of farm animals exposed to other air pollutants. Although not directly compared to other farm animals, the honey bee, which is valuable as a crop pollinator and as a producer of honey, appears to be more susceptible than cattle to fluoride and arsenic. If early stages of atmospheric poisoning are detected among farm animals, the animals can be salvaged for continued production of eggs, milk, meat and wool, provided these animals are protected from further atmospheric pollution. Although the fluoride content of milk from poisoned cattle has never been found to exceed the safe limit for humans, the calcium content of milk has been found to exceed this limit in several cases.

SUPPORTED BY U.S. Dept. of Agriculture

1.0353, BREEDING, GENETICS AND DISEASE CONTROL OF ALL TOBACCO TYPES

H.A. MENSER, U.S. Dept. of Agriculture, Crops Research Division, *Beltsville, Maryland* 20705 (0500-03-01)

OBJECTIVE: Develop varieties and breeding material of all tobacco types with resistance to diseases (pathogenic and physiological) and varying levels of chemical constituents. Transfer of disease resistance factors from Nicotiana species and foreign tobacco introductions into usable breeding material. Obtain information on air pollutants, and the physiology and anatomy of pathogens.

APPROACH: Conduct comprehensive breeding and genetics program including evaluation of germ plasm, transfer of desirable characters to all tobacco types for disease resistance, varying chemical constituents, and other economic characters. Conduct studies on the physiology and anatomy of plant pathogens and their affect on resistant and susceptible tobaccos. Study the effect of air pollution on tobacco and develop methods of control. Field evaluation of new Maryland type breeding lines at Upper Marlboro, Maryland for local adaptations is conducted as a satellite of the investigations.

PROGRESS: Optimum postinoculation temperature for infection by A. tenuis (brown spot) is 20 C. Other requirements for successful inoculation are moisture on the leaves for 3 days, pathogenic isolates and a concentration of 30,000 conidia/ml. This information makes possible greenhouse testing for resistance. Most of the chlorotic area surrounding brown spot lesion is free of fungal invasion, therefore, pathogenesis involves production of a halo inducing factor. Some of the chemical

characteristics of this factor are: stability to autoclaving for 15 minutes at 15 psi; solubility in acetone, ethanol and water; insolubility in ether; slight solubility in chloroform; not precipitated by (NH(4))(2) SO(4) or phosphotungstic acid, and stability to heating with concentrated acid. TI 1466 was found to be resistant to blue mold and is being used in crosses to develop blue mold resistant tobacco. The resistance in the line is from N. excelsior. In studying plants subjected to air pollution sensitivity, those under water stress were more resistant to ozone than plants watered normally. Nine burley varieties were tested for susceptibility to air pollutants. In the field Bu 49 and Ky 12 showed the greatest tolerance.

SUPPORTED BY U.S. Dept. of Agriculture

1.0354, CLIMATIC CHANGES THROUGH URBANIZATION

H.E. LANDSBERG, Univ. of Maryland, School of Engineering, *College Park, Maryland*

For the past three years micro - and meso-meteorological studies have been carried out in Howard County, Maryland, where the new town of Columbia is converting a rural area into an urbanized community. During the growth from a few hundred to ten thousand inhabitants measurable atmospheric changes have occurred and been documented.

Further growth of the town to 100,000 persons is expected. It is proposed to continue this study with special emphasis on the following points: (1) Pursue to study of heat island, including the radiation balance and attempt to measure the development of the country breeze. (2) Make a quantitative assessment of stream run-off in the urbanized area during heavy rainfalls. (3) Begin systematic observations of turbidity and compare values obtained with similar data from the Washington-Baltimore area. Make more sophisticated air pollution measurements in the area than heretofore. Include 'noise' in the pollution monitoring program and relate it to meteorological conditions. (4) Compare changes in meteorological data with those neighboring stations in undisturbed environments. Make meso-synoptic study to see if the town already creates an influence on showers. (5) Prepare an outline of possible remedies to counteract adverse meso-meteorological changes in town areas for consideration in planning of future new towns.

SUPPORTED BY U.S. National Science Foundation

1.0355, ENVIRONMENTAL EFFECTS OF EXPLOSIVE TESTING

E.A. CHRISTIAN, U.S. Navy, Ordnance Laboratory, *Silver Spring, Maryland* 20910

Technical Objective: Develop guide lines to be followed as part of the preshot preparations for large scale high-explosive tests. These guide lines would be directed toward minimizing environmental contamination and any basis for adverse criticism of the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0356, LOPHODERMIUM NEEDLE CAST DISEASE AND OZONE DAMAGE ON WHITE PINES

W.M. BANFIELD, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01002 (MAS00298)

OBJECTIVE: Identify and appraise the comparative pathology and damage induced by ozone and Lophodermium pinastri Chev., operating either sequentially or concurrently.

APPROACH: Comparison of the disease syndromes induced on susceptible white pines by exposure to Lophodermium, ozone, or both concurrently or sequentially on greenhouse plants otherwise shielded. Identification of the complicity of these agencies in the genesis of the white pine blight complex of field trees by cultural studies of affected foliage and by exposure of this foliage to disease inducing thresholds of ozone. Appraisal of the comparative damage of these two agencies to white pine in New England. Identification of practical techniques for their control.

PROGRESS: Diseased plants selected in the nursery were grown for two years behind activated charcoal filters during which time they developed an entirely normal dark green foliage. Of 47 such plants exposed for up to thirty 12 hour periods of fumigation with 0(3) at 5 pphm, multiple spotting of their needles was induced on only two. Fifty-two of 54 plants fumigated with SO(2) at 100 5 pphm for up to 42 consecutive 12 hour daylight periods remained dark green and spotless. Numerous stomatal line spots developed on the new foliage of the other two. All 68 plants exposed to a mixture of 0(3) and SO(2) both at 5 pphm, mostly developed a sickly yellow green color, lost all their one and two-year needles, and developed a profuse spotting of new needles, accompanied by variable quantities of blight (death and red orange discoloration of needle ends). When such exposures were made at saturated humidity, these disease symptoms were initiated even from one 12 hour exposure to SO(2) at 2.5 pphm and O(3) at 10 pphm. Results indicate the disease is due primarily to the combined action of ozone and sulfur dioxide, and that intensity of disease response is conditioned by relative humidity and length of exposure.

SUPPORTED BY U.S. Dept. of Agriculture

1.0357, AIR POLLUTION PROBLEMS IN THE NORTHEAST

W.A. FEDER, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01002 (MAS00272)

OBJECTIVE: Determine the impact of present air contaminants on the agriculture of the Northeast. Obtain information prerequisite for the development of air quality criteria as they relate to agriculture in the Northeast. The first objective will be met by the implementation of a comprehensive regional survey. The second objective will be met in a number of program areas which are described below.

APPROACH: Relate plant injury from phytotoxicants to regional meteorological conditions, and determine responses of plants to different air pollutants. Massachusetts will contribute to this program area by comparing growth rate, quality, yield, and the characterization and symptomalogy of specific responses of commercial greenhouse crops.

PROGRESS: Growth and development of Olympic Red cultivar of geranium growing in 100 cubic foot Mylar chambers supplied with 10 pphm of ozone for 9 hours per day for three months was compared with plants of the same cultivar growing in identical chambers but receiving only ozone-free air. Ozone was supplied only during daylight hours. Plants in ozonated air developed fewer, smaller leaves, longer internodes, and about 30% fewer side branches than those growing in ozone-free air. The leaves are chlorotic and exhibited marginal flecking and premature senescence and abscission. Flower quality was unaffected but flower shelf life was markedly shortened. The number of blossoms per branch was unchanged but the reduction in number of side branches reduced the total number of flowers produced by about 50% in ozonated air. Growth in ozonated air resulted in a taller, thinner, yellower plant with fewer flowers. Monitoring of ozone and oxides of nitrogen in suburban Boston revealed that levels of these pollutants at least equalled those found in downtown areas of Washington, Cincinnati, and San Francisco. Sulfur oxide levels showed a sharp rise during summer 1969.

SUPPORTED BY U.S. Dept. of Agriculture

1.0358, CLOUD EFFECTS ON PASSIVE MILLIMETER WAVE RADIOMETRIC TEMPERATURES

W.H. BAUCOM, Sperry Rand Corporation, *Sudbury, Massachusetts* (000644)

Technical Objective: To determine the microwave remote sensing technique's altitude capability and its sensitivity to adverse weather conditions.

Approach: Conduct an analytical and experimental study to isolate the effects due to clouds, instrumental effects, and mode of operation on the measured brightness temperature; the results will establish the influence of clouds on radiometric observations of the atmosphere at altitudes up to 25,000 feet. For the analytical phase, computer simulation studies will be conducted to establish the characteristics of the equipment, mode of operation, and data reduction techniques that must be implemented in the experimental program. Then, the experimental studies of cloud effects will be conducted using a 50 to 60 GHz Radiometer.

1. AIR QUALITY

Progress: During August and September 1969, computer simulation of the microwave technique indicated that infomation from as high as 30,000 feet can be received at the ground if the operating frequency is 53.5 GHz. In the experimental area simultaneous radiometer and radiosonde runs were made on three days during which the sky was clear but when air pollution conditions were quite different. Other radiometer measurements for cloud and no-cloud conditions were made. Preliminary indications are that pollution and middle clouds have little effect on the brightness temperature measured by the radiometer at these frequencies. On the other hand, it appears that a cumulus congestus on the verge of precipitation does significantly change this temperature.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

1.0359, THE ULTRASTRUCTURE OF NORTH AMERICAN HEPPIACEAE

C.M. WETMORE, Univ. of Minnesota, Graduate School, *Minneapolis, Minnesota* 55455

Lichens are one of the most sensitive indicators of air pollution because they are composed of algae and a fungus in a symbiotic relationship. They are also very sensitive indicators of climate. A better understanding of the lichens and the nature of the symbiosis would be beneficial to their utilization as indicators in ecological studies.

This research involves the comparative study of the ultrastructure of all of the 16 taxa in the lichen family Heppiaceae in North America. Using the electron microscope, a comparison will be made between the isolated algae and fungi and the intact lichen. The organelles unique to lichens will be further investigated in an attempt to determine their function in the lichen. By studying the ultrastructural differences in the same species in different ecological conditions and in different environments, information can be gained which will be useful in quantifying damage due to environmental changes. The principal objective is to expand knowledge of evolutionary relationships of this recently monographed group by including ultrastructural data.

The results should also stimulate further work on the ultrastructure of lichens by improving techniques used in working with lichen. It should also aid in understanding the unique cellular organelles and the nature of the lichen symbiosis.

SUPPORTED BY U.S. National Science Foundation

1.0360, INVESTIGATIONS IN THE THERAPY OF BOVINE LEAD POISONING

P.B. HAMMOND, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-26-026)

OBJECTIVE: Study of lead-mobilizing characteristics of chelating agents; investigate the lead content of vegetation as related to distance from roadways having variable traffic densities. Analytical data will be gathered once again with special attention to certain procedural details which may account for the disparity between our results and those of others.

APPROACH: Various analytical methods are being used to determine lead content in specimens from animals and plants. EDTA will be used to treat lead poisoning and to study the mode of action of chelating agents.

PROGRESS: The major effort during the past year has been devoted to defining the kinetics and compartmentalization of lead in the body. We had hoped to use the Armac whole body counter in connection with these studies. Problems relating to the design of the instrument have not as yet made this possible. Nevertheless, certain results of importance have emerged. The whole body burden of lead over 37 days following intravenous administration decreases at a rate which can be described by a single first order rate constant from day 4 to day 37. From day 10 to day 37 the skeletal burden falls at the same rate as the whole body burden. As a corollary of the above, the soft tissue burden falls at the same rate as the whole body burden. It had been anticipated that it would fall considerably faster. Also, the exchangeable fraction of bone, defined by the amount of lead mobilized from bone by a standard dose of EDTA, decreases considerably faster than the whole body burden or the total skeletal burden. This finding had been anticipated. Other results obtained during the year indicate that doubling the dose of EDTA by doubling the duration of the infusion period substantially increases the fraction of metal removed from bone and, to a lesser extent, from soft tissue. Also, we have determined that the chelating effects of EDTA are similar regardless of whether one is dealing with carrier or tracer doses of lead.

SUPPORTED BY Minnesota State Government - Saint Paul

1.0361, EFFECTS OF AUTO EXHAUST ON ROADSIDE MAMMAL POPULATIONS

J.L. WOLFE, Mississippi St. University, School of Arts, *State College, Mississippi* 39762

Previous work on the effects of motor vehicle emissions on mammals has consisted primarily of laboratory studies in which test animals were subjected to high concentrations of auto exhaust for relatively short periods. I propose to take this work into the field and compare several physiological, behavioral, and ecological parameters of cotton rats, 'Sigmodon hispidus', living in areas of high contamination (on road shoulders) and in uncontaminated areas. More specifically, heart rate, blood pressure, EKG, breathing rate, hematocrits, blood cell counts, adrenal and spleen weights, condition of lungs and liver, reproduction in the field, movements and spatial relationships of individuals in the field, population density and structure, exploratory behavior and spontaneous activity, social interactions, feeding behavior and weight changes, and carboxyhemoglobin and lead levels in the blood will be investigated.

Organic and inorganic particulate materials undoubtedly reach high concentrations along highway rights-of-way. Although toxic gases probably never reach the concentrations utilized in laboratory tests, animals inhabiting road shoulders are exposed continually, which could have an effect over a period of several months. Small mammals of this type occupy definite home ranges which would tend to keep individuals occupying road shoulders in constant direct contact with contamination.

Since several aspects of the animals' ecology and reproduction under natural conditions are included, the study could provide information on long range population effects of contamination, as well as on direct effects on individual animals.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0362, ATMOSPHERIC IONS AND THE INFECTION PROCESS OF FUNGI

E.L. SHARP, Montana State University, School of Letters, *Bozeman, Montana* 59715

An investigation will be made on the influence of naturally occurring atmospheric ions and associated particles on the infection process of a plant pathogenic fungus. Three separate phases of the infection process - germination, penetration and symptom development - will be investigated. Attempts will be made to determine if specific air ion mobility groups are stimulatory or inhibitory to the various phases of the infection process. The influence of various sized uncharged particles will also be investigated. Experiments will be designed to test the relative efficacy of the positive and negative ions. The effects of various sized generated inert particles on the small ion content will be related to development of the different phases in the infection process. A number of meteorological factors will be monitored to determine their relation to the air ion mobility spectrum and particulate matter in the air. The meteorological data will also be evaluated in relation to development of the infection process during coinciding periods.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0363, SURVEY OF AIRBORNE FLUORIDES IN GLACIER NATIONAL PARK AND EFFECTS ON VEGETATION AND WILDLIFE

C.C. GORDON, Univ. of Montana, Graduate School, *Missoula, Montana* 59801

Work to be performed under this contract will consist of (1) vegetation damage survey including collection and analysis of vegetation samples for fluoride accumulation; (2) trapping of small rodents and other mammals indigenous to the area and

analysis for fluoride accumulation, and (3) operation and maintenance of static and dynamic air samplers for measurement of ambient fluoride concentrations. Field work will be accomplished during 1970 growing season. Results obtained from the survey will form the basis for a later report to the National Park Service.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0364, A STUDY OF PLANTS GROWING IN POLLUTED ATMOSPHERES

C.C. GORDON, Univ. of Montana, School of Arts, *Missoula, Montana* 59801

This research program is designed to obtained further knowledge of the effects of various toxic gases on the tissues of selected species of Gymnosperms and Angiosperms. This will be accomplished by: 1. continuing to investigate the specific disease syndromes manifested by the tissues of plants growing in areas where toxic gases are present in the ambient air; 2. growing plants under controlled conditions in known concentrations of toxic gases to ascertain if histological and cytological responses to pollutants occurring in the field can be duplicated in the laboratory; 3. obtaining chemical analysis of cultivated and native vegetation from polluted areas of Montana and from controlled fumigation studies; and 4. Carrying out atmosphere gas analyses in polluted areas.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.P.P.

1.0365, PHYSIOLOGICAL RESPONSES OF PLANTS TO TOXIC AIR POLLUTANTS

E.G. BRENNAN, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00390)

OBJECTIVE: Investigation of the role of plant nutrients and other metabolites on the reaction of plant tissues to air pollutants. Investigation of the effect of air pollutants on plant metabolism at the cellular and subcellular level by studies of respiration, enzyme systems, host-parasite relationships, and other metabolic systems.

APPROACH: Plants sensitive to each pollutant will be grown in sand culture with a deficient, optimum, and luxury supply of various nutrients, exposed to the pollutant, harvested at various stages and analyzed for the nutrient involved. Respiration rates, nitrogen fractions, carbohydrate constituents and A T P production will also be determined. Species sensitive to a particular pollutant will be grown in sand culture and then exposed to the pollutant. The chloroplasts and other organelles will be separated by centrifugation. Respiration rates will be measured at the cellular and subcellural level with a Warburg manimetricon. Oxidation-reduction potential will be measured by methods, yet not to be investigated. If an electron microscope is available, the effect of the pollutant on the ultrastructure of the organelles will be determined.

PROGRESS: Local lesion assays of TMV-infected N. sylvestris showed more virus activity in ozonated than in control plants. Bean plants ozonated 3 or 24 hrs. after inoculation with TMV had more lesions than control plants./ Low 0(3) exposure increased the permeability of Bel W-3, but not of Bel B; a high exposure increased Bel W-3 permeability more than Bel B. Tomato and tobacco plants grown with high calcium showed enhanced 0(3)-sensitivity./ In solution culture tomato plants ozone injury increased with increase in phosphorus level./ Increasing the concentration of indole-acetic acid in sand-solution tomato cultures decreased ozone injury./ Ozonation of tomato plants caused an alteration in the DNA content of leaves particularly at deficient and superoptimal phosphorus levels./ Analyses indicated higher lignin, cellulose and carbohydrate in needles of pollution resistant Austrian pines than in needles of susceptible strains. ATP content of ozonated tissue increased immediately over untreated tissue, and after 3 days it decreased significantly.

SUPPORTED BY U.S. Dept. of Agriculture

1.0366, FACTORS IN RESPONSE OF AUSTRIAN PINE TO AIR POLLUTION

E.G. BRENNAN, Rutgers the State University, School of Agriculture, *New Brunswick, New Jersey* 08903

We propose to identify the pollutant responsible for observed damage to Austrian pine needles in certain areas of New Jersey and to determine the underlying morphological or physiological factors responsible for observed individual differences in susceptibility. An effort will be made to determine the heritability of these characteristics.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0367, EVALUATION OF POTATO VARIETIES

J.C. CAMPBELL, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00357)

OBJECTIVE: Evaluate new potato seedlings for plant type, tuber type, yields, total solids, market quality, and processing qualities. Evaluate varieties, seedlings, and genetic lines for type and degree of damage from air pollutants. Determine seed-piece spacing, and nutritional needs of new potato varieties.

APPROACH: Seedlings and newly-named varieties will be secured and planted at three locations and data obtained on grades, yields, and specific gravity for market acceptability and samples will be evaluated as baked, boiled, mashed, chipped, and French fried potatoes. Promising new varieties will be planted at various spacings to ascertain the best spacing. Various rates of fertilizer will be applied to determine the most suitable rates and/or methods of application.

PROGRESS: One Canadian and 8 new USDA seedlings produced excellent yields of U.S.01's. Raritan, Lenape, Pennchip, Superior, Kennebec and Norchip yielded from 363 to 327 cwt/A. 29 varieties out-yielded Katahdin. The specific gravity of all varieties was low, but S.G. of Raritan and Lenape was 1.0750 and 1.0742 respectively. Top yields were produced by BR6312-2, Kennebec, Norchip, BR5946-9 and Raritan and 15 varieties out-yielded Katahdin. S.G. of Raritan was 1.0706, but S.G. of all other varieties was low. Yields of over 300 cwt/A were produced by 9 varieties. Yields of Lenape Kennebec, Norchip and Jewel were 388 cwt or more. S.G. of Raritan and lenape were 1.0675 and 1.0672, other were very low. Top yields were produced by Kennebec, Norchip, Raritan, Jewel, Superior, and Chippewa. An air pollution evaluation study was conducted. 10 male and 10 female parents and 4 progeny of each cross were examined for air pollution injury. Injury was very slight to moderate. Seed of Lenape, Superior, Wauseon, and Raritan were spaced 8, 10, and 12 inches apart. Raritan gave highest net yield at 8'. The other varieties gave highest net yields at 10' spacing. Increasing rates of N from 50 to 150 lbs/A and k(2)O from 0.200 lb/A increased yields of Lenape, Raritan and Superior but increasing p(2)05 from 100 to 200 lb/A did not.

SUPPORTED BY New Jersey State Government - Trenton

1.0368, RELATIONSHIP OF LEAD IN THE AIR, SOIL AND PLANTS TO PROXIMITY TO HIGHWAY TRAFFIC

R.H. DAINES, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00388)

OBJECTIVE: Determine the influence of highways of varying traffic loads on the lead content of soils and vegetation in their vicinity, and determine the area influenced. Determine the effect of lead in the soil coming from various sources on the lead content and distribution within plants.

APPROACH: Grow plants in a greenhouse having lead free air, in soils of varying lead content. Study amounts absorbed and distribution in plants. Grow plants in acid washed sand in greenhouse and at various stations along highways. Pots to be sealed so as to admit only filtered air. Such plants to be studied for lead content and distribution. At each plant growing station air to be sampled and analyzed for lead content. In addition samples of vegetation and soil to be collected at varying distances from highways. These samples to be analyzed for lead content, analyzed for trends that may or may not suggest lead pollution coming from tetra ethyl lead in gasoline.

PROGRESS: A relationship exists between traffic volume, proximity to the highway, engine acceleration vs constant speed, wind direction, and the amount of lead in the air. A marked effect of traffic on the lead content of the air is limited to a zone bordering the lee side of the highways. A decrease of 50% of lead in the air occurred between 10 and 150 ft. from the highway. Beyond

250 feet a decline of lead occurs. Lead values can be expressed as a quadratic function in time and linear to traffic volume. 65% of the lead in the air between 30 and 1750 feet from a highway consists of particles under 2 microns, and 85% under 4 microns in diameter. Soils and plants lead contents tend to increase with traffic volume and decrease with distance from the highway. Much of the lead was present as a removable surface contamination. The major effect of traffic was limited to the surface soil and to a narrow zone within 100 feet of the highway. Plants grown in the field contained the most lead in the aerial portion and those grown in the greenhouse had the most lead in the roots.

SUPPORTED BY New Jersey State Government - Trenton

1.0369, AIR POLLUTION PROBLEMS IN THE NORTHEAST
R.H. DAINES, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00389)

Objective: Determine the meteorological conditions that permit the accumulation of oxidant air pollutants in excessive concentrations. Determine if pollution episodes result from pollutants generated in a given metropolitan area (local), from pollutants from other areas; or from a combination of pollutant from both sources.

Approach: Air pollution episodes will be determined by Mast ozone recorder (SO_2 removed) and by response of oxidant sensitive plants. When the Mast ozone recorder inicates a pollution of 5 pp.h.m. and above and/or when Bel W. tobacco or White Cascade petunia show visible damage, the results will be reported to predetermined cooperators in the N.E. Region. Plants will be grown in charcoal filtered greenhouses. Our reports and those from others cooperating in the Northeast will be studies to determine meteorological parameters that characterize air pollution episodes. Efforts will be made to differentiate between parameters that result in pollution from local sources and those that favor the transportation of pollutants from other areas.

Progress: Plant response was significantly influenced by the relative humidity of the atmospheres. At high humidity (95%) wet or dry Bel W3 tobacco plants exhibited similar and pronounced injury at a 90 minute exposure at 0.15 ppm ozone. At 51% relative humidity 0.30 ppm O_3 was required to produce injury of similar intesnity. At 26% relative humidity 0.35 and 0.4 ppm O_3 was required to produce equivalent plant response. Pinto beans exhibited similar response. Porometer readings demonstrated that humidity affected the leaf permeability or stomatal openings with the stomata on leaves exposed to the lowest humidity exhibiting the least permeability and the highest humidity showing the greatest permeability or stomata showing the largest openings. This provides one reason why plants in the Northeast are more readily injured by air pollutants than are similar plants in the Southwest. Since all pollutants enter the leaf through open stomata, the relative humidity should influence susceptibility. Fewer plant damaging episodes were observed in the field last year.

SUPPORTED BY U.S. Dept. of Agriculture

1.0370, STUDY OF IRRADIATED AIR POLLUTANTS ON SPREAD FILMS
A. FELMEISTER, Rutgers the State University, School of Pharmacy, *New Brunswick, New Jersey* 08903

It is the purpose of this project to: (a) continue the study of the adsorption of non-irradiated and irradiated air pollutants on various spread films in order to gain additional insight into both the site and mechanisms of action of gaseous air pollutants on biomembranes; (b) investigate the influence of air pollutants on active enzymes and enzyme -lipid complexes spread as monomolecular films. It is anticipated that this will lead to a better understanding of the mechanism of enzyme inhibition by pollutants; (c) study the properties of various monolayers, after interaction with pollutants; (d) investigate the effect of certain additives, such as antioxidants and materials known to influence cell membrane stability and permeability, on the adsorption of air pollutants on spread films; and (e) develop further the relationships between the pollutant-film interactions and the biological response observed with simple organisms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0371, RELATIONSHIPS BETWEEN CERTAIN AIR POLLUTANTS AND VARIOUS METEOROLOGICAL FACTORS
A.V. HAVENS, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00279)

OBJECTIVE: Determine the relative importance of various climatic parameters in relation to the occurrence of pollution conditions over New Jersey. Develop a mathematical relationship between levels of pollution concentration and the diffusive power of the atmosphere. This study will utilize data on $S(2)$ concentration, suspended particulate matter and related meteorological observations which have been collected over a 6-year period and made available through the cooperation of a local industry and the U. S. Weather Bureau.

APPROACH: Evaluation of a statistical model and preparation of additional publications is planned. Improvement in the prediction capability could be achieved by further model evaluations on the basis of standard forecasts by U. S. Weather Bureau. This would indicate the utility of the model as a practical forecasting tool.

PROGRESS: The concentrations of air pollutants are often highest in the early morning hours when winds are light and the atmosphere near the ground is thermally stable due to the presence of a temperature inversion. Under such stagnant conditions atmospheric dilution is at a minimum. By early afternoon, however, pollutant concentrations are usually at a minimum because of turbulent mixing of the lower atmosphere by thermal convection when the ground is warmed by bright sunshine. The effectiveness of this daytime dilution is largely dependent upon the depth to which the atmosphere is mixed by thermal convection and wind since this mixing depth determines the volume of air into which pollutants are dispersed. In this study, daily temperature and wind profiles over the New York City and Philadelphia are being correlated with hourly observations at New Brunswick and 24 other locations in and around New Jersey in an effort to develop a method for predicting the mixing depth and ultimately atmospheric dilution from readily available and inexpensive ground-level observations rather than expensive radiosonde soundings. This will be especially useful in areas located a considerable distance away from the nearest radiosonde station.

SUPPORTED BY U.S. Dept. of Agriculture

1.0372, AIR POLLUTION
A.J. KAPLOVSKY, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00526)

OBJECTIVE: Determine the rate, extent, and mechanism of absorption of low concentrations of sulfur dioxide by various textile materials.

APPROACH: Study of sulfur dioxide absorption by textile materials. The work will be continued with the procedures developed up to the present; namely, exposing the textile materials to controlled and confined dynamic atmospheres containing known amounts of $SO(2)$ moisture and to determine the removal of this gas and the effect of the environmental factors, the reactions involved, and the effects produced on the textile materials.

PROGRESS: A study of behavior of solid submicron aerosol particles in helium and argon gases as influenced by particle charge and presence of water vapor. Specific experimental system designed for diffusion measurements of poly-dispersed aerosols. Knowledge of physical forces (charge, particle size) in formation of fog and dissipation needed to study relationship to pollution and control. Liquid aerosol formed by attachment of water vapor to tungsten particles and observed change in measured particle size diameter. Scattered light measurement indicated liquid aerosol formed when either of the zero time tungsten aerosols were used as condensation nuclei. No size change detected. Results confirmed by Goetz Aerosol Spectrometer measurements. Generation of E. coli by evaporation from distilled water and collection with particle sizing prior to aerosolization and after collection showed noted difference in cell size. Analysis of particle size distribution by mathematical frequency functions completed.

SUPPORTED BY New Jersey State Government - Trenton

1.0373, EFFECTS OF AIR POLLUTION ON A FOREST ECOSYSTEM
T.H. NASH, Rutgers the State University, School of Arts, *New Brunswick, New Jersey* 08903

Pollution of air, soil and water is an environmental problem of widespread and critical importance to the health of man and the quality of his environment. Uncontrolled pollution may well exact its heaviest tool through the poisoning and disruption of delicately balanced local and global ecosystems. It is the broad objective of this research to investigate the role of air pollution as a biological stress on a natural forest ecosystem, and to study the effects of this pollution on the species composition, succession, productivity and diversity of the forest. The physiological responses of the cryptogams will also be considered. Results from the study will have importance in assessing the economic and aesthetic value of the area.

The study site is the Lehigh Water Gap area of Blue Mountain, near Palmerton, Carbon County, Pennsylvania. The situation is ideal for studying the long-term effects of pollution. A zinc smelter, located in Palmerton since 1898, is the only main source of pollution (sulfur dioxide and heavy metals) for many miles, thus creating a built-in experimental and control area. The past history of the land, the smelter and the forests is reasonably well known, and meteorological data are available since 1918.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0374, ENVIRONMENTAL REQUIREMENTS OF POULTRY
C.H. REED, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00567)

OBJECTIVE: Determine the effect of environmental components on the productive performance and various physiological measurements of poultry. Factors of environment that may be studied include: Heat level. Moisture level. Air movement.

APPROACH: Parameters for measuring these effects will be feed consumption, body-weight grains, mortality, blood volume and composition, and biochemical changes in body composition that are representative of protein metabolism within the cells of several tissues, such as serum, intestine, liver and muscle. These tissues represent 95% of protein metabolism within the animal body.

PROGRESS: Studies on the effect of air pollution (dust) and 4 light regimens (black, natural, 454 and 653 mu) on protein metabolism in immature fowl are part of a series in cooperation with the Universities of Maine and Vermont. Tissues of rapidly growing chicks reared under these experimental treatments were analyzed for protein, nucleic and free amino acids - parameters considered reflective of protein metabolism in this 'anabolic' model. Within the experimental period, liver DNA and RNA concentrations were significantly increased by moderate dust treatment; protein and free amino acids were not affected. Compared to controls, liver weight was less under black light and 454 mu. Light regimen did not affect concentrations of liver protein, DNA, RNA and free amino acids. Heart weight was significantly less under black light and greater under 653 mu. DNA concentrations were higher under 454 mu; protein, RNA and free amino acids were not affected. Total quantities of heart DNA were depressed under black light and increased under 454 and 653 mu. Black light lowered total protein and free amino acids.

SUPPORTED BY U.S. Dept. of Agriculture

1.0375, OZONE AND VASCULAR TISSUE DIFFERENTIATION IN PLANTS
J.P. RIER, Rutgers the State University, School of Arts, *New Brunswick, New Jersey* 08903

This is an investigation of the possible effects of sublethal dosages of ozone on differentiation of xylem and phloem in callus tissue and whole plants. Plant tissues grown in vitro and whole plants in vivo treated for vascular tissue induction will be exposed to ozone at a variety of concentrations and durations. Following these treatments, tissues will be examined histologically for anatomical changes and electrophoretically for possible associated changes in the quality of proteins.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0376, THE CHIRONOMIDAE OF CALIFORNIA
L.E. SUBLETTE, Eastern New Mexico University, Graduate School, *Portales, New Mexico* 88130

The family Chironomidae has an unusual ecological valence which ranges from low to high pollutional tolerance. For more precise ecological management of freshwater, we must accumulate a considerable body of knowledge of the group. The following subprojects will identify the major points of study: (1) Life history studies through rearing of immature stage; (2) Cytotaxonomy of the genus 'Chironomus' with particular reference to the 'attenuatus' and 'riparius' (equals thummi) groups; (3) Completion of a review of the Orthocladiinae of California; (4) Preparation of a handbook of the family for the California Insect Survey.

A bulk of the field work will be performed in California by Mr. Frommer.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0377, INTERACTIONS BETWEEN THE GREAT LAKES AND THE ATMOSPHERE
R.J. PILIE, Cornell Aeronautical Lab. Inc., *Buffalo, New York* 14221 (001129)

Approach: Present results indicate that the scope of the Great Lakes Snow Storm Experiment must be conducted on a larger scale so as to encompass the fundamental problems of mesoscale modification, seeding agent diffusion, city influence on weather and the increase, decrease, and/or redistribution of snowfall due to seeding. The FY-71 program will be transitional, with major emphasis directed toward expanding the overall scope of the experiment, preparatory to an expanded fild effort in FY-72.

Progress: The results of this year's experiment were: a. The previously developed mesoscale numerical model has been found to agree markedly well with the natural cloud systems, b. The basic seeding hypothesis, namely redistribution of snowfall, and overseeding, appears confirmed by surface observations of the snowfall; and c. Conditions have been demonstrated where heavy snow showers can be released artificially be airborne or ground seeding or by 'city plume'.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0378, AIR POLLUTION PROBLEMS IN NORTHEAST
B.E. DETHIER, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00080)

OBJECTIVE: Determine the impact of present air contaminants on the agriculture of the Northeast and to obtain information prerequisite for the development of air quality criteria as they relate to agriculture in the Northeast.

APPROACH: Collect data on air quality and air quality effects for compilation in the regional survey of the degree and economic importance of air pollution damage to agriculture and apply statistical weather records to estimation of frequency and duration of pollution episodes and investigate factors underlying changing pollution concentrations in the air mass.

PROGRESS: Lack of electrical power due to the relocation of the weather station prevented the monitoring of oxidant levels during the mid summer. Bel W-3 tobacco plants grown in filtered air were used as indicators during the entire summer. Some non-typical damage was observed for a short period on some plants located within 50 ft. of a construction site. Other plants a few miles away were uneffected. Oxidant levels, during all monitored periods remained below 2 pphm. Temperature differentials between two levels and wind speed and direction were recorded continuously on the 250 ft. meteorological tower. Since no pollution episodes were observed during the summer, the weather data is being used to continue the investigation of the formation and breakup of inversions.

SUPPORTED BY U.S. Dept. of Agriculture

1.0379, EFFECT OF AIR POLLUTION - MICROBES IN VIVO AND IN VITRO
G. STOTZKY, New York University, Graduate School, *New York, New York* 10003

1. AIR QUALITY

The effects of various air pollutants on growth, survival, spore germin-ation, adaptation, etc. of microorganisms in pure culture, in soils, and on plants have been studied. Differences in sensitivities between groups and species of microorganisms were observed, but sensitivity of all microbes to O sub 3 was several magnitudes greater than to SO sub 2 and H sub 2 S.

The objecties of the proposed research are: (1) to determine further the effects of air pollution on microbes in pure culture and in natural habitats, such as in soil and on plants; (2) to determine the mechanisms whereby air pollutants affect microorganisms; (3) to determine whether microbes can be used as a bioassay of air pollution; (4) to develop better methods for evaluating the effects of air pollutants on microorganisms; (5) to determine whether and how natural habitats offer protection to microbes against the detrimental effects of air pollution; (6) to determine further whether and how microbes metabolize some air pollutants.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0380, AIR POLLUTION EFFECTS ON POWDERY MILDEW FUNGI

C.R. HIBBEN, Brooklyn Botanic Garden, *Ossining, New York* 10562

The effects of ozone and sulfur dioxide on powdery mildew fungi will be investigated by exposing conidia on artificial and natural substrates to acute and chronic gas doses under controlled environmental conditions. The reaction to the gas treatments will be assessed by determining spore germination, morphological characteristics of the germ tubes, substrate colonization, and sporulation. The influences of temperature, relative humidity, light, and nutrients on the reaction of the fungi to the gas treatments will be determined. In addition, the protective effect against the gases by leaf tissue infected by powdery mildew fungi will be elucidated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0381, MULTIPLE LIGHT SCATTERING OF POLLUTED ATMOSPHERES

M. KERKER, Clarkson College of Technology, School of Arts, *Potsdam, New York* 13676

The reduced visibility in a polluted atmosphere is due to the muliple scattering of light by aerosol, in addition to the molecular scattering. For a real atmosphere containing both aerosol and molecular scatterers, the calculation is prohibitively long. This study comprises a systematic laboratory investigation of multiple scattering together with a massive computational program.

The first phase of this project, which is now just about completed, has involved (1) the construction of a multiple scattering photometer, (2) an experimental study of polystyrene latex which simulates the aerosol component of the atmosphere, and (3) comparison of the experiments with computations. This has established that our experiment can serve as an 'analog computer' for atmospheric scattering.

The proposed work will comprise three phases consisting of (1) a similar study with colloidal silica to simulate the molecular component of the atmosphere, (2) a study of synthetic mixtures of polystyrene latex and colloidal silica which will simulate real atmospheres, and (3) an attempt to solve the inverse problem of deducing the aerosol content from scattering data.

Thus, not only will the optical effects of loading the atmosphere with aerosol be amenable to accurate and rapid study, but the optical measurements can lead to information about the aerosol content.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0382, BEHAVIORAL PHARMACOLOGY AND TOXICOLOGY

B. WEISS, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)49)

Behavioral techniques are being employed to study the effects of toxic agents which act primarily on the central nervous system. One reason is that in many instances the primary impairment is behavioral; the second reason is that disturbances in central nervous system function are often best reflected in behavioral situations. The basic method is to train animals to perform in behavioral situations which permit a specific function to be studied, for example, the capacity to alter behavior as a function of specific stimuli; the ability to perform motor tasks requiring fine motor control. Digital computers are used both to control the experiments and to analyze the results. A wide range of species are studied, including man. Agents currently being assessed include mercury, carbon monoxide and chemicals affecting brain amines.

Results: In rats, 400 ppm CO produced changes in the ability to respond to stimuli associated with the passage of time. Experiments with monkeys suggest that discriminative motor control is impaired by exposure to 1 mg/per cubic m of mercury six hours per day for six months. A similar task with humans exposed to mercury vapor in industry shows the method to be applicable here, too. In studies involving dogs, squirrel monkeys, and pigeons, changes in performance have been observed at dose levels of drugs such as amphetamine and alpha-methyltyrosine which probably have little effect on catecholamine levels in brain.

SUPPORTED BY U.S. Atomic Energy Commission

1.0383, EFFECTS OF AIR POLLUTANTS ON PLANT SYSTEMS

L.H. WEINSTEIN, B. Thompson Inst. Plant Res., *Yonkers, New York* 10701

The following studies are proposed for the 1971-72 fiscal year: 1. A second interlaboratory study of fluoride in vegetation will be completed and results will be published. 2. A new method of direct analysis of fluoride in vegetation using the fluoride ion specific electrode will be subjected to an interlaboratory study. 3. Tests will continue to develop a continuous fluoride air monitor. 4. The effects of environmental factors such as humidity, light intensity, and length of photoperiod on the response of plants to fluoride will be studied. 5. Apparent photosynthesis and transpiration of intact plants exposed to air pollutants will be studied. 6. Experiments will be carried out to establish the mechanism of synthesis of fluoroacetic acid in 'Acacia georginae.' 7. The metabolism of sulfur dioxide in plants in relation to the activity of sulfite oxidase will be studied. 8. Studies will continue on senescence in plants as related to exposure to air pollutants. 9. The rate of absorption of SO2 by foliage of urban trees will be continued.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0384, EFFECTS ON FOREST TREES OF LONG-TERM EXPOSURE TO LOW CONCENTRATIONS OF AIR POLLUTANTS

C.R. BERRY, U.S. Dept. of Agriculture, S.E. Forest Experiment Station, *Asheville, North Carolina* 28802 (SE2305)

OBJECTIVE: Determine symptoms and susceptibility of forest tree species to injury by air pollution; extent to which clones can be used as indicators of air pollution; select and breed trees resistant to specific pollutants.

APPROACH: Surveys of air pollution damage to eastern white pine in the Asheville, N.C. area and study of resistance to coal smoke injury of progeny from resistant parental trees. Develop biological air pollution indicator clones; determine agent causing emergence tipburn of eastern white pine, and whether other species can be affected, and relative susceptibility of various forest tree species to different types of air pollution.

PROGRESS: In the first phase of bioindicator work, 1,439 white pine seedlings were screened in the field and 435 exhibited specific sensitivities to 3 different air pollution regimes predominantly SO(2), fluorides, or oxidants. Sixty-four seedlings were resistant to all air pollution regimes. Acute injury was induced on field-grown white pines by exposures to ambient SO(2) at concentrations of 5 p.p.h.m., or higher, lasting 4 hours. No field injury could be associated with fluctuations in O(3) although concentrations never exceeded 4 p.p.h.m. Average daily ambient SO(2) concentrations increased from summer to winter while O(3) concentrations decreased. White pines were injured less with an O(3)-SO(2) mixture in 2-hour artificial exposures of 5 p.p.h.m. of each gas than with 5 p.p.h.m. of SO(2) alone. Effects on growth have been studied by comparing trees or branches grown in fil-

tered and unfiltered air. Needle growth of sensitive white pines exceeded needle growth of resistant white pines when grown in filtered air indicating that the fastest growing trees in clean air may be those injured most by polluted air.

SUPPORTED BY U.S. Dept. of Agriculture

1.0385, BIOCHEMISTRY OF OZONE INJURY TO PINES
R.L. BARNES, Duke University, School of Forestry, *Durham, North Carolina* 27706

The broad objective of my research project is to study the effects of ozone on the metabolism of two important pine species--white pine (Pinus strobus L.) and loblolly pine (P. taeda L.). Emphasis will be on (1) basic physiological and biochemical responses to ozone exposures under controlled environmental conditions, and correlations of these responses with visible injury symptoms; and (2) the effects of controlled environmental preconditioning on sensitivity to ozone.

Two possible applications of such fundamental information will also be explored: (1) The use of biochemical and physiological knowledge to improve the usefulness of pines as bio-indicators of ozone as an air pollutant in the field. (2) The improvement of methods of handling and testing tree materials in controlled-exposure investigations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0386, EFFECTS OF OZONE ON SELECTED MATERIALS
N. BELOIN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To establish damage functions for the effects of ozone on selected materials under field conditions.

Approach: Strained white sidewalls, paint, and plastic samples will be exposed in semi-open field chambers into which controlled levels of ozone are introduced. Damage will be assessed and correlated with ozone levels.

Goals: Expose materials and assess short term damage.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0387, EFFECTS OF PARTICULATES ON SOILING OF BUILDING MATERIALS
N. BELOIN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To correlate soiling of building materials with measured levels of suspended particulates.

Approach: Three sites each in Birmingham, Alabama, and Buffalo, New York will be used to expose prefinished siding materials. Particulate levels will be monitored and reflectance measurements will be made at intervals.

Goal: Continue to expose materials and take measurements.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0388, DESIGN OF GROWTH AND EXPOSURE CHAMBERS
D. BODY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Design, build, and test field exposure chambers, growth chambers, and exposure chamber inserts for greenhouse and growth chambers.

Approach: Presently acceptable closed top field chambers are in operation based on past design and field tests. Continued design and testing is planned to determine the feasibility of constructing and using open top chambers for field exposures designed to test the impact of ambient pollution on plants, or to use for pollutant additions both singly and in combination under field conditions. Additional testing of several closed top designs will be accomplished for the same purposes. Design of acceptable growth chambers is completed and component parts have been purchased. A prototype chamber will be built and tested. Special inserts for these chambers and for greenhouses have been designed and built, they will undergo additional testing.

Goals: Design, build, and field test open top field exposure chambers; build and test growth chambers for controlled experimental work.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0389, GLACIER NATIONAL PARK ABATEMENT STUDY - ASSESSMENT OF VEGETATION EFFECTS
K.E. FOSTER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Conduct a survey of damage to vegetation in Glacier National Park and vicinity. Confirm cause of damage by chemical analysis of fluorides in vegetation and by morphological examination. Determine atmospheric fluoride concentration at four sampling sites. Expose selected vegetation specimens in environmentally controlled chambers at four locations. Establish a limited network of static fluoride sampling devices. Prepare a report of findings for use by the Dept. of Interior.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0390, SURVEY OF PLANT RESPONSES TO AMBIENT POLLUTANTS
A.S. HEAGLE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine visible injury symptoms from ambient pollution on plants grown in the field.

Approach: Plant species and/or varieties will be planted out to determine their response to ambient pollution levels in the Raleigh area. Detailed notes will be taken to varied time periods and results compared with those found in Cincinnati. Injury will be correlated with monitored environmental parameters. Varietal studies on University farms will be periodically surveyed for injury.

Goals: Determine visible injury symptoms from ambient pollution on 10-15 species and/or varieties of plants planted under field conditions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0391, RESPONSE OF PLANTS TO ACUTE DOSES OF POLLUTANT MIXTURES AT SPECIFIC GROWTH STAGES
A.S. HEAGLE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine the effect of acute exposures to pollutant mixtures of plants grown under field or greenhouse conditions, when exposed at given times during the growth cycle.

Approach: A replicated field design will be established for exposing plants at 2 week intervals throughout the growing season. Plants will receive from 1 to 6 acute exposures to mixtures of the 2 gases at the different time intervals to determine the impact of time of acute exposure and number of exposures on total growth, reproductive capabilities and yield. Time-concentration-injury equations will be developed under greenhouse conditions for a selected group of plants exposed for 5 time periods at 2 concentration mixtures of ozones and sulfur dioxide.

Goals: Determine response of 10 plant species and/or varieties grown under field and/or greenhouse conditions to mixtures of ozone and sulfur dioxide.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0392, RESPONSE OF PLANTS TO INTERACTIONS BETWEEN PATHOGENS AND OZONE
A.S. HEAGLE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objectives: Determine the effect of interactions between pathogens and ozone on the host species, when the host is grown under greenhouse or field conditions.

Approach: Selected species of crop plants will be grown in field plot designs or under controlled conditions. At varied times the plants will be inoculated with a given pathogen or exposed to ozone and the reverse procedure run on either the inoculated or the exposed plants. Some of the designs will include the inoculation before and after fumigations. Some will include an ozone fu-

migation before and after inoculation. Each study will be replicated for statistical analysis. The effects of the interaction of the pathogen with ozone on the host plants will be documented. The field studies will be used to determine the effects off ozone on disease severity, prevalence, growth and yield of the host. Both facultative and obligate pathogens will be used. As a spin-off from this project, we will determine the direct effects of ozone on host-parasite interactions.

Goals: Determine the effect of 3 host species (oat, barley, tobacco) of interactions between pathogens and ozone using several exposure times and ozone concentrations when experiments are carried out under both field and greenhouse conditions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0393, EFFECT OF NATURAL GAS ON SOIL ECO-SYSTEMS IN AN URBAN ENVIRONMENT
A.S. HEAGLE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine effect of natural gas leakage from gas mains on soil eco-systems including ornamental plantings.

Approach: Preliminary surveys have shown a severe natural gas leakage from gas lines along several boulevards in downtown Wilmington, N.C. Gas releases have been reported from time to time in other older large cities. In Wilmington, continuous loss of tree plantings along these boulevard has resulted. Preliminary studies have shown poor soil acration and low nematode counts. It was deemed advisable to determine whether natural gas acts directly or indirectly on the soil atmosphere to cause death of these ornamental city trees. Experimental field plots have been set up Wilmington. Soil samples have been set in Wilmington. Soil samples have been obtained for greenhouse studie and selected plants grown in these soils. Greenhouse experimental designs have been set up to determine the effect of natural gas on root systems of selected species. If natural gas is the cause, such a problem might develop in many eastern cities where natural gas lines are 50 to 100 years old. These studies will be combined with preliminary studies on levels of certain gasoline additives in plant species along heavily traveled and lightly traveled throughfares within Wilmington.

Goal: The results of the first year's study on effect of natural gas on soil eco-systems of urban area will be completed. The second year's study will be planned and initiated.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0394, TECHNICAL ASSISTANCE IN AIR POLLUTION PROBLEMS RELATED TO AGRICULTURE
W.W. HECK, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Give technical a sistance to requesting agencies and individuals in air pollution problems related to agriculture.

Approach: Technical assistance will be given to other Federal, State, and Local agencies and to individuals who have problems relating to the effects of air pollution on agricultural crops and other commodities. This is an on-going responsibility of the Agriculture Branch and includes responses to inquiries on injury, contact with county agents to ascertain the nature and extent of injury, and site visits to determine the cause of injury and discuss the methods of correcting the problem.

Goals: Continue to give requested technical assistance in air pollution problems related to Agriculture as time permits.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0395, AGRICULTURAL-POLLUTANT REPRINT LIBRARY
W.W. HECK, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Develop a complete reprint library on articles covering the effects of air pollutants on native and domestic receptors.

Approach: The development of an adequate reprint library to cover air pollution aspects of injury to vegetation was initiated sometime ago and its nature and function discussed with APTIC. Addition to the file is through a numbered system related to the alphabetical author index. Cross-referencing by subject has been extensively done using key-words. The file is currently being updated and contains over 2500 reprints at this time. At the present rate of effort, we should complete our search for this type of article sometime late in FY 71 and should initiate a search and development for articles relating to domestic animals. APTIC will have access to our file for their use and we would expect them to furnish reprints to other investigators.

Goals: The reprint library will be up-to-date in relation to articles on effects of air pollutants on vegetation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0396, THE RELATIVE SUSCEPTIBILITY OF WESTERN CONIFERS TO OZONE AND AMBIENT OXIDANTS
W.W. HECK, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objectives: Determine the sensitivity of western conifers to the photochemical complex.

Approach: Several species including fir, spruce and pines, at several different growth stages, will be exposed to different levels and times of components of the photochemical complex and to the ambient pollution of the Los Angeles basin. The degree of injury, the reduction in yield, reduction in growth, and projected reduction in timber yields will be determined from this study.

Goals: Determine the relative susceptibility of 10 selected western conifers to the photochemical process.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0397, RESPONSE OF SELECTED FIELD PLANTS TO AMBIENT POLLUTANTS IN WASHINGTON, D.C.
W.W. HECK, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine the effects of ambient Washington, D.C. air on ornamental crop species.

Approach: Large greenhouses equipped to remove pollutants from ambient air or to admit unfiltered air are being used in the Washington, D.C. area. Four small houses are being built for replicated studies using filtered and non-filtered ambient air in this area to determine the effects of ambient pollution mixtures on selected groups of crop and ornamental species. The research here will be aimed at determining the effects of pollutants on visible injury, growth, yield, reproductive capabilities, and quality of crop produced. Work with field grown crops will be stressed.

Goals: Determine the effects of ambient Washington, D.C. air on 15 ornamental and field crops.

SUPPORTED BY U.S. Environ. Protect Agency - N.A.P.C.A.

1.0398, RESPONSE OF EASTERN CONIFERS TO POLLUTANT MIXTURES AT SPECIFIED TIMES DURING NEEDLE DEVELOPMENT
W.W. HECK, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine the effect of pollutant mixtures on Eastern conifers when exposed to various times and concentrations of pollutants under varied nutritional conditions.

Approach: A selected group of Eastern conifer species will be screened for their susceptibility to acute and long term effects of three combinations of ozone and sulfur dioxide. Survival, reproductive capabilities, injury, and growth effects will be determined.

Goals: Determine the effect of ozone and sulfur dioxide mixtures on 10 Eastern conifers exposed to various concentrations and times of pollutants under several nutrient regimes.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0399, MT STORM - W VIRGINIA - GARRETT COUNTY - MARYLAND ABATEMENT ACTION - FIELD INVESTIGATION
T. HELMS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Conduct a field investigation designed to define the extent and cause of damage to Christmas tree plantations in the interstate area. Transplant trees to and from plantations remote and close to the suspected principal source of pollution. Deploy selected vegetation in environmentally controlled chambers. Monitor ambient air for content of SO2, NOx, O3, and F at three locations. Deploy a network of static sampling devices to determine relative geographic distribution of SO2, F, and dust-fall. Analyze vegetation samples for content of F and S. Prepare a preconference report and participate in abatement conference.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0400, DETERMINING CAUSE OF DAMAGE TO COTTON PLANTS IN BIRMINGHAM, ALABAMA
HINDAWI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Make visual inspection of damage to cotton plantations in Birmingham area. Analyze damaged vegetation chemically, morphologically, and microscopically to determine nature of the pollutant causing the damage.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0401, STUDIES TO DEVELOP DIAGNOSTIC TECHNIQUES FOR EVALUATING INJURY TO VEGETATION
R. REINERT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine the chemical and morphological response of plants to pollutants to help in the development of diagnostic tools for evaluating the injury to plants.

Approach: Tissues from plant species will be grown and exposed under a variety of conditions to determine the effects of pollutants and pollutant mixtures on various systems of the plant tissues. Selected whole plants (soybean and tobacco varieties) will be grown to specific growth stages and exposed under greenhouse or controlled exposure conditions to pollutant mixtures. Changes in morphology, histochemistry, respiration and gross quality will be determined and related to exposure concentrations and times.

Goals: From greenhouse and controlled exposures of mixtures of pollutants, determine effects on tissue growth and development, on morphology, histochemistry respiration and certain chemical constituents of selected plant species.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0402, LOW CONCENTRATION-LONG TERM RESPONSES OF PLANTS TO POLLUTANT MIXTURES
R. REINERT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine the response of plants to pollutant mixtures when exposed under field or greenhouse conditions throughout the growth cycle.

Approach: Following established experimental design the selected group of crop and ornamental species will be exposed to 2-3 mixtures of sulfur dioxide and ozone for 6 hours per day over the entire developmental cycle of the plants. Growth and injury will be recorded on a weekly basis through this growth cycle and effects of pollutant combinations on reproductive capacity and reproductive structures will be determined as well as the effect on yield and quality of final product. Field exposures will be made in special chambers using 2-4 species or varieties per chamber. Each treatment will be replicated 4 times. A field plot having no chamber will be used to determine chamber effects. Greenhouse exposures will be made in standard greenhouse exposure chambers following accepted protocol.

Goals: Determine the effects of low level mixtures of sulfur dioxide and ozone on symptom development, growth, reproductive capacity, and yield from 10 selected field and vegetable crops under field and/or greenhouse conditions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0403, ACCUMULATION OF HEAVY METALS IN PLANTS NEAR LOW AND HIGH TRAFFIC DENSITIES
R. REINERT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine the effect of traffic densities on the accumulation of heavy metals in plants.

Approach: A detailed research design will be developed to determine the concentration of heavy metals which might accumulate in ornamental and tree species in the vicinity of highly traveled roadways as a result of automobile release. The possible effect of heavy metal accumulation will be correlated with leaf injury and early senescence of urban ornamental vegetation.

Goals: A systematic collection of plant tissues in high and low traffic density areas will be made in several major urban areas and analyzed for heavy metal accumulation during the 1971 growing season.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0404, EFFECTS OF SELECTED PESTICIDES SINGLY AND IN COMBINATION WITH OZONE ON SELECTED PLANT SPECIES
D. TINGEY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine the effects of pesticides on selected plants as these effects are modified by other pollutants.

Approach: This project will be initiated as a literature review, report preparation, and state of the arts type of effort, to determine what we know and what research needs to be planned in the area of pesticide-pollutant interaction. Initial research will utilize two selected plants, which are sensitive to a specific herbicide. These plants will be grown and exposed to both the herbicide and to ozone, as an air pollutant, at a given stage of growth and at 2 ozone concentrations. Plants will be exposed to ozone prior to, at the same time as, and after exposure of the plant to the selected herbicide. This project will allow some input into the area of pesticide-pollutant interactions, as they affect plant response.

Goals: A detailed literature survey will be completed and research designed for preliminary studies on herbicide-ozone interactions during the 1971 growing season.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0405, CONTROLLED ENVIRONMENT STUDIES ON METAL CORROSION CAUSED BY AIR POLLUTION
J. UPHAM, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Object: To substantiate field observations, which relate corrosion rates to pollutant levels, with controlled environment experiments.

Approach: Galvanized steel will be exposed to controlled environments containing either singly or in combination SO2, O3, and NO2 at various levels in combination with various temperatures and relative humidities. The damage will be evaluated by conventional methods such as weight loss and less conventional methods such as microprobe analyses.

Goal: Design and initiate laboratory experiments.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0406, ECONOMIC IMPACT OF REDUCED VISIBILITY AT AIRPORTS FROM AIR POLLUTION
T. WADDELL, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To analyze the relationship between visibility reduction at selected airports and accident rates, flight interruptions, and delays in scheduled flights.

Approach: Comparisons will be made between several airports with different levels of visibility problems attributable to air pollution. Data on weather conditions, pollution levels, and visibility reduction will be obtained from local weather stations.

Goal: Document on visibility problems encountered at airports and the associated costs.

1. AIR QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0407, PENNSYLVANIA POWER PLANT STUDY
D.E. WEBER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine the effectiveness of high stacks in preventing injurious ground level fumigations and evaluate the air pollution problems to agriculture in a rural pollution situation.

Approach: Eight major study sites have been leased in the area of Indiana, Pa., to study the effects of emissions from 3 large power plants on vegetation. Each site has a farm pond, terracing, fencing, and will be equipped for monitoring 4 pollutants, air temperature, wind speed and direction, humidity, soil temperature and soil moisture. Data will be fed into a data acquisition system for computer analysis. Each study plot will contain 5 or 6 tree species and 6-12 species of crop and ornamental plants. Growth, production, and lead sulfates will be determined at the 8 sites. Field chambers will be installed to study the effects of filtered and non-filtered environments. Minor study sites (22) have been established within a 25x50 mile area extending NE from 3 power plants. There are 15 scotch and 7 white pine plantations. Growth changes will be measured on the pine. Sulfur plates and lime paper with measured background levels of SO2 and HF. Detailed observations of native vegetation will be made.

Goals: Complete establishment of 8 permanent study plots for LaPPES and statistical study of 10 environmental parameters monitored for 3 months at each of the 8 sites.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0408, PLANT AIR POLLUTION STUDIES ON LOSSES, EFFECTS, AND CONTROL AND TECHNICAL ASSISTANCE ON PROBLEMS
W.W. HECK, U.S. Dept. of Agriculture, Crops Research Division, *Cincinnati, Ohio* 45226 (0000-06-01)

OBJECTIVE: Determine the economic impact of air pollution on plants; determine the physiological, morphological and biochemical basis of the effects of various air pollutants on plants, study means of protecting plants against air pollutants, provide technical assistance to public and private agencies on plant air pollutant problems.

APPROACH: Study morphological, physiological and biochemical changes in plants exposed to toxic atmospheres, interaction of those with environmental factors, and use of specific symptoms for identification and extent of damage.

PROGRESS: Investigations with gas mixtures have shown synergistic responses between NO(2) and SO(2) on tobacco and between SO(2) and O(3) on five species. A sixth species showed no synergistic effect from SO(2) O(3). These results at low levels of pollutants emphasize the importance of monitoring for several pollutants when studying pollution effects under ambient conditions. Single gas studies must be undertaken with an understanding of possible pollutant interactions. A chlorotic dwarf condition of white pine has been related to known ambient levels of SO(2) O(3) by using laboratory exposure facilities. This work was done in a study with the Forest Service. This interaction suggests that many unexplained needle blights of eastern white pine may be caused by pollutant interactions. Injury - dose curves have been developed for 50 species and varieties to O(3), SO(2) and NO(2). These were developed in exposure chambers under greenhouse conditions using nine concentrations at five time periods. These results will be useful for development of Criteria Documents which will be used to set air quality standards. Research using well controlled growth and exposure conditions have shown an interaction between growth light and humidity on the sensitivity of pinto bean to ozone. Plants are more sensitive to ozone when grown under low light intensities but more sensitive when exposed under high light intensities. Light is more important than humidity in conditioning plants to an ozone response.

SUPPORTED BY U.S. Dept. of Agriculture

1.0409, SOLAR RADIATION AND AIR POLLUTION CLIMATOLOGY
W. BACH, Univ. of Cincinnati, Graduate School, *Cincinnati, Ohio* 45221

The objective of this research is to continue a study of the effects of air pollution on solar radiation. The work began in Cincinnati, supported by NSF grant GA-13683; and, with the move of the principal investigator to Hawaii, will continue in that environment with emphasis on the Honolulu area, the effects of natural pollutants from volcanoes and the effects above clean islands. Comparative studies will be made of these effects with airborne photometers and nephelometers as in the case of Cincinnati.

SUPPORTED BY U.S. National Science Foundation

1.0410, EFFECTS OF ENVIRONMENTAL POLLUTION FROM AIR FORCE MISSILE PROPELLANTS ON PLANTS
C.T. LIND, U.S. Air Force, Aerospace Med. Res. Lab. 6570, *Dayton, Ohio* 45433

Technical Objective: Missile propellants currently in use and those being considered for future application to advanced systems are reactive materials and are toxic to man, animals and plants. Their use in large quantities could result in significant effects on the environment due to spills and contamination by exhaust products. To insure that Air Force missile operations are not disruptive to the ecology of the environment, this effort will determine the effects of selected missile propellants on a wide variety of plant species and develop environmental pollution toxicology criteria for Air Force Compliance with all federal pollution regulations, Executive Orders, and AFR 161-22.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0411, ENVIRONMENTAL POLLUTION TOXICOLOGY OF AIR FORCE MATERIALS
A.R. SLONIM, U.S. Air Force, Aerospace Med. Res. Lab. 6570, *Dayton, Ohio* 45433

Technical Objective: Various Air Force missile propellants and other chemicals are potentially serious environmental pollutants. The objective of this work unit is to provide information on the effect of these chemicals and their degradation products on the environment. This information is basic to provide environmental pollution toxicology criteria for Air Force directives on the handling, use, disposal, and decontamination of these chemicals as required by AFR-161-22 and pertinent executive orders.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0412, RELATIONSHIP OF AIR POLLUTION TO HARDWOOD FORESTS OF THE NORTHEASTERN UNITED STATES
L.S. DOCHINGER, U.S. Dept. of Agriculture, N.E. Forest Experiment Station, *Delaware, Ohio* 43015 (FS-NE-2306)

OBJECTIVE: Define air pollution symptomatology and pollution interactions with disease incitants and evaluate efficiency of forest hardwood species in reducing air pollution.

APPROACH: Collect air samples by electrostatic and thermal precipitators, deposition, filtration, and grab samplings, and related methods; characterize atmospheric samples through analytical methods of gas chromatography, paper, column, and thin-layer chromatography, absorption spectroscopy instrumentation, and wet chemistry techniques; demonstrate pollution injury to forest hardwood species under controlled environmental growth chamber conditions, develop methodology for pathogenicity study for interactions of causal agents, biological systems, disease development, environment, and control; evaluate meterological instrumentation of wind recorders, temperature sensors, and barometric systems as they affect concentration and transport of pollutants in forests, determine physiological and biochemical mechanisms of hardwood trees which curtail air pollution.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

1.0413, SHADE TREE IMPROVEMENT THROUGH BREEDING AND SELECTION
A.M. TOWNSEND, U.S. Dept. of Agriculture, Shade & Ornamental Plants Lab., *Delaware, Ohio* 43015 (0995-10-07)

OBJECTIVE: Develop genetically superior shade and ornamental trees for urban plantings; obtain by selection and breeding horticulturally desirable elms resistant to the Dutch elm disease, phloem necrosis and other diseases; develop trees resistant to air and soil pollutants; determine efficiency of trees and shrubs in reducing air contaminants.

APPROACH: Incorporate disease and pollution resistance into selected shade tree species by hybridization with resistant exotic and native selections. Within important shade tree genera search for disease resistance and measure variation in sensitivity to specific pollutants. Using radioisotopes and other techniques determine uptake of gaseous and particulate contaminants by leaves.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

1.0414, FOREST TREE IMPROVEMENT THROUGH SELECTION AND BREEDING

H.B. KRIEBEL, Ohio Agric. Res. & Dev. Center, *Wooster, Ohio* 44691 (OHO00229)

OBJECTIVE: Determine genetic diversity within selected forest tree species. Determine the physiology and evolution of growth and morphology. Develop hybrids by crossing selected races, utilizing provenance tests as parents. Stimulate early fruit production. Shorten testing by use of juvenile-mature correlations. Test seed sources of eastern white pine, European black pine, limber pine, Japanease larch, balsam fir, eastern cottonwood, red oak, sugar maple, black walnut and yellowpoplar.

APPROACH: Two replicates of cottonwood will be planted, also a black walnut seed source test; growth studied in the red oak test; and breeding planned for eastern white pine.

PROGRESS: Geographic sources of white pine in the southern Appalachians continued to have the fastest-growing trees in the provenance test. Form of the southernmost trees, however, is inferior for timber products or Christmas trees. Air pollution injury was present in trees of various sources, indicating that individual variation in susceptibility may be more important than racial variation. Cooperative red oak provenance tests in Ohio, Indiana, Michigan, Kansas, Nebraska and Iowa were measured, and reports sent to Ohio for overall analysis. Data have not yet been obtained from Illinois. Characters measured included fall foliage color, total height, diameter, crown width, and number of flushes during the growing season. Japanese larch showed good growth but no striking provenance differences; there was some injury by the larch casebearer. Variation was observed in Fusarium canker on Populus deltoides. No detailed analysis was made.

SUPPORTED BY U.S. Dept. of Agriculture

1.0415, PLANT GROWTH RESPONSES TO AIR POLLUTANTS

A. LIST, Drexel University, Graduate School, *Philadelphia, Pennsylvania* 19140

Growth in seedlings is monitored by two different methods capable of resolving small changes in growth rates on a continuous basis. Response to air pollutants will be interpreted in terms of growth effects, including short term transients. Oxygen consumption rates and transpiration rates are simultaneously monitored. 1) Streak photography of the 'Zea' primary root is coupled with oxygen polarography, while SO2 in air is passed over the coleoptiles, 2) Time lapse photography is done on 'Helianthus' seedlings for analysis of shoot extension and leaf expansion. This work is coupled with infra-red spectroscopy of water vapor content and leaf temperature measurements in an environmental chamber. Data from both methods is digitized on a high precision x-y coordinate plane digitizer, and processed by computer.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0416, GASES AND PARTICULATES IN POULTRY HOUSES

G.O. BRESSLER, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01778)

OBJECTIVE: Measure and establish levels of CO(2), CH(4), NH(3), and S gases and particulates in poultry houses according to management systems; determine levels of outside air contamination and develop methods of minimizing; correlate gas and particulate levels with physiological changes in chickens of various ages.

APPROACH: Gas and particulate levels will be measured by approved scientific methods in 2 large and 6 small poultry houses with various management systems, involving about 8000 chickens. Samplings will also be done on commercial poultry farms and surrounding environments. Chickens from control groups and groups exposed to various gaseous and particulate levels will be used for blood studies and histopathological examinations involving respiratory, cardiovascular systems and liver. Enzymatic changes in blood serum will be correlated to pathology in certain organs. Equipment and methods will be developed to minimize levels of gases and particulates in poultry houses and surrounding environments.

PROGRESS: Measurements of CO(2) and NH(3) were made in two poultry houses with 3000 leghorns each. Before pullets were housed the air inside the house contained 750 ppm of CO(2). In November the air contained 1575 ppm of CO(2) when a ventilation rate of about 2 cfm per bird was provided. When the ventilation rate was dropped to 4 cfm per bird in near zero temperature the CO(2) level rose to 2495 ppm. At this rate NH(3) was present at 10 to 15 ppm. Ten laying hens from a house with average dust and odor conditions (A) were compared with 10 hens from a house having increased dust and odor problems (B). The score of group A was 2.8 (excellent 0 4; poor 0 1), as compared to 2.5 from house B. Histopathologic lesions of mild to moderate pneumonitis, emphysema, edema plus peribronchial lymphatic hyperplasia appeared more pronounced in group B. Dust load in lungs of group B increased. Dust particles of 0.5 to 3 microns were incorporated in lymphatic tissue or in alveolar walls. The incidence of inactive or diseased ovaries, peritonitis or salpingitis also appeared greater in group B. Dust load and odorous gases can be correlated with increased pathology in the lungs and other organs and poorer carcass condition.

SUPPORTED BY U.S. Dept. of Agriculture

1.0417, BREEDING TREES RESISTANT TO AIR POLLUTANTS

H.D. GERHOLD, Penn. State University, School of Forestry, *University Park, Pennsylvania* 16802

Objectives: Adapt methods of testing the susceptibility of trees to air pollutant damage for use in a breeding system designed to produce resistant ornamental varieties.

Compare the early phases of several breeding systems as to their effectiveness in producing trees resistant to air pollutants.

Develop improved methods for the propagation of trees so that genetically superior individuals and varieties may be mass produced for immediate use.

Procedures: In a series of fumigation experiments the needles of pedigreed Scotch pine seedlings will be exposed to acute and chronic doses of ozone and sulfur dioxide . Optimum dates, concentrations, and durations will be sought for selecting resistant trees, evaluated by visual symptoms.

A modified diallel crossing program will be employed to obtain genetic information about the crossability, growth rate, and resistance to ozone and sulfur dioxide of about 25 geographically separated populations of Scotch pine and their F1 hybrids.

A series of experiments will explore the effects of important variables that influence the rooting of cuttings from young trees, including season, age of tree, branch position, and rooting bed environment.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0418, AIR POLLUTION PROBLEMS IN THE NORTHEAST

N.L. LACASSE, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01722)

OBJECTIVE: Determine the impact of present air contaminants on the agriculture of the northeast. Obtain information prerequisite for the development of air quality criteria as they relate to agriculture in the northeast.

1. AIR QUALITY

APPROACH: The first objective will be met by monitoring oxidant levels with an ozone meter. This information will be processed at Cornell University. The second objective will be met by determining the responses of plants to hydrogen chloride fumes, chlorine, and oxides of nitrogen. Plant response to long term, low level of fumigations will also be studied as well as the influence of environmental factors on plant response to these pollutants.

PROGRESS: Tomato plants and chrysanthemum rooted cuttings were exposed to HCl gas at concentrations ranging from 0.4 to 20 ppm for time period ranging from 1 to 40 hrs. Extracts of homogenized tissues were titrated and significant increases in chloride content were recorded in all portions of fumigated plants compared to control plants. Greatest increases in tomato occurred in secondary leaves not fully expanded. Lowest increases occurred in roots. Greatest increases in chrysanthemum occurred in immature upper leaves. Lowest increases occurred in roots. The predominant symptoms in acute damage to tomato and chrysanthemum are glazing of the lower surface and a bifacial bronzing of interveinal and marginal areas of leaves. Microscopic examination showed glazing to be caused by a collapse of lower epidermal cells and partial disorganization of spongy mesophyll of leaves. Bronzing results from further collapse of the spongy mesophyll, and in some cases, the palisade mesophyll and upper epidermis. (2) Oxidant levels were monitored from July 1 through Sept. 12. Oxidant concentration exceeded 5 pphm on 24 days. Number of hours over 5 pphm was 83.5. (3) Oxidant injury was again observed on Bel W-3 tobacco indicators.

SUPPORTED BY U.S. Dept. of Agriculture

1.0419, AIR POLLUTION EFFECTS

F.A. WOOD, Penn. State University, School of Agriculture, *University Park, Pennsylvania* 16802

Studies of the influence of leaf type, leaf age, length of exposure period and seed source on the susceptibility of Austrian and Scotch pines to 10 and 25 pphm ozone were completed. Similar studies utilizing three selections of Virginia pines have been completed but not analyzed. The exposure of white oak, sweet gum and white ash seedlings to 30 pphm PAN for periods up to 8 hours resulted in various types of symptoms on all three species. The typical glazing or silvering of the lower leaf surface was not observed. Histological examination of tissues indicated that the lower epidermis and the spongy mesophyll tissues were the first to be affected. During the coming year, we will continue to examine the relative sensitivity of various species of woody plants to ozone and PAN as well as expand our studies of the influence of environmental and phenological factors on plant sensitivity.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0420, EFFECT OF VARIOUS GASEOUS CONTAMINANTS OF THE ATMOSPHERE ON PLANT GROWTH AND BEHAVIOR

M.A. TIO, Univ. of Puerto Rico, Agricultural Experiment Sta., *Mayaguez, Puerto Rico* (PR00220)

OBJECTIVE: Obtain specific information on effects of some gases such as sulphur dioxide, hydrogen sulphide, carbon monoxide, phthalic acid, ozone, carbon disulphide, fluorides and other gases, on several plant species of economic importance in Puerto Rico.

APPROACH: A comprehensive survey of the levels of contamination of the atmosphere of Puerto Rico will be carried out. Plants of economic importance will be fumigated in closed chambers, both in the laboratory and in the field to observe effects on: respiration of plants, photosynthetic rate, assimilation of nutrients, conditions of chloroplasts and stomata, morphogenetic changes and reproduction. The effects of gases on the roots and some enzymatic systems of the plants will also be studied. The tolerance of each species of plants of economic importance to contaminants will be determined. The effects of atmospheric pollutants on growth, yield, quality of crop, and reproduction will be studied in the field.

PROGRESS: A survey is in progress to determine the areas affected by contaminants emitted by different industries. Affected plant material is being collected and photographed. The managements of several concerns have been interviewed with the purpose of gaining information on concentration and site of origin of specific industrial effluents.

SUPPORTED BY U.S. Dept. of Agriculture

1.0421, THE EFFECTS OF ATMOSPHERIC POLLUTION ON EPIPHYTES

G.R. HOFFMAN, Univ. of South Dakota, Graduate School, *Vermillion, South Dakota* 57069

In Europe Lichens and bryophytes on tree bark have shown to be sensitive indicators of air pollution. In the U. S. leading lichenologists propose the same to be true here, but to date very little actual study has been directed toward the problem. I have previously studied the ecological distribution of epiphytic cryptogams on the common Douglas fir in a broad geographic transect extending from the western edge of Washington state to the middle of Montana. All sites were picked in locations where atmospheric pollution is not significantly noticeable. We are now extending our field studies to include within this broad geographic transect those fairly isolated pollution sources such as smelters, paper pulp mills, lumbering operations to determine the effects of such pollution on epiphytic cryptogams and to map the distributions of many such cryptogams in polluted areas.

The purpose is to determine the usefulness of these epiphytes as indicators of levels of air pollution.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0422, ECOLOGICAL METEOROLOGY STUDIES: A PINE PLANTATION

F.A. GIFFORD, U.S. Dept. of Commerce, Air Reso. Atm. Turb. Dif. Lab., *Oak Ridge, Tennessee* 37830 (AT(40-1))

The objective of the study is to determine the wind and turbulence characteristics within and above a loblolly pine plantation, to relate these characteristics to the structure of the stand, and to investigate the coupling between wind within and above the plantation. Information gained in this study will be of value to air pollution meteorology, ecology, and forestry. This study is included in the deciduous forest biome project of the IBP. Mean wind and temperature profiles will be measured on a 120 ft. tower using sensitive cup anemometers and thermistors respectively. Turbulent velocities are to be measured with hot wire anemometers. Temperature fluctuations are to be measured with a thermistor of kw response time (less than 1 sec.). Profile measuremefts will be used to characterize meteorologic conditions during measurement of turbulence parameters. Turbulence parameters will be used to calculate turbulent intensities, shear stress, turbulent transfer coefficients, energy spectra, and eddy dissipation rates. The test object is a pine plantation located at the ORNL Post Attack Ecology Site. The plantation is aproximately 25 years old and trees are 40-45 feet tall. The plantation is fairly uniform within 400 feet of tower in the sector south of the tower from east to northwest.

Results: Site selection and instrument acquisition completed. Measurements to begin upon completion of power line to tower site.

SUPPORTED BY U.S. Atomic Energy Commission

1.0423, SELECTED AIR POLLUTANTS AFFECTING PLANTS AND HEALTH

H.G. APPLEGATE, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01236)

OBJECTIVE: Make quantitative and qualitative measurements of air pollutants at selected sites in Texas; develop or adapt analytical methods and techniques sensitive to the lower limits known to affect vegetation, animals, and man, for sampling and measuring selected air pollutants in Texas; experimentally investigate in the laboratory those physiological responses of organisms to air pollutants observed in the field.

PROGRESS: Particulate emissions from peanut shelling plants were monitored. In cooperation with environmental engineering, recommendations were made for installing of equipment to bring the plants into compliance with regulations of the Texas Air Quality Board.

SUPPORTED BY Texas State Government - Austin

1.0424, EARLY DIAGNOSIS OF POLLUTION-INDUCED PLANT DAMAGE
J.R. ROWLANDS, Southwest Research Institute, *San Antonio, Texas* 78228

The overall objective of the proposed research is the detection and interpretation of initial structural changes produced in plant membranes and photo-synthetic systems by air pollutants. Experimental plants, principally tobacco and spinach, will be grown in a greenhouse, exposed to specific air pollutants in an exposure chamber, and the leaves will be used to obtain chloroplasts, cell wall fragments, and subchloroplast fractions. These various preparations will be studied by means of electron spin resonance (ESR), circular dichroism (CD), ESR spin labeling, nuclear magnetic resonance (NMR), and fluorescence/phosphorescence and optical spectroscopy. In addition to the membranes, the chloroplast and subchloroplast fragments will be compared as to ability to produce free radicals I and II of photosynthesis and the rates of production of these radicals.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0425, EFFECT OF DIESEL FUMES ON CONCRETE
S.J. FILLIPEK, British Railways Board, *London, England, United Kingdom* (2R52064007)

Unprotected and protected concretes made from portland and other types of cement are being exposed to intermittent diesel fumes and the effects on plain, reinforced and prestressed concretes are being assessed by visual inspection, measurement of surface hardness and strength.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

1.0426, PLANT DISEASE SURVEY
O.S. CANNON, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00034)

OBJECTIVE: Determine the presence, distribution and economic significance of diseases of major crops in Utah, including those caused by air pollutants. Also determine whether the organism which causes fire blight of apples and pears overwinters elsewhere than in cankers of diseased trees.

APPROACH: Inspect growing crops in Utah for diseases and develop new methods of control if established control methods are not giving satisfactory results.

PROGRESS: Again in 1969 fireblight (caused by Erwinia amylovora) was less prevalent than in 1967 when it caused heavy losses in both pears and apples. This bears out the observations previously made that weather conditions and their effects on hosts and the fireblight organism are more important in the development of fireblight than the number of fireblight cankers left on trees within an orchard. A graduate student, Terry Miller, developed a rapid serological bean blight detection procedure, and showed that it is much more reliable in detecting bean blight in a field than field observation. Heavy snowfall in the late winter was responsible for development of unusual amounts of snow-mold in winter wheat in northern Utah. Dwarf bunt also caused heavy losses in some wheat fields. In most areas of the state there were fewer leaf and fruit diseases than in the preceding year. There was marked SO(2) injury to alfalfa near Magna in August.

SUPPORTED BY Utah State Government

1.0427, HF-AIR POLLUTION AND INTERMEDIARY METABOLISM
G.W. MILLER, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00646)

OBJECTIVE: Determine the mechanism of fluoride enhanced respiration. Determine the mechanism of fluoride induced chlorosis and necrosis. Investigate the synthesis and importance of fluoro-carbon compounds in plants.

APPROACH: Examine the structural integrity, oxygen uptake and phosphorylation of mitochondria in relation to membrane stability as influenced by calcium and fluoride. Determine any change in adenosinediphosphate (ADP)/adenosinetriphosphate (ATP) ratios in tissue from plants exposed to fluoride or calcium deficiency. Determine increased activity of oxidative enzymes in vivo and determine if acceleration can be attributed to a source of increased substrate. Examine the fluoride induced deficiency of chlorophyll with respect to chlorophylase activity and the integrity of the chloroplast membrane. Differentiate and determine the nature of the increased protein in fluoride injured tissues. Determine the metabolic reactions resulting in accumulation of pipecolic acid in fluoride injured tissue and its relation to necrosis of cells. Establish conditions required and species capable of synthesizing fluoro-carbon compounds. Determine the carbon compound capable of being fluorinated and the mechanism of the reaction. Determine the effects of fluoro-organic acids on plant metabolism.

PROGRESS: Study results of fluoride mitochondria treatment indicate fluoride effects resulting in stimulated respiration, decreased phosphorylation and increase ATPase activity may be due to indirect effect of fluoride on mitochondrial membrane permeability or transitory direct effect of fluoride on mitochondrial permeability. Fluoride treated mitochondria respond as do those from tissue with long exposure to fluoride with inhibition of dehydrogenase enzymes and ATPase, and a reduced respiration. Wheat root injury may be caused by available calcium depletion which may alter cell permeability. Electron micrographs of fluoride fumigated tissue revealed swollen mitochondria with obliterated cristae and electron dense particle deposition. Methods were developed for gas chromatographic separation and identification of fluoroacetate and fluorocitrate methyl esters. This toxic compound presence was detected in fluoride fumigated soybean and alfalfa and in crested wheatgrass exposed to fluoride pollution.

SUPPORTED BY Utah State Government

1.0428, FLUOROSIS IN PLANTS AND ANIMALS
J.L. SHUPE, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00364)

OBJECTIVE: Determine the distribution and degree of fluorosis in animals. Conduct necropsies and pathologic studies on animals with varying degrees of clinical fluorosis. Determine and evaluate the reabsorption of fluorine from bone following cessation of excessive ingestion of fluorine. Study the breaking strength of normal and osteofluorotic bone.

APPROACH: Field surveys will be made to determine the degree and distribution of fluorosis in animals. When deemed worthwhile or necessary, animals evidencing varying degrees of clinical fluorosis will be necropsied. Clinical and detailed pathologic comparisons will be made between animals that are maintained on an excessive fluoride ration and those that have been maintained on a normal (low fluoride) ration after having ingested excessive fluorides long enough to induce characteristic dental and osteofluorotic lesions. Bones from selected cases will be subjected to torsion, bending, stretching, and compression tests to determine the breaking strength of bone as related to the degree of osteofluorosis.

PROGRESS: Horses, sheep, dairy and beef animals were clinically examined to determine and evaluate distribution and degree of flourine toxicosis in livestock. Necropsy studies were conducted on sheep, dogs, bison, dairy and beef animals. Livestock in Utah County still evidence varying degrees of fluorosis. Effects on animals of a particulate air pollutant called 'kish' is not known. The amount of this material on the vegetation and farms is related to distance and direction from the industrial operation at Geneva. Studies are in progress to determine the relationship of osteofluorosis to bone density and the breaking strength of bone, the effects of excessive intermittent fluoride ingestion, and bone enzyme activity as related to the degree of osteofluorosis. Many factors can and do influence the degree of fluorosis in animals. We have been unable to relate ambient air fluoride levels to the degree of fluorosis in livestock. In many cases vegetative fluoride levels cannot be correlated with the degree of fluorosis in livestock, however, in some cases vegetative fluoride levels can be correlated with the degree of fluorosis. Information developed here is used to help establish state and national air standards and laws.

1. AIR QUALITY

SUPPORTED BY Utah State Government

1.0429, IMPACT OF AIR POLLUTANTS ON ECOSYSTEMS
K.T. HARPER, Univ. of Utah, School of Letters, *Salt Lake City, Utah* 84112

The primary research objective of this study is to determine the impact which air pollutants have now or may have in the future on four natural ecosystems important to the Salt Lake Valley for watershed protection and/or recreation. Current levels of photochemical pollutants in air sheds over the selected ecosystems will be monitored by means of sensitive plant indicators and standard analytical devices. Effects of pollutants on growth and reproductive processes of dominant plants of each ecosystem will be determined from fumigation trials conducted under growth-chamber, greenhouse and field conditions.

Dominant plants (those plants that would most alter the ecosystem if they were eliminated) will be identified by means of modern, quantitative ecological measurements of many stands in each of the ecosystems selected. Environmental data will be taken at each stand to determine the range of site variation within each ecosystem and response of individual species to that variation. Permanent study plots encompassing the range in variation in each ecosystem will be selected for further observation and study. Changes in community composition and successional trends following field fumigations will be documented.

Fumigation studies have demonstrated the extreme sensitivity of representative native species. Whose growth was impaired at ambient peak ozone concentrations of 10 to 15 pphm. The reproduction potential of these species has been studied but data have not yet been analyzed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0430, EFFECTS AND FATE OF AIR POLLUTANTS
A.C. HILL, Univ. of Utah, Graduate School, *Salt Lake City, Utah* 84112

The first objective is to determine the effects of the major phytotoxic air pollutants, alone and in combination, on plant growth suppression. Inhibition of the rate of apparent photosynthesis will be used as a measure of growth suppression. The experiments will be conducted in environmental chambers that were designed and built specifically for the project. Temperature, light, relative humidity, wind velocity, and pollutant concentration will be controlled, and transpiration, stomatal opening, and pollutant uptake rate will be measured.

The second objective is to determine the role of vegetation as a sink for gaseous air pollutants. The uptake rates of the major pollutants (SO2, HF, O3, PAN, NO, NO2, CO, etc.) will be measured using typical vegetation canopies and environmental conditions. Measurements will be made in our environmental chambers. The effects of factors such as plant species, height and density of the vegetation cover, wind velocity, stomatal opening, light intensity, temperature, and relative humidity will be measured. Field studies will be conducted and compared with the measurements made in the chambers.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0431, EFFECTS OF FLUORIDE ON PHOSPHORUS METABOLISM OF PLANTS
M.R. PACK, Washington State University, School of Engineering, *Pullman, Washington* 99163

Studies of the response of plant respiration to fluoride have given somewhat conflicting results, and little is known about the relationship of the respiration response to effects of fluoride on other aspects of plant metabolism. The concentrations of various acid-soluble phosphorus compounds in plant tissues have been affected by fluoride treatments, but the significance of this response is uncertain.

In an effort to resolve some of these uncertainties, it is proposed to investigate the relationship between the response of plant respiration to fluoride and effects of the fluoride on phosphorus metabo...m by making concurrent, time-course measurements of oxygen uptake and acid-soluble phosphorus compounds in the leaves of bean seedlings exposed to hydrogen fluoride. Enzymes that appear to be affected then will be studied more directly to evaluate their response to fluoride.

If effects of fluoride on respiration can be related to differences in the pools of certain phosphorylated intermediates and these in turn can be linked to fluoride inhibition of specific enzymes, considerable progress will have been made in understanding the mechanisms of effects of atmospheric fluoride on plants, and some of the apparent inconsistencies of previous findings may be resolved. Such information is needed for accurate appraisal of the potential ramifications of fluoride pollution injury to vegetation.

Preliminary results of an experiment with bean plants exposed to hydrogen fluoride at 4.7 micrograms F/m3 have failed as yet to show any effects of the fluoride treatment.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0432, BACKGROUND AEROSOL LIGHT SCATTERING
R.J. CHARLSON, Univ. of Washington, Graduate School, *Seattle, Washington* 98105

The object of this research is to determine the relationship of the backscattered aerosol light component to the total light extinction, and to establish background levels of both components. This provides fundamental measurements on the aerosol content of our atmosphere before man's activities obscure the natural background.

The measurements will be taken with a specially adapted integrating nephelometer. The resulting information on the concentration and backscattering properties of the aerosol in the earth's atmosphere can be used to evaluate the role of the atmospheric aerosol in determining the albedo of our planet's atmosphere and its consequent effect upon the heat balance.

SUPPORTED BY U.S. National Science Foundation

1.0433, EFFECTS OF AIR POLLUTANTS ON AIRBORNE MICROBES
B. LIGHTHART, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

It is the purpose of this project to initiate a pilot study to screen five common urban air polluting gases, i.e., ozone, carbon monoxide, nitrogen dioxide, SO2 and formaldehyde, for their antibacterial activity on three distinctly different bacteria. The antibacterial activity of the gases will be measured in terms of changes in bacterial survival-time relationships. The organisms used will represent a broad range of bacterial sensitivity to toxic agents.

The screening experiments will be carried on in a pre-conditioned atmosphere enclosed in a rotating drum-type test chamber. Pre- conditioning includes controlled temperature, relative humidity (RH) and pollutant gas concentration. The survival of the bacteria in an aerosol injected into the test atmosphere will be monitored as a function of time. Cell survival in each of the gases will be tested at six relative humidities. (Several RH levels have been used because it is anticipated that RH will greatly temper the effects of the pollutants on survival.)

Data generated from the thirty-six survival experiments will be analyzed to elucidate the effects of pollutants on the aerial survival of the test cultures as a function of time, relative humidity and cell type. An attempt will be made to generate a mathematical model that will approximate some of the test parameters.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0434, INTERDISCIPLINARY RESEARCH PROGRAM IN CLIMATOLOGY
R.A. BRYSON, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The objective of the program is a quantitative understanding of the world patterns of climate, its causes and mechanisms, its evolution in time and the impact of climate on patterns and changes of ecological systems.

Special emphasis will be placed on the following areas of work: (1) a study of naturally bonded, internally homogeneous regions of atmospheric parameter complexes; (2) a systematic in-

vestigation of spatial and temporal covariance structure of meteorological variables; (3) a study of the distribution and climatic effect of atmospheric particulates and their role in climatic modification; (4) a study of climatonomic relations as inputs for climatic modelling and as possible mechanisms for climatic modifications; (5) development or adaptation of numerical models of climate for testing theories of climatic change; (6) development of quantitative methods for gathering and interpretation of data on past climates and the reconstruction of past climatic patterns; (7) detailed studies of climatic variability and climatic change; and (8) exploration of quantitative relationships of macroclimates, microclimates and biota including man and the ecological effects of climatic change or modification

SUPPORTED BY U.S. National Science Foundation

1.0435, VEGETABLE CROPS IMPROVEMENT THROUGH BREEDING

W.H. GABELMAN, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01025)

OBJECTIVE: Improve certain vegetable crops via genetic studies and breeding procedures.

APPROACH: Isolate heritable controls of significant plant responses and composition in vegetable crops, especially carrot, table beet, onion and bean. Determine genetic basis. Improve varieties for adaptation and nutritional value through plant breeding techniques.

PROGRESS: Inbred onions with multiple resistance to ozone, fusarium and pink root have been developed. As soon as the procedures for handling the release of inbred materials under the proposed Plant Protection Act are clarified, these will be made available to the public. Inbred lines with high color and good seed production potential and excellent combining ability have been developed in carrots. These inbreds also will be released as soon as the Plant Protection Act is clarified. Inbred liner of snapbeans have been isolated which appear to be efficient for the production of dry matter under very low levels of phosphorus as opposed to other inbreds which are very inefficient. Within each group of efficient and inefficient inbreds we also have sub- groups which either respond to added phosphorus or do not respond. This work is being continued in the Biotron to determine the heritability of these two responses.

SUPPORTED BY U.S. Dept. of Agriculture

1.0436, AIRSACCULITIS OF TURKEYS

R.P. HANSON, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01181)

OBJECTIVE: Determine environmental effects on airsacculitis.

APPROACH: Environmental variables - ambient temperature and humidity, light, feed, water, ventilation, litter condition, content of air is continuously monitored in large part by automatic recording equipment. Activity and health of turkeys is recorded in part by automatic equipment and is also a subject of sampling technics. Special attention has been given to airborne pathogens and to air pollutants.

SUPPORTED BY Wisconsin State Government - Madison

1.0437, AIR POLLUTION DAMAGE IN WHITE PINE

G.R. STAIRS, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01595)

OBJECTIVE: The objectives of the proposed research are to investigate: (1) the genetic control of resistance to atmospheric ozone and other oxidants in white pine; (2) the biochemical basis for this resistance; and (3) the areal extent of damage based on evaluations made in (1) and (2) above.

APPROACH: The following approach will be utilized: conduct a repeatability study utilizing clonally replicated material of selected resistant and susceptible white pine under controlled fumigation conditions in greenhouse chambers. Determine which, if any, of the following classes of plant chemical compounds are of importance in the mechanism of resistance: terpenes and essential leaf oils, carbohydrates, including sugars and starch, lipids, phenolic compounds, polyphenolic derivatives and free amino acids, and define suitable protein (enzyme) extraction techniques for leaf tissue of white pine, and by disc electrophoresis determine if differences exist in protein (enzyme) composition, production or activity between resistant and susceptible material before or after exposure to atmospheric oxidant (ozone).

PROGRESS: Field selections of resistant and susceptible genotypes were completed; each selection was clonally propagated by grafting to allow control-chamber repeatability testing. Chamber tests with ozone levels to 15 parts per hundred million (pphm) indicated that ozone damage was not the significant factor contributing to the air pollution damage observed under ambient conditions. Repeatability of response for pollution-sensitive material was high (0.90) and an excellent correlation was observed between field and greenhouse grown materials. Biochemical evaluations for phenolic content of the foliage by two- dimensional TLC indicated quantitative and qualitative differences between the two resistance classes but additional work is need to relate the physiological significance of these results.

SUPPORTED BY U.S. Dept. of Agriculture

1.0438, INADVERTENT WEATHER MODIFICATION BY URBAN POLLUTION

D.L. VEAL, Univ. of Wyoming, School of Engineering, *Laramie, Wyoming* 82070

Inadvertent weather modification has been shown to exist climatologically and some possible physical links have been indicated. However, no comprehensive investigation has been undertaken to describe and indicate the various physical processes that lead to the observed effects. The objectives of this proposed study therefore, are: A. Meso-scale circulation features: 1. Observe and analyze the kinematics of the meso-scale motion over an urbanized area; and 2. Numerically model the meso-scale motions associated with an urban atmosphere. B. Nucleus Concentrations: 1. Establish quantitatively the production of cloud, Aitken and ice nuclei by an urban environment. C. Cloud and Precipitation Processes: 1. Investigate the transfer processes of the urban aerosol to the cloud particles; 2. Determine the effects of urban produced cloud nuclei on the structure of the cloud; 3. Investigate the coalescence mechanism of precipitation associated with the polluted conditions; 4. Investigate the role of ice nuclei; and 5. Investigate the evolution of the resulting cloud particles into precipitation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

D. ECONOMIC ASPECTS

Includes Losses From Pollution Damage and Costs of Control Programs.

1.0439, SYSTEMS EVALUATION OF REFUSE AS A LOW SULFUR FUEL

S.B. KILNER, Aerojet General Corporation, *Los Angeles, California* 90007

Objective: Complete report on feasibility of refuse firing for power generation, preliminary engineering of preferred modes, potential pollutant reduction resulting, and recommended R&D plans.

Description: The study will assess the present and future potential for reducing sulfur oxide and particulate emissions and the costs of refuse disposal by integrated power generation and refuse disposal facilities in metropolitan areas. Estimates of present and projected quantities and composition of refuse for the U.S. and six metropolitan areas will be made and combustion and pollution-forming properties with proportions of fossil fuels will be determined. Technology and economics of present boiler and power plant practice, combined firing as practiced in Europe, and preferred configurations for U.S. application will be assessed. Economic and political feasibility and potential pollutant reduction will be estimated and projected through year 2000. Five-year R&D plans for developing promising systems and components will be detailed.

1. AIR QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0440, TECHNICAL AND ECONOMIC FEASIBILITY OF OIL-FIRED COGAS POWER STATIONS
A.J. GIRAMONTI, United Aircraft Corporation, *Hartford, Connecticut*

The purpose of the study is to investigate the technical and economic feasibility of using advanced power systems to generate electricity from heavy residual fuel oil at increased efficiency and without causing atmospheric or water thermal pollution. The advanced power system would involve gasification and purification of the oil to produce a clean fuel gas which would be burned in a nonpolluting COGAS or combined gas and steam turbine power system. Primary emphasis during the program will be placed on selection of the oil gasification process which offers the potential for producing lowest-cost nonpolluting gaseous fuel to the power system, identification of the COGAS system configuration and operating characteristics which offer the potential for producing lowest-cost electric power, and preparation of owning and operating cost estimates for prospective oil-fired COGAS power stations.

SUPPORTED BY Connecticut State Government

1.0441, ECONOMICS OF ENVIRONMENTAL EFFECTS ON SEASONAL HOMES
G.L. COLE, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00152-AE)

OBJECTIVE: Determine environmental situations associated with seasonal homes. Evaluate social and private costs and benefits of identified environmental situations. Assess current and alternative institutional arrangements. Determine potential market for seasonal homes in the Northeast.

APPROACH: A representative sample of environmental situations in seashore communities will be selected and interviews will be conducted with health officials and seasonal home owners to identify positive and negative effects of seasonal home communities. Secondary data will be used to assess non-monetary costs and benefits associated with seasonal home development, i.e., pollution, reduction of access, etc. Alternative institutional arrangements will be evaluated after assessing the current setting.

PROGRESS: Delaware's contribution to the regional effort will focus around seasonal home communities on or near the Atlantic Ocean and nearby bays. The objectives are: (1) to determine the environmental situations (positive and negative) associated with seasonal homes and to analyze the attitudes, interests and goals of people for a quality seasonal home environment, and (2) to evaluate the social and private costs and benefits of identified environmental situations at both the regional and national levels. Work is underway to develop a standard methodology and questionnaires for the region to investigate the attitudes of seasonal home occupants and developers, permanent residents and public officials concerning environmental quality in the communities. Scientists from such disciplines as sanitary and civil engineering, landscape architecture, geography and planning will be consulted in order to identify important variables to be included in the study. Field work will begin during the summer of 1970.

SUPPORTED BY U.S. Dept. of Agriculture

1.0442, MEASURING PERFORMANCE IN PUBLIC PROGRAMS
UNKNOWN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Progress 7/68 through 6/69: Definitions of and distinctions between the benefits and efficiency of public programs have been established. Program inputs, outputs and benefits have been defined rigorously as a basis for data collection and analysis. An analytical procedure is being developed and tested empirically with case studies and aggregate statistical data for science and technology programs. Data on the output and input of selected science programs have been compiled in a time series to indicate trends and relationships. Case studies are being conducted to evaluate the economic effects of public programs to improve physical measurements. Questions here are: What is the economic role of measurements; What is the effect of improving measurement; Who should decide upon the quality of measurement and pay for its attainment? A model has been developed to measure the economic value of public programs to reduce hazards (eg., fire, earthquake, crime, pollution) and is being tested empirically for fire research programs.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0443, ECONOMIC EVALUATION OF ALTERNATIVE POLICIES FOR AIR RESOURCE MANAGEMENT
A. TELLER, Univ. of Illinois, Graduate School, *Urbana, Illinois* 61801

The Specific Aims and Expected Results - The specific aim of the study is to develop a computer model for the analysis of air pollution policy alternatives and apply it to the Chicago metropolitan area. This model would incorporate information on sources of emissions (both stationary and mobile), costs of control, atmospheric conditions, and benefits from pollution control. In addition, the investigators will make detailed studies of control costs and benefits. The project would result in two reports: (1) a monograph relating scientific findings and spelling out their policy implications, and (2) a manual-type report setting out the technical details of the model so that it will be available to other metropolitan areas.

SUPPORTED BY Resources for Future Inc. - Wash., D.C.

1.0444, OPTIMAL CONTROL OF POLLUTION DISTRIBUTION
F.A. TILLMAN, Kansas State University, School of Engineering, *Manhattan, Kansas* 66502

The purpose of the research is to determine the feasibility of building a linear programming model to solve the pollution allocation problem.

This problem can be viewed as a resource allocation problem. The resource that is to be allocated is the amount of pollution that can be tolerated in each region so that the overall criteria is optimized. One aspect of the problem will be to investigate the effect of reducing the pollution in the area by considering the cost of reducing pollution to each of the contributing sources. This approach could be the basis of a tax program in which the contributing sources would be taxed on an equitable basis and the funds spent where the greatest benefits could be made. The essence of the research will be to determine if the important variables can be defined and if enough detail can be built into the model to represent the problem.

If such a model is built, these problems could be solved for each community and an overall plan developed so that a realistic policy is determined for zoning and controlling industrial parks. With these models a dynamic policy could be maintained. Thus, as critical pollution conditions exist schedules would be set up for allowing the polluting sources to operate at according to fixed schedules during the day and week. Every effort will be made to incorporate in the present techniques and information generated by Prof. Takamatsu's group. To start this exploratory investigation, their data will be used to test the proposed techniques.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0445, THE SOCIAL AND ECONOMIC IMPACT OF THE SUBSTITUTION OF LOW SULFUR COAL FOR HIGH SULFUR COAL - A PILOT STUDY OF MONONGALIA COUNTY, W. VA.
D.M. BROWN, Northeastern University, School of Liberal Arts, *Boston, Massachusetts* 02115

The purpose of this study was to show how a detailed impact analysis can be made with secondary data. A six-equation econometric model of the coal sector and county economy were constructed and alternative impacts of proposed air pollution legislation were found. The major conclusion of the study was that the coal industries will not have to shut down if strong anti-pollution legislation is passed.

SUPPORTED BY No Formal Support Reported

1.0446, AN EVALUATION OF FREE TRANSIT SERVICE
UNKNOWN, Charles River Associates Inc., *Cambridge, Massachusetts* 02138 (000427)

This study will examine the economic, social, technological, and financial factors in an evaluation of free transit in metropolitan areas as a policy alternative. The study will include consideration of such diverse factors as: the influence of cost of transportation and quality of service as an incentive to its use, implicit income transfers, changes in transportation cost in money, time and service, congestion, transportation investment, transportation facilities, air pollution, land use, financial instruments, and effect of various levels of subsidy.

The study is based on economic analysis for its findings. It relies heavily on the use of a new and improved method for predicting traffic volumes over a variety of urban transportation systems. In this method, volumes are a function of both travel times and money costs of competing systems. Findings are based on a case study of the Boston area, and on an extension of case study results to the national level.

Because of the limited scope of the contract, the study does not take into account long range benefits which may or may not accrue from the use of free transit. The study does provide estimates of short run shifts in the demand for urban passenger transportation by various modes. It finds that the short run cost of free transit to the public would be about $2 billion per year. It analyzes the impact of free transit in terms of such issues as accessibility of jobs to inner city residents, revitalizing the downtown and reducing highway congestion, air pollution and parking problems. It discusses administrative and income redistributional considerations and it identifies research needs.

Document provided to SIE by the Highway Research Information Service

SUPPORTED BY U.S. Dept. of Transportation - E.S.A.O.

1.0447, OPTIMIZATION STUDIES IN INDUSTRIAL POLLUTION CONTROL
J.L. GADDY, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

A specific pollution control problem in a chemical plant may be solved by the installation of a particular type of equipment to remove the pollutants from the effluent air or water streams. There may be several types of equipment that would accomplish the required removal. The pollutants may also be eliminated at the source, either in the raw materials or at the point where they are produced or recovered in the process. Therefore, there are many solutions to each pollution problem and, consequently, there is a best or optimum solution which will maximize the economy.

The purpose of this project is to develop a computer system to optimize industrial pollution problems. This will be done by modifying CHESS (Chemical Engineering Systems Simulator), a computer simulation program for modeling chemical processes to include pollution control modules; and the development of a mechanism for optimization of the possible pollution control methods. In addition to the optimum pollution control scheme, the program will define the investment and increased operating cost required to implement each scheme.

SUPPORTED BY University of Missouri

1.0448, NATIONAL ENERGY NEEDS AND ENVIRONMENTAL QUALITY
C.L. COMAR, State University of New York, School of Veterinary Medicine, *Ithaca, New York* 14850

The objective of this project is to systematically evaluate the options, costs, environmental consequences, and possible constraints on meeting the energy requirements of our expanding economy. Special consideration will be given to the biological costs of the various alternatives.

Over the next few decades, considerable expansion of production facilities will be needed in order to supply the energy requirements of the nation. One of the most urgent problems of the 1970's is to determine just how this necessary expansion can take place without resulting in widespread environmental damage and hazards. We are already witnessing severe conflicts between proposals for added capacity and the desire for no further deterioration of the environment. Decisions must be made on how and where facilities can be constructed in order to provide a reliable supply of power on schedule, at a reasonable cost, and with a minimum of harm to man, pollution of air or water, and despoilation of land.

The project will emphasize three phases: (1) projection of energy requirements particularly with regard to socio-economic factors and analysis of the modes of meeting these requirements; (2) comparisons of the total biological costs of the various modes of meeting energy needs as well as the biological costs of not providing additional energy; (3) analysis of the interdisciplinary procedures and organization utilized in studies (1) and (2) above.

SUPPORTED BY U.S. National Science Foundation

1.0449, HIGH SULFUR COMBUSTOR STUDY
J. BELDING, Chemical Construction Co., *New York, New York*

Objective: To determine the technical and economic feasibility of the high sulfur combustor concept.

Description: A promising technique for the control of sulfur dioxide pollution from coal-burning installations is the removal of pyritic sulfur from the coal prior to combustion. The economics of deep cleaning have prevented widespread use of the technology for cleaning so- called 'steam coals.' Significant amounts of carbon are lost in the reject material from the deep cleaning of coal. A potential solution to the problem of carbon loss is the utilization of this high-ash, high- sulfur, carbon-bearing reject material in a special combustor. The reject material should have sufficient heat value for steam raising, and the flue gas resulting from the combustion of the reject material should contain a relatively highly concentration of sulfur compounds. Recovery of these compounds by flue gas processing would provide a useful and salable product. Feasibility studies conducted previously by NAPCA have indicated that the combination of a high-sulfur combustor and a process to recover sulfur as sulfuric acid from the flue gas may provide the economic incentive for deep cleaning of steam coals. In addition, processes which would produce liquid SO2 or elemental sulfur are promising alternates, as well. The purpose of the high-sulfur combustor study is the selection, design, and evaluation of the combustor and sulfur recovery process with the greatest potential for economically utilizing high-ash, high-sulfur coal reject material produced by the deep cleaning.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0450, AN EMISSION AND CONTROL COST STUDY OF THE REACTIVE METALS INDUSTRY
F.L. BUNYARD, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop relaible, comprehensive information on the present and future costs of controlling air pollutant emissions for the reactive metals industry.

Approach: Current expenditures by the industry for air pollution control will be assessed on a national and regional basis. Provision will be made for estimating the future control costs required to meet specific emission standards. Particulates are the major emissions to be considered in this study. The study will be done jointly by NAPCA and MCA.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0451, DEVELOPMENT OF SULFUR OXIDE CONTROL COSTS FOR COMBUSTION SOURCES
F.L. BUNYARD, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop reliable control cost information for the control of sulfur oxides from combustion sources.

1. AIR QUALITY

Approach: Published information from many groups will be compiled and evaluated. Principal sources of information will be the Division of Process Control Engineering and Fuels Policy Section. Extensive baseline data will be obtained by means of the FPC Form 67 which will provide data annually on fuel quantity and quality burned by public utility companies.

Goal: The first phase of the study will be one year and be concerned with developing the baseline data. The study will be updated annually as new information becomes available.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0452, REGIONAL CONTROL COST STUDY IN BUFFALO

F.A. COLLINS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To provide control cost estimates to be used in conducting a cost benefit analysis for the Buffalo Air Quality Control Region.

Approach: The method to be followed will be similar to that used in Philadelphia. Particulate and sulfur dioxide emissions from stationary sources will be considered.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0453, REGIONAL CONTROL COST STUDY IN PHILADELPHIA

F.A. COLLINS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To make control cost estimates for the Philadelphia Air Quality Control Regions.

Approach: Estimates will be made of the costs to control particulate and sulfur oxides to achieve varying air quality levels. Much of the task will involve verification of the cost estimates generated by the Implementation Planning Program developed by TRW.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0454, ECE QUESTIONNAIRE ANALYSIS AND STUDY PROPOSAL

R.C. DICKERSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Information on economic studies related to air pollution will be collected and exhanged on an international scale.

Approach: Questionnaires have been prepared and several governments of the world have been asked to respond. Information gathered from the questionnaire will be used to evaluate past and present work to determine future needs.

Goal: The evaluation should be completed within one year.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0455, AN EMISSION AND CONTROL STUDY OF THE RENDERING INDUSTRY

G.F. EVANS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop reliable, comprehensive information on the present and future costs of controlling air pollutant emissions for the Rendering Industry.

Approach: Current expenditures by the industry for air pollution control will be assessed on a national and regional basis. Provision will be made for estimating the future control costs required to meet specific (but as yet undetermined) emission standards. Odors are the principle pollutant to be considered in this study. A special aspect of this study will be to estimate what the impact of air pollution control expenditures will be to this industry. The information will be obtained by use of a questionnaire generated by NAPCA. DAQED will obtain information with respect to the emissions (type and quantities) of this industry.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0456, ECONOMIC IMPACT OF AIR POLLUTION IN THE SAN BERNARDINO FOREST AREA

D.G. GILLETTE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Assess the economic effects of forest destruction by photochemical smog on land use, property values, recreational and aesthetic values, and the general economic activity in the San Bernardino Forest area.

Approach: During FY 71 a preliminary investigation will be conducted to determine the availability and usefulness of various sources of data to assess the economic effects of air pollution on the San Bernardino forests. Such an assessment will necessarily include an evaluation of the impact of forest destruction on the Los Angeles watershed, recreation and timber values. Among the type of data to be collected will be sales data on timber and land, fire insurance costs and cost of forest fire potection to the U.S. Government, cost of cleaning and maintaining water reservoirs, and recreation statistics. The derived damage estimates will then be correlated with physical damage estimated by remote sensing devices. Differences in value of timber loss will probably vary within the San Bernardino Forest area, because of differences in predominant land use.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0457, ASSESSMENT OF VEGETATIVE DAMAGE

D.G. GILLETTE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Compile and analyze data on the effects of air pollutants on vegetation.

Approach: Review the state of the arts in deriving dose-response relationships between pollutants and combinations thereof, and plant injury. Provide technical assistance to the Agriculture Branch in determining those crops which are economically important and in need of further research.. Assist in the development of field studies and studies designed to measure the impact of air pollutants on suppressed growth or hidden injury. Develop, where feasible, economic damage functions for those crops where physical damage relationships are available.

Goal: Derive concepts for producting damage functions from research on air pollution injury to vegetation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0458, STATE OF THE ART SURVEY (EFFECTS AND ECONOMICS) FOR METALS AND ALLOYS

F. HAYNIE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To assess the economic damage to metals and alloys caused by corrosion induced by air pollution.

Approach: Contract to survey corrosion and maintenance costs in four cities where information can be correlated with pollution levels. Extrapolate to national level. Cross check results by using amounts of materials exposed to pollution and known damage functions for specific metals or alloys.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0459, ENGINEERING COMPUTATION AND FORECASTING

M.W. HEMPHILL, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Initiate and continue and/or complete task orders in support of the Division's R&D program.

Description: This in-house service provides consultation in the fields of statistics, mathematics, computer technology and emissions forecasting. Principal applications of statistics include the design of experiments and analysis of data. Mathematical applications include the solution of differential equations and the development/evaluation of mathematical representations of process phenomena. Applications of computer technology provide support to mathematical and statistical computation as well as the storage and retrieval of data to facilitate forecasting.

The prediction of the quantity of pollutants, the degree of control and the cost of this control comes under forecasting. To form the basic forecasts and reconcile differences between reference data and other forecasts, it is necessary to construct and access inventories of emissions, sources of emissions, fuel consumption, control of emissions and related cost data.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0460, AIR POLLUTION AND PROPERTY VALUES
L. JOHNSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To improve the methodology of applying multiple regression techniques to assess the effects of air pollution on property values.

Approach: Refinement of present methods will be made and the results of existing studies will be applied and compared between different urban areas. Differences in property values will be related to different levels of air quality, housing characteristics and socio- economic variables.

Goals: To update existing property values studies with new census data. Previous studies which have been done using old census data will be compared with current studies.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0461, A SURVEY OF THE PROCEDURES FOR EVALUATING HEALTH COSTS DUE TO AIR POLLUTION
L. JOHNSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To review the techniques used to date and to outline alternative procedures.

Approach: A review of the literature, followed by a discussion with experts in the field and the Division of Health Effects personnel. From the discussions, possible alternative costing procedures will be developed.

Goal: To complete the literature survey and develop procedures for evaluating the cost of health effects attributed to air pollution.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0462, AN EMISSION AND CONTROL COST STUDY OF THE FEED AND GRAIN INDUSTRY
J.R. OCONNOR, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop comprehensive, reliable information for determining present and future costs for controlling air pollutant emissions of the feed and grain industry.

Approach: Emphasis will be placed on grinding, mixing, and handling operations generating dusts. Provision will be made to determine the future control costs for meeting specific (but as yet undetermined) emission standards. Cost and emission information will be obtained by use of a questionnaire generated by NAPCA. DAQED will obtain information with respect to the emissions (type and quantities) of this industry.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0463, AIR POLLUTION CONTROL COSTS ASSOCIATED WITH SOLID WASTE DISPOSAL
J.R. OCONNOR, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop information on the present and future costs of controlling air pollutant emissions associated with solid waste disposal.

Approach: With many communities banning open burning to alleviate air pollution, alternative methods of disposal must be considered. This study will develop cost information that may be used to evaluate these alternative methods of disposal. The principal pollutants to be considered will be the particulates, hydrocarbons and carbon monoxide. It is expected that the economics of disposal of junk autos will be an important aspect of this study. Information will be sought from other NAPCA groups as well as the Bureau of Solid Waste Management, the Bureau of Mines and the Department of Commerce.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0464, EMISSION AND CONTROL COST STUDY OF THE CEMENT INDUSTRY
J.R. OCONNOR, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop reliable control cost information for the cement industry.

Approach: The industry will provide information on their past expenditures for air pollution control. In addition, each company will provide an estimate of what their costs will be to upgrade installations to meet future emission standards. The principal pollutant to be considered will be particulate matter. An important aspect of this study will be an assessment of the value of recycled cement dust.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0465, TECHNICAL SUPPORT FOR THE THIRD & FOURTH COMPREHENSIVE COSTS REPORTS TO CONGRESS
J.R. OCONNOR, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To provide technical support in the preparation of the Cost of Clean Air Report.

Approach: Information on the costs of control for the sources understudy is supplied and review of the report at various stages of development is provided. Assistance is provided to the contractor in all phases of the report preparation. Extensive assistance with respect to the costs of control of mobile sources will be provided.

Goal: This task will be a continuing function for as long as the report is prepared under a contract.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0466, ENGINEERING AND ECONOMIC STUDY OF PRIMARY ALUMINUM SMELTING INDUSTRY
E.N. SMITH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop reliable, comprehensive information on the present and future cost of controlling air pollutant emissions for the primary aluminum smelting industry.

Approach: Current expenditures by the industry for air pollution control will be assessed on a national and regional basis. Provision will be made for estimating the future control costs required to meet specific (but as yet undetermined) emission standards. The principal pollutants to be considered in the study are hydrogen fluoride gas and fluoride particulates. An important aspect of this study is the assessment of the credit to be given for the use of collected fluoride material returned to a basic process. The information is being obtained by contract with a qualified organization.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0467, ANALYSES OF DATA & A REPORT ON RELATIONSHIPS BETWEEN SOCIO-ECONOMIC LEVELS OF AIR POLLUTION IN CHICAGO CENSUS TRACTS (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Air pollution has been related to health status by the results of a number of studies. It follows that poor health resulting from air pollution could lead to reduced learning abilities, subsequent lowered earning capacity and finally inability to move up from lowest socio- economic levels as a preliminary to subsequent investigations to determine if there is a cause-effect relationship.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0468, DEVELOPMENT OF A PACKAGE OF ECONOMICALLY IMPORTANT MATERIALS TO MONITOR THE DAMAGING EFFECTS OF AIR POLLUTION
J. UPHAM, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

1. AIR QUALITY

Objective: To develop a package of economically important materials to monitor the damaging effects of air pollution.

Approach: Economically important materials which are specifically susceptible to damage by SO sub 2, O sub 3, NO sub 2, or particulates will be selected for laboratory evaluation. A minimum number of controlled exposure chambers will be constructed so that both direct and interaction effects of pollutants can be studied to determine the most efficient techniques to use. Damage relationships expressed as cost as a function of pollutant concentration will be established.

Goals: Select materials, construct exposure chambers, design and evaluate experimental procedures.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0469, STATE OF THE ART SURVEY (EFFECTS AND ECONOMICS) FOR ELECTRONIC COMPONENTS

J. UPHAM, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To assess the economic damage to electronic components caused by air pollution.

Approach: Contract to survey manufacturers to establish rejection and failure rates that may be attributed to air pollution.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0470, DAMAGE FUNCTIONS

T. WADDELL, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop functional relationships between damages from air pollution and air pollution levels for an approach to defining the benefits of controlling pollution.

Approach: Assessment of damages in the areas of health, vegetation, property values, materials degradation, and soiling will be analyzed and utilized in a benefit/cost applicability for optimum pollution control.

Goal: To select damage areas in which functions can be developed, propose descriptive research in these areas, and examine rationale behind the use of these functions in benefit/cost analysis.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0471, GROSS DAMAGE ESTIMATES

T. WADDELL, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To systematically review and update economic estimates of air pollution damage. This task entails a continuous review of available data and periodic revision of damage estimates.

Approch: This task includes the critical review and documentation of gross damages from air pollution as related to particular receptors or pollutants. The results of such a project are to determine and substantiate reasonable estimates of damage based upon available data and to provide guidelines and recommendations for improving said estimates.

Goal: The output of this effort is to provide the 'best' estimate of gross damages from air pollution within the limitations of available data. Such estimates will provide valuable input into major policy decisions within this organization.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0472, FOSSIL FUEL COST AVAILABILITY MODELS

C. CHILTON, Battelle Memorial Institute, *Columbus, Ohio* 43201

Develop a model for simulating the availability of fuel on a short and long run basis. Calculate the distribution of fuels to the nation and determine their price in each area. Prepare a user's manual for the program. Simulate the impact of various policies and air quality control strategies on the distribution and price of fuels over the nation. Determine the sensitivity of the model of input parameters. Determine the sensitivity of the demand schedule for fuels to the control cost of sulfur oxides and the minimum acceptable selling price for each type of fossil fuel.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0473, ESTIMATE LEVEL AND COST OF AIR POLLUTION

UNKNOWN, Carnegie Mellon University, Graduate School, *Pittsburgh, Pennsylvania* 15213

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Resources for Future Inc. - Wash., D.C.

1.0474, MINERAL FUELS AND THE ENVIRONMENT - THE CASE OF INDUSTRIAL FUEL USERS

R.L. GORDAN, Penn. State University, Graduate School, *University Park, Pennsylvania* 16802

Assuring adequate availability of energy without creating undesirable environmental effects is a matter of urgent concern in the United States. In recent years the importance of improved environmental quality has also become widely recognized. Fuel producers and users have generated much serious environmental damage and, therefore, much of the corrective action has been directed at these industries. As specialists on energy economics have long argued, the difficulties are complicated by the mass of older policies affecting energy supply. Research is needed on the ability to reconcile these new and existing policies with the demand for energy.

This study will examine the impact of different sets of government policies on the supply and demand for fuel for such industries as electric power generation and steel production. Both the new environmental, health and safety programs as well as more established programs such as import controls and natural gas regulation will be considered. The objective is a systems analysis of the complexities of these markets. Models of the critical sectors of the economy involved will be built and used to analyze the impacts of alternative policies.

SUPPORTED BY U.S. National Science Foundation

E. LEGAL, ADMINISTRATIVE, AND SOCIAL ASPECTS

Air Quality Research Concerned With Standards, Management, Social Attitudes, Legislation, and Related Subject Areas.

1.0475, ALABAMA ENVIRONMENTAL STUDY-CONFERENCE PROJECT

R.K. RAINER, Auburn University, School of Engineering, *Auburn, Alabama* 36830

The Alabama Environmental Study-Conference Project is designed to promote interactions between university faculty and graduate students and state and local governmental officials in areas of environmental concern--air, water and land pollution.

A first step will be a survey of the status of pollution and control measures in Alabama, followed by a conference which will include representatives of business and industry, state agencies, cities and counties, and state legislators.

The report resulting from the survey and conference is intended to be used as a reference for planning the conservation of resources and for abatement of serious pollution problems.

SUPPORTED BY U.S. National Science Foundation

1.0476, COMEX AIR POLLUTION COMPUTER RESEARCH PROJECT

K.W. LEFFLAND, Univ. of Southern California, School of Public Admin., *Los Angeles, California* 90007

The Comex Research Project has as its purpose the development of improved teaching techniques for the University's Air Pollution Control Institute. The major research aims of the Project are: A. The development of a gaming simulation for air pollution control students and professionals (APEX); B. The development of Supplementary Training Exercise Programs; C. The expanded use of APEX throughout the country; D. The formation of an Air Pollution Simulation Laboratory.

APEX is now operational and has been incorporated into the program of the Air Pollution Control Institute. To enhance the APEX simulation game, Supplemental Training Exercise Programs (STEPS) have been developed. They provide an additional arena for gamed interactions in pollution control regulations, public hearings, court actions, budget proposals, and administrative functions. Comex is expanding the use of the APEX game throughout the country to benefit professional air pollution control groups and other interested agencies. To achieve this goal, we are developing a series of seminars to demonstrate APEX to professionals, emphasizing the value of air pollution control simulation models as an aid to management decision-making and understanding the complexities of the metropolitan environment. The objectives of the Air Pollution Simulation Laboratory are to: A. Provide an environment for advanced or special students to perform research functions and advanced projects; B. Furnish a vehicle through which APEX seminars may be conducted; C. and, serve as a collection, demonstration, and dissemination point for related research, particularly in the field of simulation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0477, THE DEVELOPMENT OF URBAN ATMOSPHERE MODELS FOR AIR RESOURCE MANAGEMENT
S.K. FRIEDLANDER, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

No summary has been provided to the Science Information Exchange.

SUPPORTED BY John S. Guggenheim Memorial Foundation

1.0478, FOR SEMINARS AND STUDIES ON ENVIRONMENTAL ARTS AND SCIENCES, POPULATION GROWTH, URBANIZATION, POLLUTION, AND RELATED SUBJECTS
B.E. WILLARD, Thorne Ecological Foundation, *Boulder, Colorado*

The Seminar on Environmental Arts and Sciences is designed to: 1. Develop an appreciation for the principles and applications of the science of ecology as a foundation for environmental arts and sciences; 2. Examine the relationship of an environmental ethic to various basic scientific and cultural disciplines; 3. Offer an intensive exploration of ecological principles for leaders in business, industry, government, politics, education, religion, the professions, the arts, and the communications field; 4. Enhance the quality of citizen leadership on environmental concerns--oriented to the broad view of ecology and conservation.

The Seminar on Environmental Arts and Sciences examines the principles of ecology as they operate in a field setting under expert leadership from the nation's top ecologists. Other staff are drawn from diverse backgrounds--physical and social sciences, environmental design, law, government, politics, industry, communications, the arts, education--to apply these scientific principles in their human context, so as to build a concern for the physical and biological environment. The formal program is designed to stimulate thought and dialogue among participants and staff. The interactions initiated produce a continuing search into ecological, social and economic relationships of our environment. These processes continue during mealtimes, around the pool, and often long into the night. Participants, in scheduled and impromptu discussions, probe the many complex problems of maintaining a viable quality environment on this earth. These opportunities provide a total immersion in facets of world ecology and social and economic systems, as well as aesthetic and ethical considerations. They result in an intellectual and emotional experience that enable one to remold his thinking about the world in which he lives.

SUPPORTED BY William H. Donner Foundation Incorporated

1.0479, DYNAMIC PROCESSES
L. MACHTA, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (001137)

Technical Objective: Synthesis & coordination of turbulence, research, and modelling efforts.

Approach: Arrange for intra-laboratory research exchange through the medium of meetings, intra-laboratory exchange of staff, and frequent travel by laboratory scientists to pertinent locations. Augment interaction with other ESSA and non-ESSA research groups through seminars, visits, and discussions. Develop diffusion models on which computer time stepping criteria and core limitation for detailed diffusions and turbulence models can be tested. The Deputy Director will represent the Dept. of Commerce on the U.S. Japan Air Pollution Panel at the planned meeting in Tokyo late in April of 1971.

Progress: The staff attended an international symposium on atmospheric chemistry and radioactivity. Three intra-laboratory meetings were held to exchange scientific results and plans. Numerous technical society meetings were attended by various laboratory personnel and these included visits to universities and ESSA laboratories, where possible. Participated in many planning studies and requirement evaluation for global geophysical monitoring. A revised and improved carbon dioxide measurement system was arranged for the Mauna Loa Observatory. A symposium was held on the requirements for radiation monitoring, solar radiation measurements in connection with aerosol pollution and a new system designed for installation at Mauna Loa. The Director participated in a UK-US high level scientific meeting on emerging problems of environmental quality at the request of the Office of Science and Technology.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0480, THE THEORY OF MAN-ENVIRONMENT RELATIONSHIPS
M.E. GARNSEY, Univ. of Colorado, Graduate School, *Boulder, Colorado* 80302 (000031)

To attempt a general statement of the theory of man and his environment.

Through twice monthly meetings of working seminars at which papers and reports on specific topics will be given. The findings are to be published.

A. During the proceeding year six presentations were made on weather modification and eight presentations on air pollution in the Denver areas. B. (Supplemental) Meetings have been held twice monthly rather than once a month. Discussion papers are recorded, transcribed, edited and circulated to the seminar members. Purchasing printed materials which the library does not acquire.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

1.0481, PUBLIC POLICY INTERVENTION IN INTER-INDUSTRY FLOWS OF GOODS AND SERVICES TO REDUCE POLLUTION
J.S. GILMORE, Univ. of Denver, Graduate School, *Denver, Colorado* 80210

The objective is to develop methodology for analyzing the flow of pollution-creating products in one sector of the market system of the United States, and to identify points where public policy intervention might affect economic decisions on production processes to reduce pollution. The research will involve economists, public policy analysts, chemical engineering faculty, and law school faculty in the collection and analysis of information by which to identify high pollution inputs and processes, identify substitution possibilities and control capabilities, inventory public policy mechanisms which may encourage these pollution-reducing activities, and develop a methodology which may be widely applied.

Using the Office of Business Economics (OBE) input-output tables, and focusing on the petroleum refining and related products industry, the high-pollution inputs and outputs to each phase of the manufacturing-use-disposal cycle will be identified. Studies will be made of substitution possibilities and opportunities for pollution control, of existing and proposed public policy incentives and constraints affecting manufacturing, and of alternative control procedures. An attempt will be made to apply the methodology developed to parts of the entire U. S. product system depicted in the OBE tables.

1. AIR QUALITY

SUPPORTED BY U.S. National Science Foundation

1.0482, AWARENESS OF AIR POLLUTION AND ITS CAUSES IN A NUMBER OF COLORADO COMMUNITIES
R. LOOMIS, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00095)

OBJECTIVE: During 1970-71 a second phase of work on public awareness of air pollution in Colorado will be initiated. Phase one of this project was concerned with a general attitude survey of several Colorado communities designed to measure public attitudes toward the problem of air pollution. In phase two, attitudes toward air pollution will be correlated with perceptions of air quality. Both field and laboratory methodology will be employed.

APPROACH: Repeated independent samples of households in north Denver known to be among the heaviest air pollution areas in Colorado will be surveyed on days varying in pollution level. Respondants will be asked their perceptions of the air quality on that day and attitudes about air pollution in general. The surveys will extend over a year. Concurrently with the field sample, a laboratory study will be performed to assess judgements of air quality from a series of photographs. The methodology of signal detection theory will be employed in the laboratory work.

PROGRESS: The investigation has been designed to survey public attitudes towards air pollution in a number of Colorado communities. Work has been completed on the review of background literature and initial development of the survey instrument. In addition, contact was made with a number of resource persons in the pollution area and their suggestions incorporated into the study. These suggestions included adding items, measuring knowledge of actual costs for pollution abatement, opinions toward groups and agencies responsible for pollution control and knowledge of consumer products (other than automobiles) that create pollution. Details of the sampling procedure are currently being worked out and the completion of survey data collection is scheduled for the end of March.

SUPPORTED BY Colorado State Government

1.0483, THE ORGANIZATIONAL FACTORS IN AIR POLLUTION CONTROL
M.E. ECKSTEIN, Southern Connecticut St. Col., Graduate School, *New Haven, Connecticut* 06515

In September of 1966, the project staff - then located at Center for New York City Affairs, New School for Social Research -- began a three-year project of research on the role of organizations involved in the control and abatement of air pollution in the New York metropolitan region. This research has focused on relationships of government agencies and business firms in air pollution control.

The major areas of data collection and analysis have been: (1) legislative and legal context of air pollution abatement programs in the New York metropolitan region; (2) principal structure and organization of control agencies at various levels of government; (3) procedures used for control, including policy and guidance; (4) patterns of coordination and interaction among control agencies, including special studies of procedures used in air pollution emergency situations; and (5) structure, procedures and policies of organizations which are generally designated as major sources or air pollution.

The collection and collation of these data have been largely completed, with the quantifiable data coded and on punched cards. The fourth year of the project will be devoted to the final phases of analysis of the data.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0484, EVALUATION OF FACTORS RELATING TO THE PROPOSED DESIGNATION OF AIR QUALITY CONTROL REGIONS
UNKNOWN, Linton Mields & Coston Inc., *Washington, District of Columbia*

The contractor will study urban areas under consideration as Air Quality Control Regions and make reports for use in the development of Consultation Reports by the Office of Regional Activities. Thirteen regions will be selected from the areas proposed by NAPCA on March 24, 1969. The study will consist principally of an examination, evaluation, and report related to the governmental jurisdictions having planning and operating authority within the regional area and their relationships to air pollution control. NAPCA will provide engineering data such as diffusion models and emission densities to the contractor for use in such evaluations. The contractor will prepare projections of the planning needs for the region, taking into account population and economic growth trends, as well as other contributive factors. Additionally, the contractor will prepare recommended courses of action and alternative solutions for strengthening air pollution planning in each region studied.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0485, PARTIAL SUPPORT OF THE COMMITTEE ON GEOLOGICAL SCIENCES
J.W. BERG, Natl. Academy of Sciences, *Washington, District of Columbia* 20037

The Committee on Geological Sciences of the National Academy of Sciences-National Research Council is undertaking a two-year study of the present and potential role of the geological sciences on human affairs. A sharply focused report for the public, Congress, earth scientists, and others on new developments in and applications of the geological (and geophysical) sciences is expected to result. Major topics of consideration include the relationship of the geological sciences to: 1) natural resources, 2) waste management and pollution control, 3) land utilization, 4) human health, 5) defense, and 6) cultural impact and need for knowledge of the earth.

SUPPORTED BY U.S. National Science Foundation

1.0486, COMMITTEE ON ATMOSPHERIC SCIENCES
J.R. SIEVERS, Natl. Academy of Sciences, *Washington, District of Columbia* 20037

The National Academy of Sciences proposes the continuation of the activities of the Committee on Atmospheric Sciences for the calendar year 1971. At present, these activities are supported jointly by NOAA and the NSF under contract C-319, Task Order No. 9.

The Committee on Atmospheric Sciences seeks to encourage the establishment of a balanced national scientific effort in atmospheric sciences and to stimulate U. S. participation in pertinent international programs. Following up on the recent summer study at Friday Harbor, the CAS will continue to examine the pollution of the atmosphere and the need for information on this. Problems of short range prediction and predictability of events such as local severe storms will be studied this coming year also, including the possible extension of numerical forecasts into mesoscale events. The appropriate technology for sensors both 'insitu' and remote, will be studied.

SUPPORTED BY U.S. National Science Foundation

1.0487, FEDERAL CONSTRUCTION COUNCIL
UNKNOWN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Progress: Task Groups of the Federal Construction Council met seven times during the period, with accomplishments as follows: prepared technical program for 68-69 operating year; met with administrators of supporting Federal agencies; studied administrative and technical problems of mutual interest to all agencies. FCC monitored work on 18 formal studies under way, as follows: air and water infiltration through non-load bearing exterior walls; air pollution (phase I); thermoplastic piping for potable water distribution systems; Federal fire standards; feasibility of standardizing design criteria; prevention of water pollution from construction activities; effectiveness and efficiency of air conditioning systems; revision of FCC Technical Report No. 44 (Boiler Rating Criteria); value engineering; seasonality in construction;

testing and balancing air conditioning systems after installation; technology forecasta-construction materials, techniques, and equipment; techniques for comparing actual performance of buildings with design objectives; humidification in buildings; plastic insulation of mechanical systems; revision of FCC Technical Reports No. 30R-64 and 39-64 (or underground heat distribution systems); Directory of Computer Programs; and air pollution (phase II). Also during the current year FCC has undertaken, as informal investigations, studies of three matters of far-reaching importance: modularization in construction; computerized specifications; and project management control. One informal investigation--on unfired water heaters--began in the previous year--has been completed.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0488, AIR POLLUTION MODELING - INTEGRATION OF TECHNICAL AND SOCIO-ECONOMIC CONSIDERATION

L.R. BABCOCK, Univ. of Illinois, School of Engineering, *Chicago, Illinois* 60680

Successful air quality management must integrate various scientific and technical facets with socio-economic implications. Computer simulations are a practical method for combining diverse facets toward first understanding the environmental system and thence for evaluating alternative pollution control strategies.

Individual meteorological, geographic, and economic air pollution models have been created. Energy parameters provide a common denominator for combination of these individual efforts.

The proposed research would stress verification and application of a generalized urban simulation model developed by the investigator. Example applications include evaluation of alternative settlement patterns, evaluation of alternative pollution control strategies, or incorporation of the model or some of its parts into simulations constructed by others.

SUPPORTED BY U.S. National Science Foundation

1.0489, DESIGN DETAILED PERFORMANCE SPECIFICATIONS FOR THE DIFFERENT TYPES OF AIR QUALITY SURVEILLANCE NETWORKS

R. GREELEY, Mitre Corporation, *Bedford, Massachusetts* 01730

Objective: To provide State and local agencies with detailed specifications for bid proposals related to the acquisition of an air quality surveillance network.

Approach: A contract will be awarded to develop the specifications for the bid packages put together by State and local agencies. Performance characteristics, sensitivity and reliability will be spelled out to enable the local agencies to have a better bid package before calling for bids for the acquisition of their air quality surveillance system. It is envisioned that five sets of specifications will be prepared for sampling networks ranging from simple mechanized devices to real time telemetry.

Goal: To prepare and disseminate a set of performance specifications for the different types of air quality surveillance systems.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0490, COLLECT AND STORE CURRENT NON-NAPCA AIR QUALITY DATA

R. GREENLEY, Mitre Corporation, *Bedford, Massachusetts* 01730

Objective: To incorporate the aerometric data collected by agencies outside NAPCA into a central data base, the National Aerometric Data Bank.

Approach: The existing contract with MITRE Corp. will be continued. Additional agencies will be contacted to acquaint them with the scope and purpose of this collection effort. Procedures will be worked out for the future transmission of this data to NAPCA in a routine manner. The data received will be converted to the SAROAD format and stored in the National Aerometric Data Bank. Summaries and reports on selected pollutants will be prepared for input into NAPCA reports on national air quality. Hopefully this effort can be phased over from MITRE to NAPCA in FY 72.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0491, THE EFFECTS OF AIR POLLUTION ON INTERPERSONAL BEHAVIOR

L.G. RIVLIN, City University of New York, Graduate School, *New York, New York* 10031

The proposed study is concerned with the relationship between observable interpersonal behavior and levels of air pollution. Using procedures developed in studies of other environmental settings, we would like to gather concrete data on how interpersonal behavior is influenced by the level of pollutants in the air. As yet, this area of research has not previously been explored. One of the immediate objectives of the present exploratory proposal is to uncover meaningful hypotheses that would focus on the specific aspects of behavior relevant to reactions to air pollution.

There are two long-range goals that could emerge from this approach. The first would be the attempt to relate the behavioral data obtained to the existing information on the physiological effects of air pollution. The second is concerned with our continuing interest in collecting a large body of data in a variety of settings on the role of physical surroundings on behavior. It is hoped to relate the effects of air pollution on interpersonal behavior to the whole range of problems dealing with the impact of the urban setting on human behavior.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0492, STUDIES FOR A SURVEY OF ENVIRONMENTAL POLLUTION, CONDUCTED BY THE NEW YORK CITY SCIENCE AND TECHNOLOGY ADVISORY COUNCIL

UNKNOWN, Columbia University, Graduate School, *New York, New York* 10027

The New York City Science and Technology Advisory Council, created three years ago, serves in an advisory capacity to the Mayor, bringing specialized knowledge to bear on the analysis and solution of urban problems. In defining areas for basic and applied research, it has had the collaboration of the School of Engineering and Applied Science of Columbia University, which provides technical advice and helps obtain factual data. The Council is currently working on recommendations for dealing with air and water poilution.

SUPPORTED BY Rockefeller Foundation - New York, N.Y.

1.0493, STUDY OF THE LEGAL AND INSTITUTIONAL ARRANGEMENTS FOR AIR POLLUTION CONTROL IN THE NEW YORK METROPOLITAN AREA

UNKNOWN, Columbia University, Center for Policy Research, *New York, New York* 10027

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Ford Foundation - New York, N.Y.

1.0494, AIR POLLUTION CONTROL IN THE NEW YORK METROPOLITAN AREA

UNKNOWN, Columbia University, Center for Policy Research, *New York, New York* 10027

This grant is for a one-year study of the legal and institutional arrangements for air pollution control in the New York metropolitan area.

SUPPORTED BY Ford Foundation - New York, N.Y.

1.0495, ENVIRONMENT AND HUMAN RESPONSE

E.L. SHAFER, State University of New York, School of Forestry, *Syracuse, New York* 12224

Studies reflecting impact of urban and regional planning toward use of natural resources and pollution. Response of rural, suburban, and city population on deterioration of environment: Foul air, chlorinated water, dirty streets, deteriorated buildings

and poor public services, polluted beaches and river banks, lack of natural areas and parks. Socio-economic background relevant to perception of environment and the involvement of population in pressure groups.

SUPPORTED BY U.S. Dept. of Agriculture

1.0496, COLLOQUIUM OF INTERNATIONAL AIR POLLUTION SCIENTISTS
A. STERN, Univ. of North Carolina, N.C. Air Pollution Symposium, *Chapel Hill, North Carolina* 27514

The Second International Air Pollution Conference of the International Union of Air Pollution Prevention Associations at the Sheraton Park Hotel, Washington, D.C., December, 1970, is expected to attract the principal Air Pollution scientists of the world to the United States. While attending the conference, these scientists will be fully occupied in presenting, discussing or listening to technical papers, keynote addresses and session summarizers; attending formal social events and viewing the conference exhibit area. No structured means will be provided to allow these scientists to get together for less formal discussions and information exchange, although some of this will undoubtedly take place in unstructured fashion.

What is herein proposed is to provide an opportunity for a selected group of these scientists to meet during the week following the conference for such less formal discussion and information exchange. It is believed that this will broadly clarify air pollution research and training objectives in both the United States and foreign countries and thereby stimulate new activities in these areas.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0497, LAW-RELATED RESEARCH ON SCIENTIFIC UNCERTAINTY AND TECHNOLOGY ASSESSMENT
C.G. HAVIGHURST, Duke University, School of Law, *Durham, North Carolina* 27706

Some of the most vexing issues now facing American society revolve around scientific judgments about the nature and extent of particular alleged hazards to life and health. For example, the health effects of air pollution and radiation are at issue in ongoing public debates, yet the necessary determinations depend upon scientific judgments that are highly uncertain. These debates problems that will increasingly be encountered in confrontations between science and law in the emerging field of technology assessment

To gain a better understanding of the nature of these problems and of the means for dealing with them, the Committee on Legal Issues in Health Care in conjunction with a number of the nation's law reviews will undertake a series of student research and writing projects on ten specific issues of current public interest. Each project will in effect be a case study on a topic which is characterized by a lack of definitive scientific understanding of the subject matter, necessitating legal decision-making in a climate of uncertainty. Included will be studies of cases concerning the health effects of air pollution , radiation, pesticides, cyclamates, and oral contraceptives. Some studies may also examine potential issues arising from advances in bio- medical engineering.

SUPPORTED BY U.S. National Science Foundation

1.0498, BASE STUDY OF THE STATUS OF ECOLOGICAL RESEARCH
H. BOND, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Establish a basis for planning and implementing a broad based ecology research program on the effects of environmental pollutants on selected ecosystems.

Approach: An ecologist assisted by technical manpower will 1) report on the general state of ecological research especially as applicable to air pollution effects and provide a list of references; 2) determine the current areas of research and the facilities involved and/or available and 3) contact investigators throughout the world and establish working communications with them.

Goals: Subsequent to completion of the report, long and short term planning for research on the effects of air pollution on selected ecosystems wil be initiated. Alternative courses of action may be provided through a systems analysis contract jointly handled by the ecologist and the Office of the Director, BCS.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0499, NATO/CCMS
K.L. CALDER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

To assist NATO member countries in their efforts to solve air pollution problems. Particular attention will be given to the development of urban diffusion models for Ankara, Turkey and possibly for other member country's cities.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0500, PRIVATELY OWNED POWER PLANTS - FEDERAL CONTRACTS
J. COPELAND, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Compile information on Navajo, Kapairwitz, Mohave, and Four Corners power plants by July 15, 1970. Meet with USDI ad present NAPCA air pollution control recommendations by August 1, 1970. Review all proposed contracts and air pollution control plans and make comment upon them within 60 days after receipt.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0501, CAVEN POINT INCINERATOR EVALUATION
J. DEALY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Participate in test of Caven Point Incinerator, U.S. Army, to determine compliance with Federal emission standards. Provide source test team as part of a larger project to measure visible and other particulate emissions during oper[illegible] Testwork to be complete by November 1,1970. Provide te[illegible] capabilities for preparing report on results of test. Report to be completed by February 1, 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0502, STUDY OF THE SOCIAL AND ECONOMIC IMPACT OF ODORS - PHASE II
R.C. DICKERSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop an efficient and inexpensive method that would provide an adequate assessment of the social and economic impact of odors on a community.

Approach: A public attitude survey will be conducted in test and control areas along with odor measurements to obtain data needed to develop an odor evaluation procedure.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0503, ADEQUACIES OF ELEMENTS OTHER THAN CONTROL REGULATIONS IN PLANS FOR SO2, PAKTICULATES, CO, HYDROCARBONS & OXIDANTS (ABBREV)
J. FARMER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The elements of the plan other than the control regulations include (1) legal authority, (2) surveillance, (3) emergency episode plan, (4) timetable for compliance and (5) resources. This evaluation will be coordinated with various other divisions in NAPCA. A report of the total evaluation with recommendations will be prepared and forwarded to the Commissioner, NAPCA for his review.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0504, THE STATES NECESSARY CHANGES AND MODIFICATIONS IN THE IMPLEMENTATION PLANS FOR

SO2 - PARTICULATES - CO - HC AND OXIDANTS (ABBREV)
J. FARMER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Once the implementation plans are received, a preliminary review will be conducted to see if all the required elements are present. If any are missing, the states will be advised informally. If they don't respond to the informal approach, a formal course of action, including formal notification from the Commissioner, NAPCA, will take place. The same steps (informal and formal notification to the states) will be undertaken for the final evaluation of the plans.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0505, DETERMINE IF THE CONTROL REGULATIONS WILL ACHIEVE THE AIR QUALITY STANDARDS FOR SO2 - PARTICULATES - CO - HC AND OXIDANTS (ABBREV)
J. FARMER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

This will be accomplished by a simulation model. Assistance in modeling will be obtained from the Meteorology Branch, Division of Abatement. The inputs required for simulation modeling are emission inventory, meteorology, air quality and growth data. These will be available, in most cases, from the states in cooperation with the technical assistance effort from DCAD. When the input data are not available from the states, appropriate in-house efforts will be undertaken.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0506, INFORMATION AND RESEARCH EXCHANGE BETWEEN SCIENTISTS
W.W. HECK, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Develop and keep updated a Directory of scientists involved in agricultural aspects of air pollution and publish a quarterly research oriented newsletter.

Approach: A list of United States and foreign research scientists has been developed and distributed to interested personnel. This list will be revised and brought up-to date as of June of each year. The preparation and distribution of a research newsletter will be implemented in cooperation with APTIC for a distribution to the research scientists on a quarterly basis. Such a publication would permit more rapidly circulation of new and important findings in the area of research in air pollution and agriculture.

Goals: Develop and information and research exchange between scientists ivolved in agricultural aspects of air pollution.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0507, LABORATORY SUPPORT IN THE ENFORCEMENT OF IMPLEMENTATION PLANS
S. HOCHHEISER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

In cases where air quality levels aren't being achieved and reasonable enforcement is not being taken, laboratory support will be provided to determine the degree of compliance with source restrictions. This support will consist of fuel sulfur analyses, analyses of raw materials and products and of samples collected by source testing personnel. Resultant measurements will be used to quantitate excessive emissions in light of air quality goals to provide assistance in court actions initiated by the Attorney General.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0508, REGIONAL CLIMATOLOGY
G. HOLZWORTH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Provide for quick tabulation and summation of meteorological or climatological data for a specific area during episode. Data may be required for documentation as a matter of public record. Services probably to be provided by the National Weather Records Center, ESSA or by the Weather Bureau, is not readily available by DM.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0509, COMMUNICATIONS
G. HOLZWORTH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Monitor air pollution potential forecasts, disseminated by the Weather Bureau's National Meteorological Center, to ensure proper issuance of advisories or meteorological information to NAPCA officials during episodes of adverse weather conditions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0510, CLIMATOLOGY
G. HOLZWORTH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Provide available diffusion climate data and its analyses in a format useful for assessing air quality management of power plants, particularly with respect to plant siting criteria in consideration of long range planning.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0511, AIR POLLUTION POTENTIAL CLIMATOLOGY
G. HOLZWORTH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Publish air pollution potential climatological data, from analyses of wind speed, mixing depth, and other meteorological data based on 62 Weather Bureau radiosonde stations.

Prepare air pollution potential climatology and other data for long range planning purposes and air quality management, reviewing quality statistics to air pollution potential.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0512, SOCIAL IMPACT OF AIR POLLUTION ON THE PHILADELPHIA AIR QUALITY CONTROL REGION
L. JOHNSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To formulate and test hypotheses on the sociological aspects of air pollution in the Philadelphia area.

Approach: Personnel in NAPCA, along with experts in the Social Science field, will be contacted in order to define hypotheses of interest. The data base available from the recent study in the PENJERDEL region will be utilized in examining the hypothese.

Goal: To complete the study, and employ the results to establish a basis for further research in the area of the social impact of air pollution.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0513, HEDONIC EVALUATION OF ODORS
A.C. JONES, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine public attitudes toward odors of different quality.

Approach: Select three areas within a city, one area exposed to an 'unpleasant' odor source, another area exposed to a 'pleasant' odor source and the third area exposed to no odor. The public attitudes in the three areas would then be surveyed and compared for significant differences. The city would be selected from among those employing the scentometer for enforcement purposes. The odorous areas should have a history of being exposed to at least a reading of scentometer No.2 odor strength; persons experienced in the use of the scentometer have stated that 'a No.2 odor, irrespective of its quality, will cause complaints; 03 and 04 odors are considered serious nuisances, particularly when they are frequent or persistent.' The history of the areas should be determined fron the local control agencies, if possible. If not, then it will be necessary for the contractor to do his own sampling.

1. AIR QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0514, SURVEY FUEL ADDITIVE INFORMATION NEEDS AND IMPROVE RETRIEVAL OF DATA
J. MERSCH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Commence development of a computer program to extract information from fuel additive registration notification forms and to present it in usable form to potential users throughout NAPCA.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0515, REGISTER FUEL ADDITIVES
H. MILLER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Register fuel additives per section 210 of Clean Air Act and make this information available for NAPCA study and analysis.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0516, DATA PROCESSING - FEDERAL INSTALLATIONS
F.B. ORR, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The GAS inventory of real property, Form 5049, and Formats A and C (or their revisions) individually contain basic data on Federal facilities. These data are being processed into computer form, and are currently being used in preparing emisson inventories for Federal facilities in AQCR's. Additional studies planned or in process include fuel use trends, compliance with appropriate regulations, refuse disposal practices, and summaries by state or local jurisdictional areas. Once the basic data is processed, the data bank will be expanded to include process emissions, aircraft and maritime operations emissions, and other specialized activities.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0517, DEVELOP NEW PROCEDURES FOR THE EOCC
D. TYLER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The purpose of this task is to expand the operation of the EOCC and develop procedures for conducting expanded operations as well as improving the present operations. The task will include the following: 1. Expand the AQ data network from the present 6 sites to 26 sites. The expanded network will use state AQ monitoring sites. 2. Increase the communications capabilities to handle the increased AQ data, the issuance of HAPPA bulletins and action advisories to the states. Various communications systems such as teletypes will be considered and recommendations made for their use in the EOCC. 3. Assemble or work with DAQED elements in the development of emissions inventories. 4. Work with the Argonne National Laboratory in designing a procedure for developing incident control models for episode prone areas.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0518, OPERATION OF EOCC
D. TYLER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The purpose of this task is to conduct the day to day operation of the EOCC using the procedures specified in the SOP. This task will include the following functions: 1. Acquire and analyze air quality and meteorological data. The data will be received daily and analyzed against the episode criteria. 2. Disseminate the HAPPA bulletins as required. This task is presently being done by the Meteorology Branch. 3. Make recommendations as to what Federal action is called for in any episode area. 4. Maintain a log book on the daily activities of the EOCC. 5. Prepare and disseminate after action reports on the EOCC's actions during a particular episode.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0519, EVALUATE EPISODE SECTION OF AQCR IMPLEMENTATION PLANS
D. TYLER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The EOCC will assist other DA elements in evaluating the episode section of each AQCR Implementation Plan. Such evaluation will insure that the episode plans developed for each AQCR are capable of preventing emergency episode situations. Each plan will be examined to assure that the legal authority for controlling episodes exists and that the plan shows that the state agency has the capability of operating an episode contract program.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0520, EVALUATE SURVEILLANCE DATA
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Examine surveillance fleet data for compliance with Federal emissions standards.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0521, DEVELOP STANDARDS FOR FEDERAL FACILITIES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Based on health-related values, develop air quality standards applicable to Federal facilities for various air pollutants.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0522, STATE ASSISTANCE IN STANDARDS FORMULATION
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Provide assistance to the several States in the formulation of Regional standards for 5 pollutants covering some 57 Regions by comparing proposed standards with reference air quality standards, with emphasis on appropriate averaging times. Making presentations at public hearings to provide guidance to the participating public. Pollutants of current concern are: SOx, suspended particulate matter, oxidants, carbon monoxide, and hydrocarbons.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0523, EVALUATION OF ADOPTED AIR QUALITY STANDARDS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Review adopted state standards for 5 pollutants (SOx, particulates, oxidant hydrocarbons, CO) for 100 air quality control regions, in terms of: proper protection of the health and welfare of the populace, existing air quality, compatibility in Interstate Regions and, public participation in standard setting. Prepare complete concise summaries of reviews together with recommendations on approval.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0524, DEVELOP REFERENCE AIR QUALITY VALUES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Based on criteria for HC, CO, NOx, lead, fluorides and polycyclic organic matter, develop values of air quality as a function of averaging times for association with biological and nonbiological effects.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0525, DEVELOPMENT OF REFERENCE AIR QUALITY STANDARDS

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Determine concentration-time relationships for pollutants applicable to effects on health, vegetation and materials from appropriate Criteria Documents. Determine appropriate averaging times for various effects. Develop reference standards in terms of effects and outline complete review techniques. Coordinate reference standards and review techniques with higher echelons within NAPCA. Prepare in final form standard procedures for review of adopted State standards for the following pollutants: (1) carbon monoxide, (2) photochemical oxidants, (3) hydrocarbons, (4) lead, (5) fluorides, (6) polynuclear organics, and (7) oxides of nitrogen.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0526, REVIEW AND PREPARATION OF CRITERIA DOCUMENTS FOR NO, F, ODORS (INCLUDING H2S) HCL, CL2 (GAS)

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To support the Office of Criteria and Standards in the public action of criteria documents.

Approach: As assigned prepare, review, or both, sections of criteria documents related to materials damage.

Goals: Prepare and/or review materials damage section for NOX and F.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0527, LEGISLATION AND REGULATIONS - AQCR PLANS

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Assist States in the development of adequate legal authority and emission control regulations for their respective AQCR implementation plans. Existing legislation will be evaluated for adequate authority to adopt emission control regulations, require registration of emission information, require permits prior to construction and operation; inspect and test facilities, enforce regulations through adequate sanctions and administrative orders and hearings, and implement emergency episode action. Emission control regulations will be evaluated to determine gaps in coverage and to judge consistency with modern control techniques, good practice and enforceability.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0528, LEGAL INFORMATAON HANDLING SYSTEM

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Develop and implement a legal information retrieval system. The system will be based on an accessable card file containing information on air pollution rules, regulations and legislation which have been adopted by the various States and local jurisdictions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0529, EVALUATE THE EFFECTS OF SOURCE CONTROL PROGRAMS ON AIR QUALITY LEVELS

R.T. WALSH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

When air quality standards aren't being achieved and reasonable enforcement is not being provided, the degree of compliance with source restrictions will be evaluated to provide assistance in court suits. Visual surveys will be conducted and technical data will be assembled such that the effect of the excessive emissions can be evaluated. This information will be provided to the Attorney General for use in court actions initiated pursuant to the act.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0530, EFFECT OF CHANGES IN AIR QUALITY ON COMMUNITY ATTITUDES, INFORMATION SEEKING, AND KNOWLEDGE

R.G. MASON, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00890)

OBJECTIVE: To determine the level of public knowledge and information about and attitudes toward air conservation and to measure the effect of a deterioration in air quality on these interdependent attributes.

APPROACH: A theoretical model has been formulated that can be described mathematically as a system of simultaneous equations. Personal interview surveys of the general public in two Oregon cities will be conducted that will include measures of endogenous and exogenous variables. Each city will represent a known difference in range in air quality; one city experiences only nominal loss of visibility throughout the year while the second is subjected to continuous and severe deterioration in air quality part of the year. One survey will be conducted when visibility in both cities is high; the second survey when visibility is high in one city but low in another. Change scores of endogenous variables will be used to test the model. Analysis by two- stage least squares is planned.

PROGRESS: Initial phase of the study was to develop measures of the knowledge and attitude measures described in the theoretical model of the work plan. The first step was to locate published material concerning air pollution. Microfilm tapes of the daily newspapers in the two planned target areas and the Readers' Guide were surveyed and all material concerning air pollution was noted. Time interval, in all cases was the past 5 years--Jan. 1, 1964 through Dec. 31, 1968. Appropriate material from these sources was reproduced by Xeroxing. Coders trained to perform a content analysis of the Xeroxed material completed their coding and all statements--approximately 3,000--were typed on cards. A classification system was developed for separating statments into first, knowledge or attitude categories, and further, into mutually exclusive sub-categories. Intensive interviews of the general public in the target cities were completed, tapes transcribed, and a content analysis completed. As well, similar interviews were completed with professionals in the air quality field in Oregon and these interviews were transcribed and a content analysis completed.

SUPPORTED BY U.S. Dept. of Agriculture

1.0531, EVALUATION OF ALTERNATIVE AIR RESOURCE MANAGEMENT POLICIES

UNKNOWN, Temple University, Graduate School, *Philadelphia, Pennsylvania* 19122

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Resources for Future Inc. - Wash., D.C.

1.0532, SECOND INTERNATIONAL CLEAN AIR CONGRESS, INTERNATIONAL UNION OF AIR POLLUTION PREVENTION ASSOCIATIONS, WASHINGTON, D.C. (ABBREV)

A. ARCH, Air Pollution Control Assn., *Pittsburgh, Pennsylvania* 15213

The International Union of Air Pollution Prevention Associations was founded in Washington in June 1964 at a meeting of representatives of six national air pollution prevention associations and held its first congress in London in 1966. The purpose of the International Union is to promote collaboration and exchange of information on air pollution problems and to organize, through its member associations, international congresses, the proceedings of which are published. For the Second Congress there have been organized program committees representing 35 countries plus the World Health Organization and the Pan American Health Organization. The program includes plenary sessions for keynote and summary addresses and technical sessions in six air pollution subject areas: chemistry and physics, meteorology, medicine, and biology, engineering, control administration, and community and area studies. This award defrays costs of simul

taneous translation services in five languages at plenary sessions aad in two languages at technical sessions.

SUPPORTED BY U.S. National Science Foundation

1.0533, DOCUMENT RESPONSES OF URBAN CITIZENS TO DIESEL EXHAUST
K.J. SPRINGER, Southwest Research Institute, *San Antonio, Texas* 78228

Complete opinion survey of population responses in selected cities to odors generated under controlled conditions in a mobile laboratory equipped with a diesel-electric power source.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

F. CONTROL METHODS

Equipment, Abatement, and Operations Relating to Air Quality Control.

1.0534, AEROSOL FILTRATION IN SLIP AND TRANSITION FLOW
S.L. GOREN, Univ. of California, School of Chemistry, *Berkeley, California* 94720

The proposed research is an experimental and theoretical study of the pressure drop and aerosol filtration efficiency in fibrous media in the slip, transition, and free-molecular flow regines, i.e. when the mean free path in the gas is comparable to or larger than the diameter of the fibers. Motivation for this research stems from the expectation that filtration efficiency is significantly increased and pressure drop decreased under these conditions. Our experiments are to cover a wide range of Knudsen numbers, from 10 to minus 2nd power to 10 to the 2nd power, using carefully prepared monodisperse aerosols and carefully prepared fiber mats made from uniform diameter fibers. The results should be of use in designing reliable filters for removing particulate matter, including small biological particles, from gases.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0535, AIR POLLUTION CONTROL BY CATALYSIS
K. NOBE, Univ. of California, School of Engineering, *Los Angeles, California* 90024

The purpose of this research program is to investigate the elimination of pollutants formed in combustion processes (e.g., nitrogen oxides, sulfur oxides, carbon monoxide, hydrocarbons and oxygenated hydrocarbons) by heterogeneous catalysis. Catalytic studies on rate of oxidation and reduction, and on catalyst activity - time characteristics under the oxidizing and reducing exhaust gas conditions in the absence of and the presence of various catalyst poisoning agents are in progress.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0536, SULFATION KINETICS IN SO2 ABSORPTION FROM FLUE GAS
R.W. BARTLETT, Stanford University, School of Earth Sciences, *Palo Alto, California* 94305

A continued study of the kinetics of sulfur dioxide reaction with selected oxides is proposed. This work is related to the removal of sulfur dioxide from coal burning power plant flue gases. Continuous monitoring of weight change during sulfation of a suspended sample and infrared analysis of SO2 gases passing through fixed bed reactors are the principal experimental methods being used. The role of oxygen, water vapor and temperature are being determined. The role of pore diffusion is being followed by microprobe analysis and from rate variations with pellet size. Alkalized alumina and Bayer alumina plant solid wastes are the sorbents receiving primary attention. Both have significant sulfur loading capacities at flue gas temperatures.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0537, A STUDY OF SURVEILLANCE INSPECTION AND MAINTENANCE PROCEDURES FOR MINIMIZING AUTOMOBILE EXHAUST EMISSIONS (CAPE-13)
N. RICHARDSON, T R W Incorporated, *Redondo Beach, California* 90278

A contract presently in effect will acquire and develop the data necessary to determine to what degree various inspection, maintenance and surveillance systems are effective in reducing automobile exhaust emissions. It will develop exhaust emission inspection procedures which can be performed in a short period of time for both state-owned and state-franchised inspection stations. It will evaluate inspection instrumentation and develop a short driving cycle. In addition, vehicle parameters such as engine idle speed, spark timing, PCV system operation, and ignition system conditions will be studies and related to vehicle emissions. Deterioration of these parameters with mileage accumulation will also be studies.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0538, BASIC STUDY OF AIR POLLUTION WET-SCRUBBERS
S. CALVERT, Univ. of California, Air Pollution Research Center, *Riverside, California* 92507

The specific matter of the program will be the investigation of several gas treating mechanisms which show evidence of being especially effective. These subjects are as follows: 1. Gas contract with atomizing liquid. 2. Hot gas interaction with cold surfaces for (a) the removal of particles under the influence of combined inertial, thermal, and possibly mass flux forces and (b) condensation on particles due to radiative and convective heat transfer. 3. Gas contact with packed beds, including regular arrays of cylinders, etc., for the removal of particulates. (4) Gas contact with suspensions of adsorbent or reactive particles. (5) Develop a method for determining economic optimum scrubber designs for principal types and use it to evaluate new design approaches.

The aims of this work are to define the basic mechanisms involved in gas absorption and particulate collection in the above systems. The attainment of these specific aims will bring us nearer to the ultimate goal of being able to completely define the performance of gas scrubbing equipment. This will require an understanding of the basic mechanisms involved and of the effects of the all significant variables such as fluid properties, flow rates, system geometry, particle properties, etc.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0539, LOW EMISSION FUELS FOR VEHICLES
PEFFLEY, Univ. of Santa Clara, Graduate School, *Santa Clara, California* 95053

This project will represent the third phase of a study investigation the potential of methyl alcohol as vehicle fuel. It will concentrate on engineering development of an integrated system utilizing exhaust system waste heat to catalytically decomposed methanol to hydrogen and carbon monoxide.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0540, REDUCTION OF NITRIC OXIDE BY GRAPHITE
H.W. EDWARDS, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

The major objective of the research program is to determine the conditions under which the rate and extent of reduction of nitric oxide by graphite are significant in terms of possible NOX emission control. While formation of reaction products is highly favored thermodynamically, there is considerable disagreement in the literature concerning the rate and extent of reaction between nitric oxide and carbonaceous materials at temperatures and compositions typical of those in automobile exhaust systems. Present plans also call for exploration of methods by which the graphite surface can be altered to favorably affect the reaction rate.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0541, TECHNOLOGICAL AND ECONOMIC FEASIBILITY STUDY OF ADVANCED POWER CYCLES AND METHODS OF PRODUCING NON-POLLUTING FUELS
F.L. ROBSON, United Aircraft Corporation, *Hartford, Connecticut*

Description: This is an analytical program for the purpose of defining fuel desulfurization and conversion processes and advanced- cycle control power stations which in combination will reduce or eliminate emissions of sulfur dioxide and other pollutants resulting from the combustion of high-sulfur coal and residual fuel oil. The program consists of estimates of the technical and economic feasibility of (1) clean-up processes for removing sulfur from fuel prior to combustion, (2) advanced-cycle power stations, and (3) integrated fuel clean-up processes and power stations. Processes and stations considered are those utilizing currently available technology, and those using technology judged to be potentially applicable in commercial configurations within both the next ten years, and the next twenty years.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0542, NAPCA/AISI SINTER PLANT EMISSION CONTROL DEVELOPMENT PROGRAM
UNKNOWN, Amer. Iron & Steel Institute, *Washington, District of Columbia*

Objective: Develop project plan and fabricate hardware.

Description: The purpose of this project is to develop and/or demonstrate, by joint cooperation between NAPCA and the AISI, new technologyy for controlling all emissions (particulates, sulfur oxides, fluorides and hydrocarbons) from the sintering process. Several approaches have been evaluated that make use of both bag houses with dry additive injection, aqueous scrubbers of various types and wet electrostatic precipitators. Until these processes are developed and demonstrated, a clear cut decision relative to their applicability to the industry cannot be made. This research and development program on control technology will provide the information to help make that decision and will hasten the application of controls of this emission source.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0543, ENGINEERING REVIEW CONSULTATION
R. CROZIER, Natl. Academy of Sciences, *Washington, District of Columbia* 20037

Objective: Initiate and continue and/or complete task orders in support of the Division's R&D program.

Description: The National Academy of Engineering will review engineering research, development, and demonstration programs of both government and industry in new and improved control technology for abatement of air pollution; analyze technical progress in air pollution control; identify technical or economic deficiencies or limitations to orderly scale-up; recommend new technical work or modification of existing work in order to achieve the most rapid development or process under consideration; recommend additional engineering and economic considerations and priorities; review HEW's program for balance and objectivity; perform such other additional work in the field of air pollution abatement and control including associated problems of potential water and land pollution; and report findings and recommendations as appropriate.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0544, AIR CLEANING
C.M. HUNT, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Samples of dust have been collected from various room locations at NBS and at the Post Office Building in Omaha, Nebraska by means of high volume samplers. It is now possible to collect weighable amounts of atmospheric dust and compare airborne dust levels in building spaces with National Air Sampling Network data. A procedure has also been developed for determining the lint content of collected dust.

It has been experimentally demonstrated that airflow through filters can be expressed by the empirical relationship, v equals kAp super n, where v is face velocity, A is filter area, p is pressure drop across the filter, n is constant having a value less than unity, and k is a parameter which varies with the amount and type of dust. This equation suggests a starting point for predicating roll filter performance from panel filter tests, and to predict the effect of changing air velocity, pressure switch settings, and type of dust on roll filter performance.

An analysis, of the relationship between roll diameter and the amount of filter on a roll has been made, comparing empirical data with calculations in which a roll filter has an archimedian spiral.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0545, MISCELLANEOUS AIR CLEANER TESTS
UNKNOWN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Progress: 011068 to 300669; Improvements in the design and construction of the roll filter test apparatus have been made. One roll filter manufactured by Filter Fabricators, Inc., Millersport, Ohio, was received for test.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0546, NAVY FIRE FIGHTING SIMULATION
E. SWIATOSZ, U.S. Navy, Training Device Center, *Orlando, Florida*

Technical Objectives: Investigate and experimentally test various fire fighting simulations such as logic circuit controlled gas burners for reduction of pollution effects and reduced danger to trainees. These concepts should provide the essential characteristic elements of a real fire for teaching the specific behaviors associated with fire fighting training.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0547, LOW POWER TURBOPROPULSION EXHAUST EMISSIONS
S.A. MOSIER, United Aircraft Corporation, *West Palm Beach, Florida* (F33615-71-C-1870)

Technical Objective. The objective of this program is to identify and develop improved component design techniques which will increase part-power performance, namely, combustion efficiency and thus reduce or eliminate those exhaust products considered to be toxic or potential health hazards. Furthermore, the design concepts developed will be fully substantiated by testing over a broad operating range to assure that performance and exhaust emissions at and near full power are not compromised.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0548, AIR TREATMENT FOR ODOR CONTROL IN THE HOSPITAL
T.W. KETHLEY, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332

The objective of the study is to determine the ability of air treatment systems employed in hospitals to remove from the air odorants originating intramurally and or extramural gaseous air pollutants. During the past year work has continued, evaluating components of air handling systems. The evaluation of dilution ventilation is an essential part of these studies. It has been determined that odorant compounds not only sorb or condense upon surfaces and subsequently desorb or evaporate, and thus are slowly removed by ventilation, but also that for many of these compounds even the aerial content is not reduced with the expected efficiency by dilution ventilation. This difference becomes greater with increasing molecular weight of the odorant compound. The practical consequence of this finding is that increasing volumes of fresh air, or equivalent fresh air will yield poor results in reducing levels of higher molecular weight odorants in hospital rooms.

1. AIR QUALITY

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0549, RESEARCH INITIATION - APPLICATION OF HIGH VOLTAGE ELECTRIC FIELDS TO THE REMOVAL OF SO2 AND NO2 FROM COMBUSTION EFFLUENT
M.J. MATTESON, Georgia Inst. of Technology, School of Engineering, *Atlanta, Georgia* 30332

This investigation involves a new method by which sulfur dioxide and nitrogen dioxide gases may be removed from industrial combustion effluent. A simulated combustion effluent will be studied where SO2 and NO2 are ionized while flowing through a high voltage, wire-to-cylinder electric field. The ions react with oxygen and water vapor in the gas stream to produce charged nuclei of sulfuric and nitric acid which grow in the humid atmosphere and are precipitated on the grounded cylinder. The efficiency of removal of SO2 and NO2 are to be determined as a function of the concentration, gas velocity, relative humidity, and electric field strength.

SUPPORTED BY U.S. National Science Foundation

1.0550, REDUCTION OF ATMOSPHERIC POLLUTION BY THE APPLICATION OF FLUIDIZED-BED COMBUSTION
A.A. JONKE, Argonne National Laboratory, *Argonne, Illinois* 60439

Objective: To study the fluidized-bed combustion process as a method for reducing atmospheric pollutants.

Description: This program is concerned with a study of fluidized- bed combustion (FBC) as a method of reducing the quantity of atmospheric pollutants (oxides of sulfur and nitrogen) released during the combustion of fossil fuels. Basic and fundamental reaction kinetics and mechanisms of the SO2-limestone reaction are being investigated. A six- inch diameter FBC is being used to identify and study the principal factors affecting SO2 removal.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0551, A MODEL FOR AIR POLLUTION CONTROL
R.E. KOHN, Southern Illinois University, Graduate School, *Carbondale, Illinois* 62901

There is no single measurement of air quality as such. Air pollution is an overall category including individual pollutants such as aldehydes, carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides, particulates, benzo(a)pyrene, etc. Since control methods usually affect more than one pollutant and sometimes increase some while decreasing others, a multi-pollutant model is required to determine an efficient set of control methods. Linear programming can be a useful vehicle for the multipollutant model.

Generally, linear programming models are static, optimizing for a specific year. However, air pollution control requires long-run considerations. The solution for any one year, if implemented, restricts the choice of control alternatives for future years. This project considers the implementation of a dynamic model. Such a model can suggest optimal long-run strategies for air pollution control, assess the significance of technological advancement in abatement, and be useful in providing the pollution parameters for solving the growing problem of solid waste disposal.

The site of this research is the St. Louis airshed, the most thoroughly investigated area in the United States as far as air pollution is concerned. Not only is a great amount of data from past studies available, but the fact that air pollution regulations have already been passed makes industry leaders much more communicative on the subject of control technology.

SUPPORTED BY U.S. National Science Foundation

1.0552, CONTROL OF PARTICULATE EMISSIONS FROM GASOLINE ENGINES
M.R. JACKSON, I I T Research Institute, *Chicago, Illinois* 60616

This project will continue two experimental programs which will establish the feasibility of developing high efficiency devices for removal of particulate matter from internal combustion engine exhausts.

The first approach is based on sonics glomeration in a fluidized bed. Theoretical considerations suggest that the power density requirements can be substantially reduced by sonic agglomeration in a fluidized bed of relatively larger particles.

The second technique makes use of the phenomenon of particle migration in a temperature gradient. Particle migration and deposition will be maximized by the sharp temperature gradients and small migration distances in a cold bed of packed particles. Relatively cool ambient air will be used to cool the bed, resulting in a cyclic operation of alternately heating and cooling the bed.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0553, STUDY OF PETROGRAPHIC AND MINERALOGICAL CHARACTERISTICS OF CARBONATE ROCKS RELATED TO SULFUR OXIDE SORPTION IN FLUE GASES
R.D. HARVEY, State Geol. Survey, *Urbana, Illinois* 61801

Selected carbonate rocks will be subject to detailed petrographic, mineralogical, and chemical analyses to determine what effect these parameters have on the capacity and rate of SO2 sorption. This project is to run concurrently with full-scale injection tests at TVA coal-fired power plants in Kentucky. Examination of the rocks considered and selected for injection into boilers as well as reacted products will be conducted during the course of this project. An automatic image- analyzing microscope system will be used to determine the crystalline- particle and pore-size distributions of the carbonate-rock samples. Petrographic examination will be supplemented with scanning electron-microscope observations. Complete chemical analyses will be obtained including trace-element analyses utilizing neutron-activation techniques.

SUPPORTED BY Illinois State Government - Springfield

1.0554, DETERMINATION OF MASS FLOW AND CONCENTRATION OF SUSPENSIONS
S.L. SOO, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

Accurate measurement of fuel flow in pulverized fuel lines is studied for better heat rate computations. Incorporation of a fuel flow signal in feed-back control systems will lead to significant improvement in the performance of pulverized fuel units. Study is made with an electrostatic probe. Measurement of dust concentration in stack gas is studied to determine a dependable means for the purpose of air pollution control on large steam generators.

SUPPORTED BY Detroit Edison Company

1.0555, FUNDAMENTAL STUDIES ON THE PROCESS FOR REMOVING NOX FROM FLUE GASES
R. KUMAR, Indian Inst. of Science, *Bangalore, India*

Description: The capability of the lime/limestone wet scrubbing process for the control of NOx and the effect of the presence of nitrogen compounds on the SOx removal efficiency are to be studied in the laboratory in a bench scale system. The chemistry, mechanism of reactions and kinetics of the heterogeneous gas-liquid-solid system involving the following problems are to be investigated; (a) gas phase interactions of NO, NO2, SO2, O2, and CO2, (b) liquid phase interactions of HSO3, SO3, SO4, NO2, NO3 with each other and NO2, SO2, and O2, and (c) effectiveness of different alkaline solutions for scrubbing NOx from flue gas.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0556, STUDY OF MECHANISM FOR INCREASING THE SOLUBILITY/HYDRATION OF LIME/LIMESTONE IN THE WET SCRUBBING SYSTEM FOR SOX CONTROL
R. KUMAR, Indian Inst. of Science, *Bangalore, India*

Description: The overall efficiency of SOx in the wet scrubbing process has been found to depend mainly on the hydra-

tion and dissolution of lime in the slurry hold tank. The present task will investigate the conditions under which an increase in solubility may be achieved. The use of additives, precipitation and dissolution mechanisms, effect of fluid dynamics and alterations in the design of slurry hold tank and recycling-system will be studied in detail. Correlations between operating conditions and hydration dissolution rate will be derived.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0557, CONTROL OF NOX EMISSIONS FROM AIRCRAFT GAS TURBINES
A.M. MELLOR, Purdue University, School of Mechanical Engin., *Lafayette, Indiana* 47907

Continue research presently in progress under sponsorship of Army Tank-Automotive Command, but scheduled to be terminated because of budgetary problems. The study will develop computer simulation techniques to aid in prediction of NO formation in gas turbine combustors at high inlet air temperatures. It will also conduct experimentation in single combustor facilities to verify the computer predictions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0558, SMOG ELIMINATION RESULTING FROM BUILDING DESIGN AND CITY PLANNING
G.M. PALMER, Purdue University, School of Aeronautics, *Lafayette, Indiana* 47907

To study experimentally the effect of building design, building placement, and overall city layout on minimizing the smog accumulation potential of metropolitan areas by significantly reducing the critical wind velocity needed to purge areas of emission concentrations.

The above will be accomplished by scale model parametric studies of city arrays in a smoke tunnel. The basic model and the more promising innovations will be built on a larger scale and exposed to a scaled velocity--altitude wind profile in a large subsonic wind tunnel at varying wind directions from 0 degrees to 360 degrees or asymmetric fraction thereof. Observations will be made by eye and stop-motion movie camera of the effect on smoke introduced at judiciously chosen points. In addition, measurements of local velocities will be made by means of a hot film anemometer in an effort to quantify results.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0559, CONTROL OF AIR CONTAMINANTS IN THE HOME
P.J. ANNIS, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00691)

OBJECTIVE: Determine the effects of hood geometry, hood-range relationship, and hood air flow rate upon airborne contaminant capture efficiency. Determine whether: Vacuum cleaning causes appreciable amount of settled dust to go into suspension, this dust differs in size and character from that normally in suspension, this dust behaves as normal atmospheric dust while in suspension, vacuum cleaner design has an effect upon these variables.

APPROACH: Using mock-up hoods, geometry, location and air flow will be varied and each combination tested for efficiency in solid aerosol and water vapor removal. Atmospheric dust in several homes will be sampled to ascertain the problems in determining dust concentration level. Periods immediately before and after vacuuming and while using several styles of vacuum cleaners will be studied. Samples would be taken on MSA 1106 BH glass-fiber paper using a Gelman No 13200 carbon- ring, pistontype portable vacuum pump. Later, samples would be taken on type AA Milipore filters, from which size analyses can be determined by the MSA-Whitby method.

PROGRESS: The Effects of Range Hood Geometry, Location and Air Flow on Cooking Contaminant Removal. Data from 240 water vapor removal tests have been analyzed. Recommendations are being made for construction, location and usage of vented and unvented range hoods. Previous work with solid aerosols has been reviewed and additional testing with fluorescent tracers begun. The Effect of Vacuum Cleaning Upon Household Atmospheric Dust. Earlier work established that vacuum cleaning was a serious source of household atmospheric dust was followed by experiments measuring the filtration efficiency of various vacuum cleaner bags. A set of tests employed four bags, two vacuum cleaners, two laboratory residences and two types of occupancy periods. The test dust was that naturally occurring on carpets in the residence. The door openings, rug passages and rainfall were monitored to evaluate experimental control. Simultaneously, laboratory measurements enabled calculation of the two correlation parameters, the effective fiber size and filter solidarity factor, which have produced the best means of predicting filter performance. Statistical analysis of the data, to date, has shown one bag to be distinctly better than the others.

SUPPORTED BY Kansas State Government - Topeka

1.0560, ODOR REMOVAL FROM AIR BY ADSORPTION ON CHARCOAL
B.G. KYLE, Kansas State University, Graduate School, *Manhattan, Kansas* 66502

Description: The contract is expected to accomplish the following: a) Development of suitable experimental techniques so that reliable adsorption equilibrium and kinetic data may be obtained; b) Provide data for several homologous series of adsorbates; c) From data gathered and analyzed, acquire an understanding of the thermodynamics and kinetics of adsorption at low adsorbate concentrations.

The data and conclusions resulting from this study will be useful in the development of package adsorption devices for industrial odor control.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0561, SHOCK STABILITY OF BACKUP SUBMARINE ATMOSPHERE CONTROL COMPONENTS
R.B. CAREY, U.S. Navy, Ship Research & Dev. Lab., *Annapolis, Maryland* 21402

Technical Objective: Determine the ability of oxygen (O2) candles and lithium hydroxide (LIOH) canisters to perform their intended end use after being subjected to shock and vibration.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0562, PROTOTYPE STUDY OF LIMESTONE SCRUBBERS FOR SO2 DUST REMOVAL SYSTEMS - PHASE IIA EXTENSION
I.A. RABEN, Bechtel Corporation, *Gaithersburg, Maryland* 20760

Objective: Complete design of test program for Shawnee test facility.

Description: Planning and design of the test program for NAPCA's limestone-wet scrubbing test facility at TVA's Shawnee Station will be completed under this extension of Phase II A. The work remaining to be done includes portions of the following tasks:(1) simulation and evaluation of screening experiments using process models, (2) development of data handling and analysis manual; (3)design of the primary experiments, and (4) preparation of a test program manual.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0563, SO2 AND NOX REMOVALS FROM STACKS GASES BY CO
W.L. SHORT, Univ. of Massachusetts, School of Engineering, *Amherst, Massachusetts* 01002

In the second year of AP 00791 experimental results were obtained that indicated complete removal of SO2 by catalytic reduction with CO can be achieved at temperatures greater than 800 degrees F, at stoichiometric ratios of CO/SO2 and with contact times of O.05 to O.2 seconds. The best catalyst, chosen from the several tried was copper supported on alumina. There is a side reaction between the elemental sulfur formed from the reduction of SO2 and CO to produce COS. This side reaction has limited the total sulfur removal (SO2 plus COS produced) to about 70%. The

progress report discusses the techniques to be explored to overcome this problem.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0564, CONTROL TECHNIQUES FOR POLYCYCLIC ORGANIC MATTER

R. FOX, G C A Corporation, *Boston, Massachusetts*

Mail 1st draft to in-house and 3 review committees by August 1970. Revise into 2nd draft according to review comments, and submit final revision to OTIP for editing and publishing.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0565, RECOVERY OF NITROGEN AND SULFUR OXIDES FROM BOILER FLUE GASES

A. GRUBER, Tyco Laboratories Incorporated, *Boston, Massachusetts* 02154

Description: The work would include: (1) the operation and parametric study of the Tyco process, using a 'mini-plant' with 10 SCFM flue gas capacity; (2) the preliminary design of a 2,000 SCFM pilot plant; and (3) the development of improved NOx analytical and control techniques of the Tyco process.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0566, CRITERIA FOR DESIGN AND CONTROL OF INCINERATORS

A.F. SAROFIM, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

A number of design and operating variables will be investigated in an attempt to find a variable which can be related to the residue quality and which can be used to activate corrective action when the unburned fraction of the residue or in the stack gases becomes excessive. Included in these variables are excess air, fraction of air overfired, longitudinal distribution of air above and below the grate, air preheat, refuse bed height, and grate speed.

An experimental study of combustion will be made on a stationary fuel bed simulating a section of a traveling-grate stoker. Detailed measurements will be made of compositions and temperatures in and above the burning fuel bed in addition to infrared transmittance across the top of the bed. Concurrently, a semi-empirical mathematical model will be designed to extrapolate existing data to new conditions of operation or design so that adjustments can be made to incinerator operating conditions to accomodate changes in refuse quality.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0567, RESEARCH INITIATION - RATES OF SORPTION OF MOLECULAR SIEVES IN MULTICOMPONENT SORBATE SYSTEMS

Y.H. MA, Worcester Polytechnic Inst., Graduate School, *Worcester, Massachusetts* 01609

In this research constant volume techniques will be employed to obtain sorption rate data and sorption isotherms for gas mixtures on various molecular sieves. Data on sorption rate and sorption isotherms will be obtained for carbon dioxide, sulfur dioxide, and carbon monoxide on various commercial as well as specially synthesized zeolitic materials. Experimental studies will be conducted in a well-stirred reactor. The rate will be measured by either introducing the system which is already filled with 'inert' gas. Analyses of samples obtained from the well-mixed phase will be obtained by gas chromatography. The results of the study should find applications not only to the immediate problem of catalyst evaluation but also the evaluation of sorbent materials for removal of pollutants from exhaust gases.

SUPPORTED BY U.S. National Science Foundation

1.0568, NEW INORGANIC MATERIALS FOR SULFUR OXIDE REMOVAL

L.B. SAND, Worcester Polytechnic Inst., School of Engineering, *Worcester, Massachusetts* 01609

The objective of the project is the molecular engineering of porous inorganic materials, principally molecular sieve zeolites, which will perform selectively as sorbents in the removal of sulfur oxides and other noxious gases in effluent released to the atmosphere.

For the study, samples of every commercially available molecular sieve zeolite have been obtained either in powder or particulate form from the major suppliers, and a field trip was made to the western United States to obtain samples from deposits which have potential use in this application.

Three types of sorption equipment are in use on the project: a mechanical constant volume balance for rapid screening of porous materials, a manometer-reading constant volume glass apparatus (in duplicate) for the second stage of evaluation, and a quartz microspring balance with a Baratron pressure meter for final data accumulation. Comparative data have been obtained on sorption capacities for SO2, rates of sorption, and stability in a sulfuric acid system. All zeolites evaluated sorbed SO2 rapidly in amounts up to 35 wt. % (faujasite) and in direct proportion to their pore volumes. Mordenite (24 wt. % capacity) was found to be most acid stable. Current research is on particulates and the SO2-H2O sorbate system at simulated operating conditions.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0569, ADSORPTION RATE STUDIES - AIR POLLUTION

I. ZWIEBEL, Worcester Polytechnic Inst., School of Engineering, *Worcester, Massachusetts* 01609

It is expected that separations by adsorption will provide wide applications for packed-bed systems in combatting air pollution. Several processes have been developed for the cleaning of stack gases by such technique such as the removal of SO2 by the Reinluft Process and the Alkalized Alumina Process. However, currently, the economics of widespread implementation appear unfavorable because the necessary data and knowhow are lacking. In the design of such equipment the equilibrium phenomena are of paramount importance. Together with the rate criteria they determine the dynamic behavior of the process, and thus influence the sizing of the equipment, which in turn may economically make or break the operation. Furthermore, the coadsorption of several adsorbates, or the relative selectivity of the adsorbent for the various species in the gas, determine whether or not a desired separation is feasible.

It is felt that the most serious shortcoming of the past analyses is due to the restriction of the one-component isotherms. The purpose of the current project is to obtain the desired data with a high degree of accurary to satisfy the needs of a sophisticated design model. The adsorption properties of multicomponent systems of several gas mixtures consisting of O2, N2, SO2, CO2, H2O, CO, H2S, NH3, using a variety of adsorbents, will be measured. The behavior of the system will be observed to enable conclusions regarding the mechanism of adsorptions, interactions between species, and the energetics of the process. The results will be correlated with existing equilibrium equations as well as with the thermodynamic functions derived from Gibbs' relationship and the two-dimensional equations of state.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0570, EVALUATION OF EMISSION CONTROL SYSTEMS FOR EXISTING VEHICLE

H.L. GOMPF, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Those devices or techniques that are being publicly promoted as being suitable for retrofit on used cars are evaluated to determine their emission control effectiveness, their influence on vehicle performance and driveability, and their potential impact on vehicle operating costs. This information is required to be responsive to inquiries received by NAPCA from Federal, State, and local agencies concerning such devices. The level of effort planned for FY 71 is based on the assumption that there will be no Congressional action which directly involves NAPCA in used venicles. Should such legislation be passed, the level of effort would be approximately quadrupled.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0571, TEST EVALUATION REPORT COVERING PAST UNPUBLISHED CONTROL DEVICE EVALUATION TESTS
H.H. HOPKINS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

A large number of in house tests conducted by NAPCA over the past years have not been reported in a form which could be widely distributed. This task will provide funding and assistance to a contractor to prepare a report in which all such tests will be listed including descriptions of devices tested and results achieved.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0572, CONTROL OF CO AND HC EMISSIONS FROM LIGHT AIRCRAFT AND OTHER NON-REGULATED MOBILE SOURCES
B.D. MCNUTT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

This project will follow up present tests on light aircraft emissions and initiate investigation of methods for control of emissions from this source, considering modification in flight procedures and in powerplant accessories.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0573, DEVELOPMENT OF IMPROVED NOX CONTROL FOR DIESEL ENGINES
S.L. QUICK, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

The contract will cover the development of one new nitrogen oxides control system to the point permitting detailed experimental evaluation in a vehicle.

The system chosen will be applicable to either or both spark ignition and diesel powerplants and will be based on research presently being started under several FY 70 contracts.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0574, DIESEL EMISSION CONTROL
R.C. STAHMAN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Control devices and fuel additives are screened using laboratory smoke and odor test techniques developed early in this continuing program. The more effective controls are fleet tested for period of at least six months to determine their effectiveness with time and mileage accumulation under typical fuel conditions. Fleet test vehicles are periodically returned to the laboratory for smoke and odor tests. Concurrent with these tests, chemical analyses of diesel exhaust are made for correlation against odor readings.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0575, EVALUATION OF EMISSION CONTROL SYSTEMS FOR NEW VEHICLE
J.C. THOMSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Those devices and techniques that are being publicly promoted as having capability of meeting 1975 and later standards are evaluated to determine the validity of such claims, to assess the state of the art emission control technology, and to support standard setting. Such systems are generally supplied NAPCA at the developer's expense but where it is warranted, the government would provide a control for the developer to bring the control system to Government laboratories and assist in operation of the system during evaluation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0576, TESTING OF EMISSION CHARACTERIZATION AND CONTROL PROJECTS
J.C. THOMSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Tests will be run as requested to provide evaluation of control devices or techniques which are products of the Emission Characterization and Control Branch. Emission characterization studies will be made where NAPCA facilities and analytical procedures can provide the repuired information.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0577, LOW EMISSION ULTRABAN PISTON
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Development of a stratified charge engine applicable to passenger car.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0578, CATALYTIC MEDIA TO REDUCE NOX EMISSIONS FROM GASOLINE
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Investigate new catalytic media for elimination of NOx emissions from gasoline engine exhaust.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0579, FUEL INJECTION
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Experimental determination of the maximum nitrogen oxides control achievable with an existing fuel injectionn system.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0580, REDUCTION OF EMISSION CONTROL SYSTEM DEGRADATION
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

Determine the potential for and aid the development of high-durability, engine related components to minimize emission control system degradation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0581, INVESTIGATE NON-CARBGNACEOUS ALTERNATIVE FUELS FOR CONTROL OF EMISSIONS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ann Arbor, Michigan* 48103

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0582, CARBURETORS - REDUCTION OF EXHAUST EMISSIONS
J.A. BOLT, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

This proposal is concerned with the reduction of undesirable exhaust emissions from automotive engines. The most important single factor affecting the quantity of undesirable exhaust emissions from gasoline engines is the fuel/air mixture ratio. The carburetor establishes this mixture ratio delivered to the engine cylinders. In general, the use of a lean mixture (more excess air) will result in a reduction in the emissions. It is therefore important to develop engines capable of using the leanest possible mixture ratio, and to have carburetors that deliver this mixture as precisely as possible under all conditions.

This PHS project AP00365 is concerned with evaluating the sources of metering error in present carburetors, and with means

for reducing these errors, and includes the following: (1) Further evaluation of the effect of variation of commercial gasoline properties on carburetor metering, and efforts to reduce these errors, (2) to develop a computer simulation of an automotive carburetor, which will require additional experimental data. This simulation will lead to greater understanding of the complex flow phenomena involved, permit further study of variables which affect carburetor metering accuracy, and hopefully will demonstrate to industrial carburetor engineering groups the merits of more analytical techniques than they have used for the design of carburetors, (3) study and simulate the effect of pressure pulsation upon carburetor metering characteristics, (4) determine the influence of some variables on the leanest practical mixture ratio of engines, for example, the advantages of preheating the engine inlet air.

This type of work is presently carried on with graduate students and results in more men being educated in this area of engineering.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0583, FUEL INJECTION SYSTEM ANALYSIS - DIESEL SMOKE REDUCTION

J.A. BOLT, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

This proposal is concerned with the reduction of smoke from diesel engine exhaust, especially as affected by the fuel injection system characteristics.

Our experience and research work with experimental and production diesel engines at the University of Michigan, and the experience of others expert in this field, has convinced me that important reductions in exhaust smoke could be accomplished if the engines had better fuel injection systems. For example, my observation, confirmed by many diesel engine research men, indicates that many diesel engines produce unnecessary smoke because the injection systems have line pressure waves which cause the fuel injection nozzles to inject a secondary fuel quantity after injection is normally completed. This program is aggravated by the fact that supercharging of diesel engines requires that the range of fuel flow from idle to maximum power be greatly increased.

We have developed a mathematical model which accurately simulates the hydraulic phenomena of a typical diesel fuel injection system. With this computer tool efforts are being made to identify design changes of the injection system which will improve the nozzle fuel spray characteristics.

The merits of such improved, or different, systems will be evaluated on one of our research engines. This will include measurement of the smoke and exhaust emissions.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0584, SCRUBBING OF REFUSE INCINERATOR EMISSION GASES

W.J. WEBER, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

An experimental investigation of the scrubbing of particulate and gas-phase components from refuse incinerator effluent streams with liquid wastes. The object of this research is to significantly reduce the air pollution hazards associated with incineration of municipal and industrial refuse. A secondary benefit of considerable import will be the sorptive and coagulation effects of the wetted and precipitated particulate matter from the incinerator gas stream on the purification and clarification of the liquid waste.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0585, HYBRID COMBUSTION PROCESS (FCP) APPLICATIONS FOR MILITARY VEHICLES

A. SIMKO, Ford Motor Company, *Dearborn, Michigan* (DAAE07)

Technical objective: The technical objective is to lower fuel consumption in military vehicles through better combustion at part load operation. An additional objective is to reduce air pollution. The technical question being explored is whether efficient, low emissions combustion and acceptable durability can be achieved in an internal combustion hybrid engine. The hybrid combustion process will have direct application for improvement of all engines used in military vehicles. The performance goals are to reduce fuel consumption by 30-40 percent with no loss in performance and to drastically reduce undesirable exhaust gas pollutants to meet 1975 federal standards.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0586, MATERIALS HANDLING, COLLECTION AND DISPOSAL IN THE MID-SOUTH AREA

O.L. MCCASKILL, U.S. Dept. of Agriculture, Agricultural Engineering Div., *Stoneville, Mississippi* (308-035-C115)

OBJECTIVE: Conduct tests to identify the gin trash emission problem and develop a more efficient system of receiving seed cotton at the gin, gin trash collection and disposal, and packaging lint cotton.

APPROACH: Conduct tests in a commerical size plant, determine the air emission characteristics and problem at cotton gins handling machine picked cotton. Test and adapt commercially developed air pollution abatement equipment into a system which will meet the various state air quality standards for cotton gins. Based on previous studies, develop and test a packaging system for lint cotton which would require a minimum of power and supervision at the gin, lend itself to simplified handling procedures in the channels of trade and easily handled, opened and blended at the mill. Develop a system for receiving cotton at the gin utilizing a method being developed by others for transporting the material from the harvester.

PROGRESS: An experimental roller-dropper shows some promise for improving efficiency. The number of rollers and thickness of the lint batt, not the roll pressure, is significant in batt compression. The use of precompression rollers on the lint slide had no effect on bale density. Air volume has a significant effect on cyclone operating efficiency. Feed rate has no effect on cyclone efficiency. Interaction of feed rates and operating air volume affect dust concentration in the cyclone exhaust. An experimental bale forming system was redesigned, fabrication has been completed, and assembly is underway. At a ginning rate of 10 bales per hour on machine-picked cotton, an average of 13.5 pounds of dust per hour will be emitted from cyclone and condenser exhausts. Cyclone emission was 1.3 and condenser emission was 12.2 pounds per hour.

SUPPORTED BY U.S. Dept. of Agriculture

1.0587, COTTON LINT HANDLING AND PACKAGING AND TRASH COLLECTION

V.P. MOORE, U.S. Dept. of Agriculture, Agricultural Engineering Div., *Stoneville, Mississippi* (308-035-C107)

OBJECTIVE: Develop low-cost methods for unloading and conveying seed cotton and its components, and collecting, packaging, and disposing of materials incident to ginning.

APPROACH: Investigate commercially available filter principles for possible use or adaptation for use in gins. Investigate the possibility of modifying standard condensers to perform the dual purpose of filtering the air as well as their normal function. Undertake development of a complete trash and dust collection system which can meet standards for air pollution. Investigate new methods and equipment for packaging cotton with major emphasis given to forming a picker lap-like package.

PROGRESS: The prototype of a new packaging system was tested and indicated modifications are underway. A commercial skimmer showed promise as a primary collector of gin trash which does not contain lint. A second year's test results show that there is considerable variation in the amount of particulate matter in the atmosphere at given distances downwind from a gin. Efforts to develop prediction equations have been unsuccessful. Tests of cyclone design indicated that the conventional Atomic Energy Commission design was more efficient for the collection of fine dust than one having an envolute entrance.

SUPPORTED BY U.S. Dept. of Agriculture

1.0588, SYSTEMS STUDY OF NITROGEN OXIDES CONTROL METHODS FOR STATIONARY SOURCES
W. BARTOK, Standard Oil Co. of New Jersey, *Linden, New Jersey* 07036

Description: The purpose of this study is to obtain needed additional data on nitrogen oxides formation, sources, and control techniques to assist NAPCA in evaluating, and executing the appropriate research and development program to make available control technology for nitrogen oxides. This work will extend and supplement the information obtained in the first phase. The specific work functions include: 1) acquisition of NOx emissions data from existing power plants, 2) develop mathematical models and conduct lab experiments for NOx formation, and 3) design experimental test programs for modifying and testing utility-scale boilers for lower NOx formation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0589, FUEL MODIFICATION FOR ABATEMENT OF AIRCRAFT ENGINE EMISSIONS
A. SKOPP, Standard Oil Co. of New Jersey, *Linden, New Jersey* 07036 (F33615-71-C-1575)

Technical Objective: Determine whether or not fuel modification is a feasible approach for significantly reducing the oxides of nitrogen (NOx) emissions of aircraft gas turbine engines. Fuel modification means any treatment, including the addition of catalytic or other agents, that results in a slight change in fuel composition.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0590, CONTROL OF ETHYLENE-INDUCED SEPAL WILT OF ORCHIDS
O.W. DAVIDSON, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00244)

OBJECTIVE: Study control of sepal wilt of orchids demonstrating that traces of ethylene can be successfully removed from a polluted air supply by drying that air and then passing it through brominated activated carbon.

APPROACH: Revise equipment to permit accurate determination of the permissible moisture content of the filtered air. Simplify the mechanical equipment.

PROGRESS: Work on this project was terminated in June of 1968. This investigation has demonstrated that traces of ethylene can be removed from a polluted atmosphere by means of filtration through brominated, activated carbon. Factors limiting the reaction between trace amounts of ethylene and brominated carbon, including degree of bromination, and the temperature relative humidity and residence time of the filtered air have been studied, and the extent of influence of these factors established. Also investigated was the maintenance requirements of the equipment used, including methods for recharging the filters while in operation. A manuscript is being prepared to cover the results of this investigation, and it will be completed this spring. Subsequently the endogenous production of ethylene by orchids and other flowers has been studied. This work has demonstrated the evolution of ethylene in responses to pollination by all species studied.

SUPPORTED BY New Jersey State Government - Trenton

1.0591, COTTON MATERIALS HANDLING AND AIR TRASH SEPARATION
V.L. STEDRONSKY, U.S. Dept. of Agriculture, S.W. Cotton Ginning Res. Lab., *Mesilla Park, New Mexico* 88047 (308-037-C108)

OBJECTIVE: Develop low-cost methods for unloading and conveying seed cotton and its components, and collecting and disposing of materials incident to ginning.

APPROACH: Continue modification of a commercial air flotation conveyor for moving various materials during the cotton ginning operation. Adapt the laboratory-developed inline filter for use in conjunction with a moisture restoration system previously developed. Study additional methods of air-trash separation in an effort to devise alternate means for meeting air pollution standards.

PROGRESS: A hopper feeder was designed to receive seed cotton from a farm trailer. It handled loose cotton and cotton compressed to a density of 12 pounds per cubic foot satisfactorily. Cotton which was tramped in the hopper bridged above the feed mechanism. A commercial inertial air cleaner was found to be 80 to 90 percent efficient in collecting material which emitted from the exhaust of a cyclone handling gin trash. A 90 degree elbow at the inlet of a cyclone causes the cyclone to lose twice as much dust as when it is fed from a straight pipe. To eliminate the efficiency loss, elbows should be at least 10 pipe diameters from the cyclone. Back pressure on a cyclone was found to be highest when handling air only. There was a 25 percent drop with the same air volume when trash began entering it.

SUPPORTED BY U.S. Dept. of Agriculture

1.0592, CLOSED LOOP FILTERING SYSTEM FOR USE IN COTTON GINS
V.L. STEDRONSKY, U.S. Dept. of Agriculture, S.W. Cotton Ginning Res. Lab., *Mesilla Park, New Mexico* 88047 (308-035-C114)

OBJECTIVE: Evaluate various types and combinations of experimental and commercial filtering equipment incident to the design of a closed loop moisture conditioning system for use in cotton gins and the use of condenser covering having small openings on the quality of cotton.

APPROACH: Using as a basis, the high efficiency cyclone and the in-line filter, combinations of filtering equipment will be devised for the various types of foreign matter discharged from the several processing steps in the plant. If the foregoing filter combinations do not prove to be adequate, airwash or additional dry types of filters will be added to the combination to prevent particulate matter buildup in the system as the air is cleaned and transferred from one process to another in the plant. Particulate matter will be measured by conventional means. A plant will be equipped with conventional and experimental condenser drums and direct comparison of the grade and fiber properties will be made of the lint from the two ginning conditions.

PROGRESS: An inertial air cleaner proved to be 43 percent efficient in handling fine dust following two sets of cyclones. A mechanical telescope with the lip pulsating at 600 cycles per minute increased feed rate 27 percent and reduced power requirements by 27 percent. A condenser covered with 70 mesh screen emitted 32 percent less particulate matter than with the conventional covering.

SUPPORTED BY U.S. Dept. of Agriculture

1.0593, HYBRID COMBUSTION PROCESS (TCP) APPLICATION FOR MILITARY VEHICLES
E. MITCHELL, Texaco Incorporated, *Beacon, New York* 12508 (DAALO7)

Technical Objective: Research objective is to lower fuel consumption in military vehicles through better combustion at light-load operation. Additional goal is to reduce air pollution. The technical question being explored is whether efficient low emissions combustion can be achieved in internal combustion engine. The combustion process will have direct application for improvement of all future engines used in military vehicles. The performance goals are to reduce fuel consumption by 30-50 percent with no loss in performance and to drastically reduce exhaust gas pollutants to meet 1975 federal standards.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0594, PILOT PLAN STUDY OF LIMESTONE-WET SCRUBBING IN A TURBULENT CONTACT ABSORBER
UNKNOWN, Babcock & Wilcox Company, *New York, New York*

Objective: Test the effect of major design and operating variables on SO2 removal for a limestone-wet scrubbing process.

1. AIR QUALITY

Description: This project consists of experiments on a coal-fired furnace connected to a scrubber pilot plant. The pilot plant comprises both a venturi-cyclone scrubber unit and a turbulent contact absorber (TCA) unit. Testing of the pilot plant will include investigating the effects of reactant type, coal type, inlet, flue gas temperature, gas- liquid contact time, scrubber type, use of ash alkalinity, and degree of CaSO3 oxidation. Results of this program will support the testing planned for the TVA, Shawnee test facility.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0595, FILTRATION OF AEROSOLS BY GRANULAR BEDS

A.M. SQUIRES, City University of New York, School of Engineering, *New York, New York* 10031

The immediate objective of the proposed research is to learn the mechanics governing the formation and retention of a filter cake of power station fly ash on a 'free' surface of a granular solid--i.e., a surface retained at substantially the angle of repose of the solid. Viewed more broadly, the objective is to understand the factors which govern the fly-ash collection efficiency of a 'panel-bed' filtration device treating power-station stack gases--i.e., a device in which the gases flow across a tall, narrow bed of granular solid retained between two parallel, vertical, perforate walls--the gases entering the bed via free surfaces on which filter cake forms. In the practical operation of such a device, the filter cake together with a small amount of the granular solid is removed periodically, thereby allowing new free surfaces to arise.

Another objective is that the research shall serve as an introduction to a program studying panel-bed filters for a variety of important dusts of industrial origin (such as iron-oxide fume and cement fines), studying the behavior of such filters at high temperatures, and studying their performance with the help of 'filter aids' (such as asbestos dust) and with granular solids carrying electrical charge.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0596, FUNDAMENTALS OF AIR CLEANING BY SORPTION PROCESSES

M.J. LOW, New York University, School of Arts, *New York, New York* 10003

Gaseous impurities in air streams may be removed by condensation processes during which the contaminant is converted to a liquid or solid and is thus removed from the air, or by solution processes, during which the contaminant is dissolved in a suitable solvent, or by gas-solid interactions causing concentration of the contaminant at the surface of a solid.

Of the methods available, the most generally useful are those involving gas-solid interactions such as physical or chemical adsorption. However, although some technological practice has become established for some aspects of air cleaning, gas-solid interactions are extremely complex, and the fundamental mechanisms involved are far from being understood.

A program of fundamental research on the mechanisms of gas-solid interactions is being carried out at New York University. Infrared spectroscopic techniques, including Fourier transform spectroscopy, are being used.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0597, REVERSIBLE METAL COMPLEXES WITH AIR POLLUTANTS

L. VASKA, Clarkson College of Technology, Graduate School, *Potsdam, New York* 13676

The principal objective of this research program is to develop economically feasible materials which would reversibly absorb some common air-polluting molecules and/or catalyze their conversion to non- volatile, harmless, and useful substances. The proposed research is based on the author's discovery of a series of metal complexes which combine reversibly with SO2, CO, NO, and a variety of related gases, and the subsequent development of a theory for the reversible activation of these molecules. Another objective is to gain insight into the physiological effects of air pollutants by using the reactions of the latter with metal complexes as model systems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0598, DUST DEPOSITION AND RETENTION

P.E. MORROW, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)49)

The capacity of the respiratory system to eliminate normal secretions, macrophages and cellular debris, also serves to remove the constant influx of airborne contaminants of the particulate type. Until the advent of radioisotopes, this capacity was not subject to quantitative examination. At present, the several cleansing mechanisms serving the respiratory system are being investigated in our laboratories by the use of special 'tagged' aerosols whose behavior can be followed by external radiation counters. This approach, which is equally suitable to laboratory animals and to man, is also being examined as a practical way for evaluating pulmonary functions previously inaccessible in intact subjects, e.g., the movement of mucus in the bronchial tree. This potentiality has important implications in the study of pulmonary disease. The general approach is capable of supplying information relevant to pneumoconioses and experimental pulmonary pathology, providing new physiological and cytological data; and contributing to an essential activity of health physics and toxicology, the evaluation of airborne hazards.

RESULTS: Clearance studies with heterodisperse and monodisperse aerosols have been conducted in normal human subjects. Results indicate that both kinds of aerosols are useful for evaluating tracheobronchial clearance. A gradient of mucociliary velocities was verified ranging from 0.1 to approximately 1.5 cm/min. The clearance pattern of a given aerosol was found suitably reproducible although complex. In subjects with pulmonary abnormalities, differences from normal clearance patterns have been revealed. Recently the external counting system has been redesigned to provide greater sensitivity and versatility for future studies.

SUPPORTED BY U.S. Atomic Energy Commission

1.0599, CONTROL TECHNIQUES FOR CHLORINE AND HYDROGEN CHLORIDE EMISSIONS

G.C. CRANE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Monitor contract and mail 1st draft to in-house and 3 review committees by February 1971. Hold review meetings with Advisory Committee and with Federal Agencies. Complete 75 percent of 1st revision by 6/71.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0600, ALKALINE ADDITIVES FOR SULFUR DIOXIDE CONTROL

D.C. DREHMEL, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Description: The reactivity of limestones, dolomites, and their derivatives with sulfur dioxide will be investgated and correlated with physical and chemical properties. The kinetics of the reaction of these materials with SO2 and their capacity for sorption of SO2 will be measured. Rate and capacity-limiting factors will be defined and mechanisms will be elucidated. Technical advice will be rendered for the full scale dry limestone injection trials.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0601, FABRIC COMPOSITION AND STRUCTURE STUDY - CHARACTERIZATION OF ABOUT 65 DIFFERENT TYPES OF FABRICS

B. EUSEBIO, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Description: One hundred twenty three (123) fabrics of varying compositions and structures will be characterized to identify and determine composition and structure effects on: Collection efficiency for fly-ash dust, ability to clean bags, residual drag and

pressure drops. Fly-ash, under controlled humidity conditions will be used as the test dust. Results should be applicable in general to dust particulates. At least half of the 123 various fabrics will be studied and characterized in FY 71.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0602, GAS CLEANING PROCESS STUDIES
L.H. GARCIA, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Description: Bench scale gas liquid contactors (i.e., batch reactor, laminar jet absorber, and packed scrubber) will be used to investigate the absorptivity of NOx and other gases in aqueous solutions and slurries. Parameters such as L/G ratos, temperature, and recycle ratios will be evaluated. Mass transfer coeffifients and their dependence on Reynolds numbers will be measured. Kinetics of the reactions will be measured, mechanisms will be defined, and factors affecting the efficiency of removal of the specific pollutant gas under investigation will be evaluated.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0603, DESIGN OF WET SCRUBBING TEST FACILITIES
D.B. HARRIS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

This task is for the design of two pilot scale test facilities for use in conducting in-house research activities at the new research facility in North Carolina. Two test systems, one for particulate control and one for odor control are to be designed. It would have maximum flexibility for unit testing and a high level of control will be maintained on test parameters to allow accurate testing and continuous monitoring of major parameters.

After completion of the design of these two test loops, they will then be installed during the last half of FY 71. Such scheduling means that the system would be available for testing at the time of relocation and research program interruption caused by the move and limited in- house personnel would be minimal, if any.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0604, PARTICULATE CONTROL STUDIES
D.B. HARRIS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Description: A program to test the characteristics of control devices as particulate collectors has been underway. At the end of 1969, an extensive period of testing was complete with the first unit during which experimental procedures were developed. This test indicated an acute need for a system to adequately redisperse the test particulate. Meanwhile, DPCE priorities had changed and the system was converted to handle the study of sulfur dioxide-limestone wet scrubbing.

A development program will begin early in FY 71 to provide a system to study the redispersion problem. Literature and manufacturers will be surveyed to identify the present practices which can be used as a base for designing a unit to meet our needs. Testing will be accomplished with new particulate characterization equipment and monitoring the success of redispersing particulates. The particulate collection study will be reactivated. A test system will be constructed to continue the study of scrubbers as particulate collectors. Testing will continue through FY 72 on four additional collect-types. Advance particle characterization units will be added to the testing program during both years.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0605, CONTROL TECHNIQUES FOR ASBESTOS EMISSIONS
R. HORRES, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Monitor contract and mail 1st draft to in-house and 4 review committees by Febraury 1971. Hold review meetings with Advisory Committee and with Federal Agencies. Complete 75 percent of 1st draft revision by 6/71.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0606, SO2 WET SCRUBBING REACTION RESEARCH
T.A. KITTLEMAN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Description: Bench scale packed scrubbers and the laminar jet absorber will be used to investigate the reactivity of squares solutions and slurries with sulfur dioxide. Effects of various L/G ratios, temperatures, and recycle rates will be evaluated. Mass transfer coefficients and their dependence on Reynolds numbers will be measured. The kinetics of the reactions and their influence on mass transfer coefficients will be studied. Mechanisms of the chemical reactions will be defined. Properties of the sorbent reactants will be determined and their effect on the sorption reaction will be evaluated.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0607, CONTROL OF COMBUSTION CHEMISTRY - KINETICS AND CATALYST
G.M. MARTIN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine feasibility of controlling, NOx SOx, particulate emissions by altering the chemistry of combustion.

Description: This project will investigate the control of emissions from oil-fired combustion systems by modification of combustion kinetics or by catalysis. Existing information of the kinetics of formation on oxides of sulfur and nitrogen will be surveyed and applicable technology explored. Correlation of various fuel composition with combustion emissions and kinetics will be determined experimentally. Based on these technologies modification, the combustion kinetics will be evaluated as a control method.

Similar review of the literature will be made to obtain information which will lead to control of emissions through catalytic effects in the combustion flame. This information will be incorporated into a control program through catalysis. As a part of this investigation, the study of the effects of proprietary fuel additives on air pollutant emissions (particulate, SOx, NOx, CO, and HC) from oil fired combustion sources, especially residual oil, will be continued. In addition, pure organometallic compounds will be tested to provide fundamental data on the effects of metallic species on combustion. The relation-ship of fuel composition to additive effectiveness will also be investigated.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0608, ODOR CONTROL RESEARCH - COMPLETE KINETICS STUDY AND INITIATE SCRUBBER DEVELOPMENT
B.N. MURTHY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Description: Simple odorous gases representing emissions from offensive industries are being treated with various reagents in a set of screening tests designed to select promising scrubbing reagents. Selected reagents will be subjected to detailed kinetic studies and a rate expression for each set based on an understanding of the reaction mechanism will be derived. Mass transfer effects and process and design variables will be studied in pilot scale test units for a set of six types of scrubbers. Optimum conditions will be used in the design of prototype units to be operated on actual industrial sites for demonstration and economic studies.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0609, APPLIED SCRUBBER RESEARCH FOR CONTROL OF SOX AND NOX
B.N. MURTHY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Description: Design data needed for the design of the prototype lime/limestone and dolomite wet scrubbing system for SOx and NOx control are to be collected in a pilot scale scrubbing test system in-house. The following factors affecting effectiveness in

removal of SOx are to be studied. a) Mass transfer in the scrubbing section; b) Hydration, dissolution and chemical reaction rates of lime/limestone and reaction products in the slurry hold tank and the scrubber; c) particle size of recycling limestone; d) Physical and chemical characteristics of the limestone used; e) Type of scrubber used.

Results from the study will be analyzed to derive the required correlations between process variables and SOx absorption efficiency.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0610, CONTROL TECHNIQUES FOR BERYLLIUM EMISSIONS
J. PEOPLES, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Monitor contract and mail 1st draft to in-house and 3 review committees by February 1971. Hold review meetings with Advisory Committee and with Federal Agencies. Complete 75 percent of 1st draft revision by 6/71.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0611, PUBLISH NATIONWIDE EVALUATION OF AEROMETRIC DATA ON A REGIONAL BASIS FOR SPECIFIC POLLUTANTS
J. REAGAN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To summarize and make available aerometric data on an air quality control regional basis.

Approach: Brief summaries of Federal and non-federal air quality, emissions and related data are compiled and presented on an air quality control regional basis of SMSA basis. Statistics are augmented by brief interpretations of data.

Goal: Publish report on sulfur dioxide and particulates and a report on total oxidants, hydrocarbons and carbon monoxide.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0612, ARGONNE NATIONAL LABORATORY INTERAGENCY AGREEMENT
D. TYLER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Under interagency agreement with the Argonne National Laboratory the following will be developed: 1. Preparation of an incident control model operations manual that is applicable to all areas of the country. Such a manual has been prepared for the City of Chicago; the task here is to make this manual applicable to all regions. 2. Develop incident control modeling techniques that can be used by the EOCC to develop abatement strategies for episode-prone areas. 3. Develope new procedures for the operation of the EOCC designed to expand and improve its operation. An operations manual will be included. 4. Develop procedures by which the EOCC will respond to accidental episode situations resulting from industrial process accidents and spills.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0613, AIR QUALITY CONTROL SERVICE
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Continuing subsequently to the adoption of each 'NAPCA standard method', NAPCA laboratories using the method will be supplied carefully standardized materials or procedures as appropriate, and then analyses will be reported for recording on control charts derivation of standard deviations and assessment of accuracy. This will be a continuing operation to provide standards and procedures by which the standard deviation and accuracy of a laboratory's analyses may be determined. NAPCA, and State and local laboratories on a voluntary basis, will be served.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0614, EVALUATE CONTROL TECHNOLOGY APPLICABLE TO MOTOR VEHICLES AND STATIONARY SOURCES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Independent evaluation of control technology applicable to motor vehicles and stationary sources in relation to the existing state-of- the-art as well as the projected state-of-the-art for the next 15-year period.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0615, COMPLETE EVALUATION OF STANDARDS FOR MOTOR VEHICLE FUEL COMPOSITION (INCLUDING ADDITIVES)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Federal legislation which provides for national emission standards restricts the Secretary's authority to the control of air pollution from motor vehicles and from Federal facilities. Federal standards, accordingly, are directed against the motor vehicle. There is considerable evidence that the control of air pollution would be furthered through the control of vehicle fuel composition and boiling point as well as additive content. Determination of the trade-offs in the effectiveness and costs between this avenue of control and direct control of emissions from the motor vehicle is required prior to requesting that Congressional authority for the control of motor fuels be given to the Secretary.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0616, COMPLETE FEASIBILITY STUDY OF EVAPORATIVE STANDARDS FOR THE MARKETING OF GASOLINE
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

HC emissions from the rate vehicles are being controlled to the point where evaporative losses associated with the marketing of gasoline may represent a significant fraction of the remaining HC emissions to the atmosphere. The cost effectiveness and control technology involved in the elimination of the source will be examined.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0617, AQCR ASSISTANCE - CONTROL STRATEGY
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Assist States in the development of the control strategy that will be used to meet the air quality standards. Such assistance will include the utilizaton of mathematical diffusion models needed to estimate reductions in pollutant emissions needed to attain ambient air quality standards.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0618, AQCR ASSISTANCE - EMERGENCY EPISODE PROCEDURES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Assist states in the development of emergency episode procedures. This will include development of alert systems and procedures for the curtailment of specific industrial process, fuel combustion and incineration sources.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0619, SOME TRANSITION METAL CHEMISTRY AND STRUCTURES OF COMPLEXES INVOLVING TWO COMMON AIR POLLUTANTS
W.A. MCALLISTER, East Carolina University, School of Arts, *Greenville, North Carolina* 27834

The broad objectives of this project are to examine various transition metal carbonyl and nitrosyl compounds for their catalytic effectiveness in reducing NO and oxidizing CO to non-toxic gases. Included in this is the search for effective catalysts at low temperature. The bonding in these catalysts will be investigated and related to the measured catalytic effectiveness. The actual reaction of interest is: 2NO plus 2CO yields N2 plus 2CO2. Since both are present in combustion products this represents a real system.

Reactions are carried out in glass reaction systems with measured amounts of catalysts over reproducible temperature ranges. Analysis of the gaseous products are accomplished using a gas chromatograph. The bonding in the metal complexes used as catalysts will be principally examined using infrared, U.V.-visible, and Raman spectroscopy. Force constants and other bonding data will be obtained through standard calculations.

The relative reaction rates and the physical bonding data will be hopefully related in an obvious manner.

SUPPORTED BY North Carolina State Government - Raleigh

1.0620, INTERACTION OF FUEL AND ENGINE FACTORS INFLUENCING EXHAUST EMISSIONS
W.F. MARSHALL, U.S. Dept. of the Interior, Bureau of Mines, *Bartlesville, Oklahoma*

Purpose: To amplify and refine information showing the dependence of exhaust composition on fuel composition and on the primary factors that control combustion; in applying these findings, to show how fuel and engine factors are manipulated to best advantage in reducing objectionable air pollutants.

Method: Continue work with multifunctional fuel additives to control engine cleanliness and combustion-system deposits. Obtain emission data using vehicles and engines with prototype low-emission systems to provide information on emission levels attainable with each of the several systems and to make a comparative study of differing fuel formulations proposed for the systems. Continue experimental research using a single-cylinder engine to study fuel as a variable in combustion.

Achievements 1969-1970: It was found that the additives studied produced no significant effect on exhaust emissions. Two additives were intended to maintain induction-system cleanliness-- a nickel alkyl phosphate and an alkylaminoalkyl phosphate-- and one additive was designed to reduce lead salt deposits in combustion chambers-- a cresyl diphenyl phosphate. Experimental work involving a single- cylinder engine using pure hydrocarbons and simple mixtures of pure hydrocarbons showed that paraffin-aromatic and olefin-aromatic mixtures as fuel produced larger quantities of several alkylbenzenes and alkenylbenzenes than was produced by the aromatic used alone as fuel. Inlet mixture temperature had little or no effect on exhaust emissions when the temperature was varied from 160 degrees to 280 degrees F.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0621, EVALUATION OF METAL OXIDES AS SORBENTS FOR SO2 IN POWER PLANT FLUE GASES
H.J. KELLY, U.S. Dept. of the Interior, Bureau of Mines, *Albany, Oregon*

Description: This effort will evaluate metal oxide sorbents as offered by industry and private or government institutions. Such sorbent evaluation is oriented to generate sorption and regeneration rate data and to test a sorbent performance under solid gas contacting conditions deemed to be appropriate for a particular sorbent. In the process of the above sorbent testing, some development work on improving chemical and/or physical sorbent characteristics is possible.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0622, EVALUATION OF METAL OXIDES AS SORBENTS FOR SO2 IN POWER PLANT GASES
J.W. TOWN, U.S. Dept. of the Interior, Bureau of Mines, *Albany, Oregon*

The objectives have been redefined to cover a wider scope of sorbent research than encompassed in previous years. The development of sorbents for the removal of SO2 from coal combustion gas will emphasize carriers impregnated with metal oxide sorbents. Sufficient kinetic information will be developed to evaluate these systems in their application to air pollution control. The work will include development of a suitable carrier, methods of impregnation, evaluation of performance in both thin-bed sorbers and regenerators and by semi- continuous fluid-bed reactors. Physical stability of the sorbent also will be measured during the sorption-regeneration cycle. An additional phase of the research will be to evaluate sorbents prepared by industry.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0623, FIELD BURNING AIR POLLUTION ABATEMENT INVESTIGATIONS
D.O. CHILCOTE, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00883)

OBJECTIVE: Develop methods of crop residue incineration which minimize the emission and effects of smoke and maintain crop production and quality standards. Investigate alternate methods to field incineration for residue removal, field sanitation, seeding preparation, and physiological stimulation of crop yields. Investigate commercial utilization of crop residues including associated problems of densification and storage.

APPROACH: Crop residues will be burned under different atmospheric conditions in the field to determine the optimum for minimal pollutant emission, favorable smoke dispersal and maximum seed yield and quality. Measurements made of burning emissions, atmospheric parameters, soil and residue moisture, and temperatures during incinerations will be related to pollutant emission and subsequent seed yield and quality, stand longevity, pest incidence and control, and herbicide and fertilizer efficiency. Alternate methods to burning for residue removal including mechanical removal techniques, propane flaming, and combinations of these will be studied. Methods of crop establishment with and without residue removal will be investigated. Commercial utilization of crop residues and methods of densification will be evaluated.

PROGRESS: Demonstrated the benefits of burning early (August) on particulate emission and subsequent grass seed crop yield. Determined the need for removal of residue from seed fields and the relative yield reduction for various species from removal methods other than burning. Demonstrated propane flaming as a promising alternative to open burning. Seed yields are comparable to open burning. Costs are much higher. Assisted in the development of a formula to predict areas which could be burned in certain areas without causing reduced air quality depending on meteorological conditions. Evaluated backfiring of fields as a means of reducing pollutant emission. Results suggest better combustion does occur. Determined thermal treatment necessary to destroy weed seeds and effects of high temperatures and the burning process on grass plants. Determined that straw can be utilized as an animal feed and in paper making and participated in tests on micro-biological transformations of straw and straw as a source of cellulose for plastics. Expanded efforts on development of a field incinerator.

SUPPORTED BY Oregon State Government

1.0624, APPLICATIONS OF CRYOGENIC TECHNIQUES TO PROBLEMS IN AIR POLLUTION
R.J. DONNELLY, Univ. of Oregon, School of Liberal Arts, *Eugene, Oregon* 97403

Preliminary studies carried out at the University of Oregon indicate cryogenic trapping is an effective means for removing low level pollutants from energy production source. Not only does the technique show promise in pollution abatement but the design of the cryogenic device permits it to be used as a monitor. As an integrating pollution meter it appears to be three orders of magnitude more sensitive than any existing commercial monitor. So far tests have shown cryogenic trapping is capable of removing sulfur dioxide, hydrogen sulfide, and methyl mercaptan. The technique is potentially capable of removing from air streams any condensable hydrocarbon. In addition to developing the cryogenic trapping device as a pollution monitor, the possibility of applying cryogenic techniques to internal combustion engine

emissions, radioactive gases from nuclear reactors, and SO2 pollutants from coal burning furnaces will be investigated.

SUPPORTED BY U.S. National Science Foundation

1.0625, REGENERATION OF CARBON ADSORBENTS FOR SO2
R.W. COUGHLIN, Lehigh University, School of Engineering, *Bethlehem, Pennsylvania* 18015

Work will be continued in testing and evaluating schemes and processes for regenerating active carbon loaded with SO2 and sulfuric acid. Various techniques using water, bases and reducing agents will be studied. In addition, work will continue in developing a mathematical model to describe the simultaneous sorption, chemical reaction and regeneration that occurs during countercurrent flow of SO2 bearing gases and aqueous solution through a sorbent bed of carbon.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0626, IMPROVEMENT OF URBAN TRANSPORTATION
UNKNOWN, Day & Zimmerman Incorporated, *Philadelphia, Pennsylvania*

A utilization study is being conducted of methods to obtain improved results from existing transportation technologies. Improvements to ameliorate air pollution, traffic congestion, transit failings, and citizens total lack of access to economical and convenient transportation are being analyzed for introduction into cities and towns.

Document provided by Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Housing & Urban Development

1.0627, THE DUST LAYER AND PRECIPITATOR EFFICIENCY
G.W. PENNEY, Carnegie Mellon University, School of Engineering, *Pittsburgh, Pennsylvania* 15213

The study relates to precipitator troubles which are associated with the layer of collected dust. It is primarily directed to two very different, but interrelated properties, adhesion of the dust, and sparkover originating in the dust layer.

The mechanism of adhesion is being studied to obtain information regarding the best means for removing the dust. Empirical methods for evaluating adhesion properties are being developed.

Tests are being made with perfectly adhering particles and compared with results using more typical dusts in order to evaluate losses due to imperfect adhesion.

In the study of sparkover, the mechanism by which the sparkover develops, and the influence of various precipitator conditions are being investigated. The relationship between sparkover voltage and circuit capacitance is being studied in order to improve the prediction of the performance of a full size precipitator from tests on a small unit.

The effects of various gases on the development of a spark are being investigated in order to predict effects of gas composition on precipitator operation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0628, SO2 SORPTION BY AND REMOVAL FROM POLYMERIC MATERIALS
R.L. ZAHRADNIK, Carnegie Mellon University, School of Engineering, *Pittsburgh, Pennsylvania* 15213

The overall objective of this project continues to be the investigation of macroreticular ion exchange resins as SO2 sorbent materials. Research during the current year has focused on the determination of the sulfur dioxide (SO2) sorption rate and capacity of a number of specific resins.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0629, REMOVAL OF SULFUR OXIDES FROM FLUE GAS
M. BERMAN, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

Selected sorbents will be studied as follows: Utilizing high angle X-ray diffraction, determine phases present in sorbents showing good activity but limited attrition resistance or those having limited activity but good resistance at stages in the preparation, sorption, and regeneration cycle.

Analyze line profiles and line broadening of the active phases to determine crystallite forms and sizes and possible phase shifts during the cycle.

Study small-angle X-ray patterns of the above sorbents to determine pore sizes and shapes as they affect sorptive capacity and sorption rates.

Investigate possible function of iron in promoting reduction of the spent sorbents. Utilize X-ray fluorescence, electron microscopy, and electron diffraction to aid in this study.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0630, ENVIRONMENTAL CONTROL RESEARCH - CONTROL TECHNIQUES DEVELOPMENT
J. CERVIK, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

The flow of gas through coalbeds is controlled by definite laws and, therefore, methods of controlling gas flow during mining naturally follows from these laws. However, before meaningful measurements can be made underground of control methods developed, equipment and apparatus to accomplish this task must be developed. Measurement of the virgin gas pressure of coalbeds requires the drilling of smooth walled, horizontal holes, 400 feet or more in length, incrementally and suitably packing the hole to measure gas pressure. Packers to accomplish this task are not suitable and are too costly. Therefore, a relatively inexpensive and reliable packer is being developed in cooperation with the rubber industry. These packers also will be used in underground experiments to determine the effects of waterflooding, and the use of unstable foams as a means of diverting the flow of gas from active face areas. The use of surface boreholes to degasify coalbeds in advance of mining is also being investigated.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0631, CHARACTERISTICS AND REMOVAL OF PYRITE FROM AMERICAN COALS
A.W. DEURBROUCK, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

The objective is to determine the degree of correlation between the removal of pyritic sulfur by conventional washing methods and the size and mode of distribution of the pyrites. Coal samples sized 1- 1/2 inch by 100 mesh, 3/8 inch by 100 mesh, and 14 mesh by 0 will be washed at specific gravities of 1.30, 1.40, and 1.60.

Atmospheric pollution by sulfur oxides originates mainly from the combustion of fossil fuels to generate heat and power. Pyritic sulfur, depending on the manner in which it is distributed in coal, can be removed substantially by conventional gravity-separation methods used in coal preparation processes.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0632, POTENTIAL SORBENTS AND CATALYSTS FOR SO2 REMOVAL FROM FLUE GASES
J.H. FIELD, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

Purpose: To develop new processes for removing sulfur oxides from flue gas by assaying materials as to their absorptive capability and subsequent regeneration characteristics. The development of a cyclic process with a salable by-product is the objective, but alternative systems using very cheap disposable absorbents will also be studied.

PART A: Emphasis will be given to investigating inexpensive minerals, ores, or waste products. Two bench-scale units, each comprising an absorber and regeneration system will be constructed. A simulated flue gas will be used. Types of material to be tested include clays, bauxites, oil shales and oil-bearing sandstones, phosphate rocks, and mineral ores.

PART B: Gaseous SO2 will be reacted with metal carbonyls (cobalt, manganese, iron) and metal complexes and the ease of formation of insertion compounds will be studied.

PART C: Spent absorbents from the most promising materials from Part A and Part B will be studied by the spectrometric group to identify products formed, and provide information to optimize development of new SO2 removal processes.

PART D: Materials from Part A which are active absorbents will be tested with gas from combustion of pulverized coal. This will require construction of a furnace burning 20-25 lbs coal/hr.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0633, REMOVAL OF SULFUR OXIDES FROM FLUE GAS

W.P. HAYNES, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

Assay of Potential Sorbents and Catalysts. Continue bench-scale assay of new materials, particularly those of low cost. Tests will be made with simulated flue gas containing 0.3 percent SO2, 0.05 percent NOx, 4 percent 02, 12 percent CO2, 6 percent H20, and the balance nitrogen. SO2 removal efficiency will be studied for these selected materials at temperatures in the range of 130 degrees to 600 degrees C and an hourly space velocity around 1050. Materials active as sorbents will be tested for thermal regeneration and by regeneration via reduction.

Sorbent Testing. Intensive tests will be made of tentative sorbents which appear to show merit for further study as a result of basic studies conducted by the spectroscopic and solid state physics groups.

Chemical stability will be studied in actual flue gasses by conducting cyclic adsorption-regeneration tests using flue gas from onsite combustion of sulfur-bearing fuel in a laboratory furnace.

In addition and if time permits, it may be desirable to design, construct, and test a bench-scale tray-type absorber in which the flue gas contacts the surface of thin layers of sorbent. The would permit the evaluation of the performance of the absorbents in a reactor that could have a low attrition loss, low pressure drop, and yet might provide ample gas-solids contact surface.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0634, VORTEX INCINERATION OF COMBUSTIBLE WASTES

C.H. SCHWARTZ, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

To conduct research on incineration. A pilot-scale vortex incinerator with a nominal capacity of 200 pounds of refuse per hour has been designed, constructed and tested. It is refractory-lined, provided with continuous charging, agitation, and has ports for directing secondary air to the center of the vortex.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0635, POTENTIAL SORBENTS AND CATALYSTS FOR SO2 REMOVAL FROM FLUE GAS--PART C

A.G. SHARKEY, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

Spectrometric Analyses of Sorbents and Sorbates - Selected sorbents will be analyzed by infrared and spectrometric methods to identify the formation of new compounds; and spectra of products from spent sorbents as well as time-temperature patterns of products from regeneration will be studied.

The effect of nitrogen oxides on the sorption of SO2 and regeneration of sorbents will be studied.

Combined differential thermal analysis-mass spectra techniques will be used to study reactions of sorbents with SO2 at selected temperatures. Temperature of reaction, weight change, and specific gases associated with the reaction will be determined simultaneously.

High-resolution mass spectrometry (direct probe technique) will be applied to study in detail all gases obtained from spent sorbents.

Survey runs of original, spent, and regenerated sorbents for SO2 will be made by electron spin resonance to search for paramagnetic species and the effect of SO2 on such species.

Low-power laser irradiation of surfaces of sorbents will be carried out to determine the concentrations of sorbed gases at the surface and to study the relative bond strengths between sorbates and catalyst.

The sorption and regeneration of sorbents will be monitored by a system constructed around a high-sensitivity mass spectrometer, to determine accurately and continuously the chemistry and physics of sorbent systems.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0636, INCLUSION ADDUCTS FOR AIR PURIFICATION

H.R. ALLCOCK, Penn. State University, School of Science, *University Park, Pennsylvania* 16802

The principal objective of this work is the synthesis and evaluation of a new series of clathrating compounds based on the cyclophosphazene system. It has recently been shown that several crystalline compounds of structure, (NPR2)3, form strong inclusion adducts with organic vapors. These materials appear to be particularly promising candidates for the removal of air pollutants from the atmosphere either in air purification equipment or in pollution testing equipment.

This project is designed to evaluate as many candidate compounds as possible, to examine the adducts by X-ray diffraction, and to determine which compounds are most suitable for this application.

Research on this project does not include human subjects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0637, SORPTION OF GASEOUS POLLUTANTS BY CYCLED OPERATION

A.J. ENGEL, Penn. State University, School of Engineering, *University Park, Pennsylvania* 16802

The combined process of absorption and adsorption of a gaseous pollutant in a slurry of a solvent and an adsorbing agent has been entitled 'sorption'. Previous studies have shown it to hold a great deal of promise for the effective removal of pollutants from gaseous emission streams. At the same time, the cyclic operation of absorption equipment has proven to be very efficient, and it appears reasonable, therefore, to attempt to merge these two techniques for (1) studying the fundamental parameters governing the sorption process and (2) determining the feasibility of operating a cycled sorption column successfully.

The proposed research will deal with the continuous sorption of sulfur dioxide in an air stream into a sorption suspension of activated carbon in water. It will be carried out in a cyclically operated sieve- place column. Ultimately, this work will be extended to simulated coal- furnace flue gases and the removal of other pollutant gases from a variety of exhaust streams.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0638, USE OF ELECTRIC FIELDS IN COMBUSTION

R.J. HEINSOHN, Penn. State University, Center for Air Env. Studies, *University Park, Pennsylvania* 16802

Electric fields have a pronounced effect on the geometry, flammability limits, heat transfer, luminosity and carbon formation of flames. While research in this country and Europe concerning this flame-field interaction is currently in progress, sufficient evidence exists to suggest that electric fields may be used to suppress pollutant production.

Electric fields may suppress pollutant production in either (or both) of two ways. The flame-field interaction might result in a direct alteration of combustion chemistry and consequently pollutant production. In addition, the interaction might result in indirect suppression by enabling the combustor to satisfactorily burn fuel oxidant mixtures in proportions which of themselves produce tolerably small pollutant amounts. It is proposed that a study of the production of carbon and nitrogen oxides in flames subjected to electrostatic fields be conducted.

1. AIR QUALITY

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0639, ENTHALPIMETRIC ANALYSIS
J. JORDAN, Penn. State University, Graduate School, *University Park, Pennsylvania* 16802

The thermodynamics of interesting acid-base, complexation and oxidation-reduction processes will be explored. Organic functional group reactions will be investigated with a view to obtaining information on thermochemical substituent effects, bond strengths and mechanisms. It is anticipated that methods developed may revolutionize organic functional group analysis. The thermochemistry of immunological reactions will be studied systematically. Concomitantly, instrumental methods of antibody-antigen analysis will be developed. Other significant areas include: accurate measurement of heats of reaction between gases and liquids and applications to gas analysis and atmospheric pollution control; endothermic-exothermic reaction sequences due to entropy effects; and micro-scale miniaturization of enthalpimetric analysis.

This research represents a continuation of that currently being supported by Foundation grant GP-11386.

SUPPORTED BY U.S. National Science Foundation

1.0640, ENGINE EMISSION REDUCTION BY COMBUSTION CONTROL
W.E. MEYER, Penn. State University, School of Engineering, *University Park, Pennsylvania* 16802

The proposed work is to supplement the research under the original grant with respect to emissions in the range of engine operating conditions which extend from normal into the knocking regime. It is particularly intended to find out if the emission picture can be generalized over a broad range of the knock intensity scale developed under the original grant. Further investigations concerning irregularity of emissions from cycle to cycle are to be carried out. Bomb experiments are proposed which are novel in that they combine sampling of gases with a microprobe near the bomb wall and observation of the sampled region with an interferometer. Through these several techniques it is hoped to show new ways to emission control and better describe the engine combustion process in terms of the conditions and processes which produce undesirable combustion products.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0641, THE BINDING AND ACTIVATION OF SMALL COVALENT MOLECULES BY TRANSITION METAL COMPLEXES
J.A. STANKO, Penn. State University, School of Science, *University Park, Pennsylvania* 16802

The research will involve chemical studies of the binding and activation of the gaseous non-metal oxides, carbon monoxide, sulfur dioxide, nitric oxide and nitrogen dioxide by transition metal complexes. The work will include both x-ray crystallographic and electronic structural studies of the complexes under investigation. The planned studies have relevance to the field of air pollution control in that they have the potential for affording new chemical means of control of such oxides in an air environment through the ability of the metal complexes to promote the chemical reactions necessary for the conversion of these oxides to less noxious substances.

SUPPORTED BY U.S. National Science Foundation

1.0642, INTERACTION OF FLUE GASES WITH CARBON SURFACES
P.L. WALKER, Penn. State University, School of Earth Sciences, *University Park, Pennsylvania* 16802

The work proposed is closely linked to the over-all objective of removal of SO2 from flue gases using carbon. We have shown that it is technically feasible to remove SO2 from flue gases at 800 degrees C by interaction with carbonaceous solids. In the process, COS and H2S are produced, as well as an activated carbon. We now propose to examine the fundamentals and kinetics of air oxidation of COS and H2S to elemental sulfur over microporous carbon surfaces at temperatures between 130-200 degrees C. The importance of metallic and oxide impurities in catalyzing the reaction will be studied by comparing the activity of commercially available active carbons (of reasonably high impurity contents) with a high purity carbon especially prepared by the activation of carbonized Saran.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0643, DEVELOPMENT OF NAVY METAL SURFACE TREATMENT PROCESSES FOR COMPLIANCE WITH POLLUTION CONTROL REGULATIONS
S.R. BROWN, U.S. Navy, Air Development Center, *Warminster, Pennsylvania* 18974

Technical Objective: Develop and evaluate metal surface treatment processes and materials in conformance with pollution regulations for application at Naval rework facilities.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0644, INVESTIGATION AND ANALYSIS OF GASES AND CRYOGENIC MATERIALS USED IN NAVAL AIRCRAFT
E.R. WRIGHT, U.S. Navy, Air Development Center, *Warminster, Pennsylvania* 18974

Technical Objective: To develop methods for the qualitative and quantitative analysis of gases and cryogenic materials, and contaminants contained therein, for which analyses have not been established. The ultimate objective is to provide gaseous systems with materials that will produce environmental operating conditions for the pilots and crew for safe and effective operation of the aircraft.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0645, REGENERABLE CHAR SORPTION PROCESS FOR SOX CONTROL
UNKNOWN, Westvaco Corporation, *Charleston, South Carolina*

Description: This effort represents a step in process development on the pilot plant scale using sorbent/regenerator capacity equivalent to some 600 cph of flue gas. Up to this stage, the process was researched and advanced privately by Westvaco. The major goal of this effort is to determine whether or not the proposed process chemistry can be effected and controlled on a continuous basis in the integrated pilot plant. Also engineering design of a 20,000 cph plant will be produced under this contract.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0646, SEPARATION AND COLLECTION OF COTTON GIN DUST
W.E. GARNER, U.S. Dept. of Agriculture, S.E. Cotton Ginning Res. Lab., *Clemson, South Carolina* 29631 (308-037-C109)

OBJECTIVE: Develop low-cost methods for unloading and conveying seed cotton and its components, and collecting and disposing of materials incident to ginning.

APPROACH: Conduct basic studies, primarily electrostatic principles, of dust and trash collection for an airstream and develop and evaluate air-wash systems suitable for gins as an alternative method for separating foreign matter from the air. Construct and test these devices on a pilot basis and analyze the type and amount of foreign matter entering and leaving the system as a means of determining their acceptability by the industry. If promising, conduct tests under commercial conditions before making final recommendations.

PROGRESS: An experimental inertial separation chamber effectively collected particulate matter discharged from the seed cotton unloading system. Injecting water spray into the chamber reduced emission to the atmosphere up to 92 percent, compared with dry operation. Plans for design and operation of the chamber were prepared. A commercial centrifugal separator effectively provided suction for unloading seed cotton from trailers, and also collected a high percentage of particulate matter from the discharged air. Discharging air from the centrifugal separator into the inertial separation chamber during wet operation controlled emission of small particles. The centrifugal separator is not suita-

ble for handling air containing fibrous material. At selected commercial gins approximately 65 percent of total connected horsepower was applicable to materials handling and collecting systems. Power consumption varied from 28 to 71 kw.-hr/bale. Tests showed that significant savings in power costs can be made by more efficient gin plant operation. In tests to determine the electrostatic force on cotton, attractive force of the positive charged plate of a capacitor was 11 to 17 dynes while the repulsive force was 1 to 3 dynes at 50 percent relative humidity and a field strength of 895 to 1075 volts/cm. This method was approximate, since drag forces was neglected.

SUPPORTED BY U.S. Dept. of Agriculture

1.0647, PILOT PLANT STUDY OF AMMONIA SCRUBBING OF POWER PLANT STACK GASES
T.M. KELSO, U.S. Tennessee Valley Auth., *Knoxville, Tennessee* 37902

Description: A slip stream (3000 SCFM) of flue gas from a coal- fired power plant will be treated in a number of different scrubber designs. Aqueous solutions of ammonia will be used as the scrubbing medium. An experimental program will be designed to determine SO2 and particulate removal efficiencies as functions of scrubber design and operating parameters. Performance data will be used to evaluate whether NAPCA should pursue development of a closed-100p, regenerable ammonia process for SO2 recovery.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0648, CONSTRUCTION AND OPERATION OF LIMESTONE-WET SCRUBBING TEST FACILITY
A.V. SLACK, U.S. Tennessee Valley Auth., *Knoxville, Tennessee* 37902

Objective: Reach the 90% completion stage in construction of test facility.

Description: TVA will construct NAPCA's limestone-wet scrubbing test facility at Shawnee Power Station according to Bechtel-furnished design and engineering and using major equipment procured by Bechtel. TVA will furnish bulk construction materials and certain specific items not supplied by Bechtel. Following construction, TVA will provide operating manpower for start-up and operation of the unit during the test program. In addition TVA will participate on the technical teams on directing the work during the test program phase.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0649, DESIGN STUDY FOR AIR FORCE ROCKET PROPULSION LAB EXHAUST GAS CLEANING SYSTEM
J. GARRETT, Aro Incorporated, *Tullahoma, Tennessee* 37389 (F40600-71-C-0002)

Technical Objective: This effort is a study to determine the most technically and economically feasible exhaust detoxification system for rocket test stands at the AFRPL and a design of a pilot system to demonstrate the performance of the system. Phase 1 will consist of investigating methods of scrubbing the exhaust gases of rockets up to 250,000 lbs thrust. Phase 2 will result in the design of a prototype scrubber system for a 5000 lb thrust rocket test stand at AFRPL.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0650, SAMPLING AND ANALYTICAL METHODS DEVELOPMENT FOR PROTOTYPE LIMESTONE - WET SCRUBBING TESTS
P.S. LOWELL, Radian Corporation, *Austin, Texas* 78758

Objective: Develop accurate and reliable sampling and analytical methods for laboratory and field use during pilot plant and prototype tests of limestone-wet scrubbing processes.

Description: Efficient conduct of the wet scrubber test program at the Shawnee test facility and planned pilot plant projects in support of this program will require adequate methods for sampling and chemical analyses of major liquid process streams. The purpose of the present study will be to evaluate, select, and adapt methods and equipment for rapid and accurate determination of the important chemical species in limestone-wet scrubber processes. The methods and equipment recommended will be based on accuracy in the presence of interfering compounds, on the need for rapid analysis, and on simplicity and reliability. The study will also include development of techniques for handling and treating samples to prevent composition changes between time of sampling and analysis.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0651, RI - ADAPTIVE MIXTURE CONTROL FOR INTERNAL COMBUSTION
J.J. ALLAN, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

Recent efforts to reduce exhaust emissions have been directed at improved combustion chamber design and more accurate fuel/air mixture control. The purpose of this work is to investigate the feasibility of taking the next logical step beyond basic feedback fuel/air mixture control systems.

Introducing adaptive control techniques into an electronic fuel injection system allows the modification of the fuel/air ratio algorithm based upon actual analysis of the exhaust gas constituents. Such a system would continuously monitor and modify performance index using analog computation. The work under this proposal would use a digital computer to begin an investigation of an adaptive algorithm that would allow such considerations as 'cold' starts and acceleration. Decreased levels of undersirable engine emissions are to be obtained while retaining engine performance.

SUPPORTED BY U.S. National Science Foundation

1.0652, AIR POLLUTION CONTROL FLUIDIZED VORTEX INCINERATION
J.P. HOLMAN, Southern Methodist University, School of Technology, *Dallas, Texas* 75222

The second year of this project will collect specific data pertaining to fluidization and swirl characteristics of a vertical vortex incinerator. Ash collection characteristics will be measured as well as localized heat transfer along the vertical length of the furnance. Shredded paper will be used for burning with propane augmentation at the inlet to the incineration. The influence of various tangential flow rates on the above parameters will be studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P H.S.

1.0653, COTTON MATERIALS HANDLING, COLLECTION, AND DISPOSAL IN THE TEXAS STRIPPER COTTON AREA
R.V. BAKER, U.S. Dept. of Agriculture, S. Plns. Cotton Gin. Res. Lab., *Lubbock, Texas* 79401 (308-035-C112)

OBJECTIVE: Develop low-cost methods for unloading and conveying seed cotton and its components, and collecting, packaging, and disposing of materials incident to ginning.

APPROACH: Investigate commercially available filter systems for possible adaptation for handling the heavy loads imposed by cleaning machine-stripped cotton. Study, adapt, and/or develop new principle of air-particulate matter separation to the ginning operation. Develop methods of handling and conveying with less power materials incident to ginning.

PROGRESS: The operating capacity of an air-belt lint feeder for a gin press was found to be 11 pounds of lint per tramper stroke. A round air filter for condenser exhausts was constructed and tested. This unit performed the same function as a standard inline air filter but was less costly to build and install. Dust losses from two types of inline air filters and a covered condenser drum were determined for several condenser locations. A pilot model seed cotton feeder for baled seed cotton was tested and found to be feasible for handling compacted masses of seed cotton.

1. AIR QUALITY

SUPPORTED BY U.S. Dept. of Agriculture

1.0654, RESEARCH ON THE REMOVAL OF NOXIOUS COMPOUNDS FROM WASTE GASES; STUDY OF POLLUTION FROM MOTOR VEHICLE EXHAUST
UNKNOWN, Ministry of Technology, *Stevenage, England, United Kingdom* (000878)

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

1.0655, NON-FERROUS SMELTER CONTROL TECHNOLOGY
UNKNOWN, Battelle Memorial Institute, *Richland, Washington* 99352

Projected study will probe the feasibility of partially oxidizing MeS, specifically, Cu ore stream for H2S production which then could be reacted with SO2 in other smelter streams for production of elemental sulfur and thus preventing emission of sulfurous gases into the atmosphere.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0656, ENGINEERING SYSTEMS FOR UTILIZATION OF HEAVY TIMBER STANDS OF THE PACIFIC COAST INCLUDING ALASKA
H.H. LYSONS, U.S. Dept. of Agriculture, Pac. Nw. For. & Rg. Expt. Sta., *Seattle, Washington* (PNW3701)

OBJECTIVE: Improve the efficiency and mechanization of materials handling and transportation systems for forestry operations in heavy timber on difficult access areas with emphasis on harvesting by aerial methods while safeguarding watershed, soil aesthetic and recreation values.

APPROACH: Develop design and performance criteria and parameters through systems analysis for logging systems for difficult access areas including Alaska. Emphasis to be given to balloon, skyline, and helicopter methods; and methods of removing and utilizing logging residues to reduce air pollution from any slash burning. Engineering systems analysis techniques will be used in the development of improved materials handling systems.

PROGRESS: A two-line mechanically-operated slack-pulling carriage has been designed for use with running skyline systems. Development of this carriage and yarding system will make it economically feasible to greatly extend yarding distances and harvest partial cuts in areas previously considered not commercially accessible. A USDA patent application is being prepared to cover this invention. A means has been developed to employ desk-top programmable calculators and plotters for skyline designs. This will provide almost instant design results where previously there was either a delay time of one to four weeks on the large central computers, or costly man-hours were consumed on tedious manual procedures.

SUPPORTED BY U.S. Dept. of Agriculture

1.0657, ODOR FORMATION IN ALKALINE PULPING
K.V. SARKANEN, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

The broad objectives of this program are to develop means of reduction or elimination of odor release from alkaline pulping processes, through a team effort in the following areas. 1. To evolve fundamental information on the formation of malodorous methyl mercaptan and dimethyl sulfide in the kraft batch and continuous pulping processes, and on the factors governing the atmospheric release of these two components together with possible other sulfur compounds during the various phases of the process. 2. To develop alternative process modifications for kraft pulping through engineering design studies, so as to avoid or minimize release of odorous compounds. 3. To explore new ways to delignify wood under alkaline conditions in order to determine whether or not an intrinsically odor-free alkaline pulping process is feasible.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0658, REMOVAL OF PYRITE FROM COAL BY DRY METHODS
W.T. ABEL, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia*

Purpose: Since pyrite contributes substantially to the sulfur content of utility coals its removal prior to burning reduces sulfur dioxide in stack gases. This program involves the selective dry grinding (ball mill and race mill) of coal-pyrite blends and coals to liberate the pyrite from the coal for subsequent removal by air classification and electrostatic separation. Work has been directed toward optimizing grinding times, presizing of the ground coal for most effective centrifugal separation and investigating variables in the electrostatic process.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0659, REMOVAL OF PYRITE FROM COAL BY DRY METHODS
W.T. ABEL, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia*

Purpose: Since pyrite contributes substantially to the sulfur content of utility coals its removal prior to burning reduces sulfur dioxide in stack gases. This program involves the selective grinding (ball mill race mill) of coal-pyrite blends and coals to liberate the pytire from the coal for subsequent removal by air classification and electrostatic separation. Work has been directed toward optimizing grinding times, presizing of the ground coal for most effective centrifugal separation and investigating variables in the electrostatic process.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0660, FLUIDIZED-BED COMBUSTION
N.H. COATES, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia*

Purpose: To investigate fluidized-bed combustion as a boiler firing technique which may offer methods for reducing the emission of pollutants from coal-fired boilers. Goals for fiscal year 1970 include investigations of 1) amenability of various coals for combustion in a fluid-bed boiler, 2) erosion, corrosion and deposition associated with heat transfer surfaces in a fluid bed, and 3) heat-transfer characteristics of a fluid-bed boiler.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0661, REDUCED SO2 IN COMBUSTION GASES
C.C. SHALE, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia*

Purpose: Conduct exploratory studies on processes for removing sulfur oxides from stack gases.

Pilot-Scale Study for Removal of SO2 from Stack Gases with Ammonia - Sulfur dioxide from the combustion of coal is a contributor to air pollution and presently is the primary target in abating air pollution from stationary power generators. Previous laboratory-scale efforts to remove SO2 from simulated stack gas by vapor-phase reactions with ammonia have been successful. Results of this work show that complete removal of SO2 from the gas phase is obtained with conversion to a solid salt using a residence time under one- half second in the vapor-phase reactor. Subsequent removal of the solid salts from the gas is obtained by water scrubbing.

After establishing operability of the process in a continuous system, data on operating characteristics will provide a broader and more significant base for determining operating costs.

SO2 Removal Using Pyrite Sorbent - Evaluate on a small scale the removal of sulfur dioxide from stack gas by reaction with metal sulfides. An immediate objective is to achieve the simultaneous conversion of sulfur dioxide to elemental sulfur and of pyrrhotite to iron oxide.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0662, STACK GAS SULFUR REMOVAL PROCESSES
C.C. SHALE, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia* 26504

Purpose: To explore (a) vapor-phase reactions of ammonia, water, and the acidic components in simulated powerplant stack gases; (b) removal of the resulting finely divided solid ammonium saltes in a water scrubber; and (c) regeneration of ammonia from the recovered salts.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0663, WET SCRUBBER STUDY - VENTURI SCRUBBER AND TURBULENT BED CONTACTOR
C.Y. WEN, West Va. University, Graduate School, *Morgantown, West Virginia* 26506

Description: Mathematical models describing the process characteristics will be developed for the venturi scrubber and turbulent bed contractor in controlling sulfur dioxide and particulate emissions. Computer simulations of process variables under a variety of operating conditions will be performed. Optimization studies will be undertaken on both performance and economic factors. Sensitivity analysis will be performed on the optimum solutions. Recommended design parameters for these units will be identified. Information generated will be an input to the prototype limestone-wet scrubbing plant to be built at the TVA facility.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0664, PROCESSING RETORTING WATERS AND GASES FOR POLLUTION CONTROL
A.B. HUBBARD, U.S. Dept. of the Interior, Bureau of Mines, *Laramie, Wyoming*

The objective of this research is to make detailed studies of waters and gases produced by various oil shale retorting processes to: (1) Determine the components having significant pollution potential, (2) define to what extent such pollutants represent valuable by-products that might be recoverable to offset waste disposal and pollution control costs and (3) provide guidance for development and demonstration of means of treating retorting waters and gases in the interest of pollution control and by-product recovery to the extent that existing technology is inadequate.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

G. MEASUREMENTS

Instrumentation, Air Pollution Monitoring, and Identification of Pollution Sources.

1.0665, A NEW DETECTOR FOR CARBON MONOXIDE IN AIR
S.A. HOENIG, Univ. of Arizona, School of Engineering, *Tucson, Arizona* 85721

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0666, LIDAR PROBING OF THE ATMOSPHERE
J.A. REAGAN, Univ. of Arizona, School of Engineering, *Tucson, Arizona* 85721

The purpose of this research is to conduct a program on the development and application of lidar as a remote atmospheric probe. The program will be carried out jointly by the Electrical Engineering Department and the Institute of Atmospheric Physics.

The experimental phase of the research will be concerned primarily with utilizing the bistatic lidar system now being constructed to obtain measurements of the intensity and polarization of angularly scattered laser light as a function of height under various meteorological conditions. Data from these measurements will be used to infer information about the sizes and concentrations of atmospheric aerosols and to determine the sensitivity of lidar to various structural features in the atmosphere.

Results from concurrent theoretical studies will be used to aid in interpreting the lidar measurements, particularly with regard to inverting to inverting lidar measurements to determine the aerosol distribution function.

The research is unique in that it will permit measurements of both intensity and polarization (the four Stokes parameters) of the angularly scattered light. This capability will provide considerably more information concerning the distribution of absorbing and scattering constituents in the atmosphere. Theoretical work indicates that this is the case.

SUPPORTED BY U.S. National Science Foundation

1.0667, NAVY ENVIRONMENT - COMPUTER CONTROL OF CHEMICAL INSTRUMENTS
G.S. WILSON, Univ. of Arizona, School of Liberal Arts, *Tucson, Arizona* 85721 (N00014-67-A-0209-0014)

Technical Objective: The Navy uses instruments such as gas chromatographs for identifying and measuring trace toxic materials in the atmospheres of closed environments, for example in submarines. It is the purpose of this research to improve the performance of such instruments by computer-aided optimization of the conditions under which the instrument operates.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0668, HIGH ALTITUDE BALLOON SAMPLING PROGRAM (PROJECT HIBAL)
J.W. HILLIER, Australian Dept. of Supply, *Mildura, Victoria, Australia* (AT(49-7)1908)

Project 'HIBAL' is a cooperative U.S. Australian effort to provide stratospheric air samples from the Southern Hemisphere. High volume balloon-borne air filter samplers are flown quarterly at altitudes of 70,000, 80,000, 90,000, and 105,000 at Mildura, Victoria, and semi- annually at Longreach, Queensland, Australia. Occasional samples are obtained at Mildura from 120,000 and 135,000 feet. Samples are forwarded to the AEC Health and Safety Laboratory in New York. Radiochemical analysis is carried out by HASL on contractor analytical laboratories under HASL management. Several fission products are analyzed routinely and at times shorter-lived and selected trace elements the Air Resources Laboratory, Environmental Science Services Administration for evaluation and interpretation as related to fallout mechanisms and to the inventory of fallout radioactivity in the stratosphere.

SUPPORTED BY U.S. Atomic Energy Commission

1.0669, STUDIES ON AEROSOLS OF SIZES DOWN TO 0.05 MICRON
O. PREINING, Univ. Wien, *Vienna, Austria*

The work mainly covers methods of aerosol sizing down to small particles: I) Aerosol spectrometers: The selectivity (resolution power) of the instruments could be increased under special operating conditions to 1:10 to minus the 3rd power. For spray-dried Dow latex Aerosols of .79 u. The selectivity was measured to 5,5.10 to minus the 3rd power.

II) Condensation nuclei counter: Investigations with the previous reported model showed that the growth rate of droplets at the beginning of growth depends on the hygroscopicity of the nuclei. To investigate further into this interesting phenomenon the automatic instrument will be completely rebuilt to permit measurements in the .1 ms time range in dependence on the expansion ratio. A new light source (laser) and a modulator with a short time constant for it will be used.

III) Photochemical aerosol production: Decomposition of H2S in N2 by UV-irradiation produces particles. Suitable conditions permit to produce S-Aerosols of a standard deviation of their Stokes-diameters of c.1o % with mean particle sizes of about 1 micron diameter.

IV) Detection of Submicron particles: An experimental cooling stage for a microscope was designed, which permits exposure

of samples of aerosol deposites to differently humidified atmospheres. First experiments with NaCl particles on varnished paper foils yielded the following: NaCl particles of .7 micron geometric diameters start to grow at a temperature of plus 16 degrees C foil temperature; such of .14 micron at 11.8 degrees C if the atmosphere (N) is saturated at 18 degrees C. A clean foil condenses particles on it at plus 7 degrees C.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0670, DEVELOPMENT OF AN IMPROVED NON-DISPERSIVE INFRARED ANALYZER FOR CARBON MONOXIDE
W. LINK, Arkon Scientific Laboratories, *Berkeley, California* 94710

The work proposed in this task element is intended to provide NAPCA with an improved NDIR CO analyzer based on fluorescent emission of carbon monoxide. This technique could serve as forerunner of a family of inexpensive instruments capable of measuring both source and ambient levels of a variety of pollutants.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0671, DEFINE AND DEVELOP UNIFORM PROCEDURES FOR MEASURING PERFORMANCE EVALUATION PROCEDURES FOR CONTINUOUS ATMOSPHERIC ANALYZERS
T.W. STANLEY, State Dept. of Pub. Health, *Berkeley, California* 94704

Define performance criteria and develop uniform and acceptable procedures for measuring these criteria. Criteria to be investigated, where practical, will include but not be limited to the following: Analyzer, pollutants measured, detector, absorber, range(s), reagents, power requirements, physical dimensions, flow diagram, reagent utilization, and an overall appraisal. The above criteria will have subcategories such as zero drift, span drift, electronic drift, reliability, readability, sensitivity, integration of output signal, lag time, response time, collection efficiency, effect of flow rate, and interference equivalents.

Representative types of continuous air analyzers for pollutants such as sulfur oxides, carbon monoxide, oxides of nitrogen, ozone and oxidants will be evaluated.

The criteria selected and procedures developed shall be consistent with a subsequent goal of defining the minimum performance specifications of analyzers. Guidelines will be established by recommendations of the SAD and the Intersociety Committee. Priorities will be established by the NAPCA and the present or anticipated issuance of Air Quality Criteria Documents and the publication of Standards in the Federal Register.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0672, A NEW INSTRUMENT FOR KINETIC STUDIES OF AIR POLLUTION
K.D. BAYES, Univ. of California, School of Letters, *Los Angeles, California* 90024

The proposed research will attempt to develop a photoionization mass spectrometer which could be applied to a wide variety of air pollution problems. The instrument should have a senstivity in the ppb range with a high selectivity for most pollutants. It is planned to use the instrument to measure the rate constants for certain reactions involving reactive intermediates, such as free radicals, NO3, O2. The instrument should also be useful for monitoring pollutants in the atmosphere, although that is not part of the proposed study.

The aim of this study would be to provide critical rate constants which are needed in computer simulation studies. Certain neglected reactions would also be studied. The more reactions and rate constants that are known experimentally, the greater the probability that such simulation studies will reflect the actual environment. Computer studies are needed to establish priorities on pollutant controls.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0673, MOLECULAR-BEAM SAMPLING FROM CYCLING-PRESSURE SOURCES
E.L. KNUTH, Univ. of California, School of Engineering, *Los Angeles, California* 90024

The objective of the proposed project is to investigate the feasibility of using molecular-beam techniques and a mass spectrometer in studies of sampling from combustion chambers of reciprocating internal-combustion engines. If such sampling studies were feasible, they would facilitate direct measurements of the composition and temperature of the gas mixture in the combustion chamber. Such information would be valuable in efforts to identify the important reaction mechanisms and in subsequent efforts to control the composition of the gases exhausted by automobile engines.

The relatively complicated problem of direct sampling from automobile engines is being approached via a series of increasing complex studies on a small motored engine. Measurements have been made on a pure gas and on three inert binary mixtures. It is proposed to make measurements now on a dissociating-recombining binary gas mixture and then on a more complicated reacting gas mixture. If feasibility of the method is demonstrated in these preliminary studies, then a proposal for sampling from combustion chambers of automobile engines would be prepared.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0674, LIDAR MEASUREMENT OF BACKSCATTER COEFFICIENT RELATED TO INFRARED EMISSIVITY OF CLOUDS
P.A. DAVIS, Stanford Research Institute, *Menlo Park, California* 94025 (003200)

Approach: The LIDAR will be mounted on an aircraft and flown over the BOMEX area during July 1969. The transmitter receiver will be a co- aligned telescope and will be fired when the range is clear and when ideal conditions exist. Information about the physical dimensions of the cirrus clouds, the relative backscatter from clouds, lidar returns from haze layer and the extent of the haze layer will be documented. Concurrent radiometric measurements will be taken and finally the lidar and IR measurements will be integrated to study the properties of the cirrus clouds. As a further comparison between experimentally measured values, particle count and size date obtained by Colorado State University on the same flights will be used to compute expected values and compared with actual measurements.

Measurements of laser backscattering from clouds were made with an infrared radiometer in the 10-12-micron band during BOMEX and during local flights from Moffett Field, California. A final report is in preparation comparing the infrared transmittace and emittance from the two devices.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

1.0675, CARBON MONOXIDE DIFFUSION MODEL
W.B. JOHNSON, Stanford Research Institute, *Menlo Park, California* 94025

Conduct field tests in San Jose, California and another city (to be selected) to measure CO concentrations and meteorology, for validating a diffusion model for predicting automotive generated pollutant (CO) concentration distribution in any urban area.

Contract sponsored jointly with Coordinating Research Council (CRC).

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0676, TECHNIQUE FOR ACID AEROSOL DETECTION AND ANALYSIS (ABBREV)
G. SAINTJOHN, Stanford Research Institute, *Menlo Park, California* 94025

The use of thin metal films for sulfuric acid aerosol analysis was previously investigated. These have advantages over existing

methods, but also some serious limitations. Stanford Research Institute has proposed the use of plastic and cellulosic films as substrates as a result of success in preliminary experiments.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0677, BIOENGINEERING ASPECTS OF AIR POLLUTION
S.K. FRIEDLANDER, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

Experimental studies on deposition in the two dimensional model lung will be extended to smaller particle sizes, in the diffusion range. New methods for measuring particle deposition and concentration employing a vibrating quartz crystal technique are being explored. Deposition studies will be extended to three dimensional lung models.

Experimental and theoretical work on the conversion of reactive gas phase pollutants to particulate form, recently initiated, will be expanded. The concept of information, adopted from communication theory, has been applied by our group to the characterization of aerosols distributed with respect to size and chemical composition. It is now being used to classify instruments used for measuring the properties of aerosols, and this work will be continued.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0678, HIGH SPEED INTERFEROMETER EXPERIMENT DEVELOPMENT
D.P. BURCHAM, U.S. Natl. Aero. & Space Adm., Jet Propulsion Laboratory, *Pasadena, California*

The high speed interferometer is a fourier spectrometer designed specifically for remote operation in a satellite or spacecraft environment. The end objective of the present instrument development program is to use the system in an earth orbiting satellite for surveying, on a global scale, the distribution of atmospheric trace constituents and pollutants. The present phase of the work is concerned with verifying the performance of the laboratory version of the instrument and gaining experience with its operation and data handling. The program during the current year will yield useful scientific data in the form of high resolution atmospheric spectra and levels of minimum detectable concentrations. The investigator shown is the Project Monitor.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0679, EVALUATION & APPLICATION OF CONVAIR IR SPECTROPHOTOMETER FOR LONGPATH ABSORPTION SPECTRA OF OXIDIZING ATMOSPHERE (WEST COAST) (ABBREV)
C. LUDWIG, General Dynamics Corporation, *San Diego, California* 92112

Development of Convair IR instrument will be completed at the time of the smog season in the West Coast. Contract scope of work will be extended to evaluate the instrument's performance in the field and obtain spectra in Los Angeles during the smog season in October under various pollutant conditions. Plans will include operating the Bendix Longpath Ozone Monitor simultaneously and also a Fourier Transform Spectrometer in cooperation with its developer, the Pomona Division of Convair.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0680, CONTINUOUS ATMOSPHERIC LEAD SAMPLER
J.M. BEECKMANS, Univ. of Western Ontario, School of Engineering, *London, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

1.0681, THE APPLICATION OF THE DIFFRACTION SIZE FREQUENCY ANALYSER TO THE ASSESSMENT OF DUST HAZARDS IN CANADIAN INDUSTRY
F.T. WHITE, Mcgill University, *Montreal, Quebec, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

1.0682, EVALUATION OF THE DEGREE OF AIR POLLUTION BY PHOTOSYNTHETIC MEASUREMENT
S. JEGIER, Univ. of Montreal, Graduate School, *Montreal, Quebec, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

1.0683, EXPERIMENTAL LASER MEASUREMENT RESEARCH
H.S. BOYNE, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Boulder, Colorado*

Objective: To investigate the measurement of laser parameters involved with new exploratory laser devices, such as fast flow CO2 lasers, pulsed atmospheric CO2 lasers, and other chemical lasers.

Approach: To design and build a facility for fast flow electric discharge lasers and for high power pulsed CO2 lasers and to investigate the properties of these lasers using various diagnostic techniques.

One possible output of this project could be the development of a convenient computer program for easy use by physical chemists and which will be able to use short excerpts of existing tables (such as JANAF tables) for thermodynamic functions in computing equilibria for pollution constituents.

A possible second output, whose importance will depend on the densities of interest in the processes studied, may be an easy to use computer program which predicts intermolecular potentials from known empirical rules, for such possible pollutants as may have thermal functions included in the JANAF tables.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0684, CONSULTATION AND ADVISORY SERVICES FOR ROCKET-BORNE CRYOGENIC WHOLE AIR SAMPLER
J. HORD, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Boulder, Colorado*

Consultation and advisory services on air-sample modifications continue on an as-needed basis. Examples are advice on the selection and placement of instrumentation, selection of construction materials for both high and low temperature service, selection of thermal insulation materials, and review of designs pertaining to fluid flow, fluid phenomena, heat transfer, and structural strength and stability.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0685, HIGH RESOLUTION IR ABSORPTION SPECTRA OF GAS POLLUTANTS AT AMBIENT CONDITIONS AND TO INCLUDE SO2, NO, NO2, NH3, HNO3, C2H4 INITIALLY
J.S. NADER, U.S. Dept. of Commerce, Wave Propagation Laboratory, *Boulder, Colorado* 80302

Basic information on the IR absorption spectra of pollutants at high resolution will be obtained from controlled laboratory experiments. A model of a simulated atmosphere and the expected spectra will be developed to correspond to an urban atmosphere containing a mixture of pollutant gases. This data will be used to analyze the empirical spectra observed in the field under various environmental conditions. It will also provide a basis for design and performance criteria of IR spectroscopic instrumentation for measurement of specific pollutants.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0686, SUB-MILLIMETER RESEARCH
UNKNOWN, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (011667)

1. AIR QUALITY

(1) Development of coherent radiation techniques in the submillimeter and infrared. (2) Development of methods for remote sensing of atmospheric components.

(1) Continue spectroscopy of H2O in the range of 550 to 650 GHz. (2) Complete Stark effect measurement and dipole moment calculation of D2O And H2O. (3) Develop dye lasers for laboratory Raman resonance studies. (4) Perform field experiments using Raman lidar to prove feasibility of water vapor profile measurement. (5) Field experiment using HCN laser to measure humidity fluctuations. (6) Laboratory search for resonance Raman effects.

(1) Generation of coherent sub-millimeter wave power at 600 GHz. (2) Measurement of 3 sub-millimeter wave water transitions near 600 GHz. (3) Laboratory measurement of water vapor content by use at 311 and 337 micron laser lines. (4) Development and publication of theorems on the Fabry-Perot resonator. (5) Lidar System Study for NESC. (6) Haswell field experiment showing passive infrared correlation of water vapor emission by crossed beam radiometers. (7) Measurement of relative Raman cross section of H2O , O2 and CO2.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0687, MEASUREMENTS FOR AIR QUALITY
B. WOODWARD, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Boulder, Colorado*

Objective: To study various scattering mechanisms to determine significant parameters such as density, size distribution, and chemical composition of particulate matter and foreign gases in the atmosphere.

Approach: The present approach is defined by three experiments (1) differential scattering and polarization experiments to determine particulate size distribution; (2) Raman scattering in an attempt to identify the constituents in an atmospheric aerosol; (3) absolute Raman cross section measurements to be used as a standard for determining concentrations of foreign gases in the atmosphere.

Outputs Expected: Publications, Improved Measurement Techniques for determining air quality parameters.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0688, DISTRIBUTION OF NITRIC ACID IN THE STRATOSPHERE
D.G. MURCRAY, Univ. of Denver, School of Arts, *Denver, Colorado* 80210

The objective of this research is to determine the distribution of HNO 3 with altitude at various times of the year in order to determine whether or not HNO 3 is a variable constituent of the atmosphere. These data are obtained by performing a series of balloon flights at various times of the year with instrumentation designed to measure the atmospheric emission due to HNO 3 as a function of altitude. It is expected that the SST flights will affect the quantity of HNO 3 in the stratosphere; thus, measurements of this quantity are being made before the occurrence of extensive SST flights.

SUPPORTED BY U.S. National Science Foundation

1.0689, ATTENUATION OF THE SOLAR BEAM BY POLLUTION IN THE BOUNDARY LAYER OF AN URBAN ATMOSPHERE
W.E. REIFSNYDER, Yale University, Graduate School, *New Haven, Connecticut* 06520

This grant is for support of measurements of the effects of the urban atmosphere on the solar radiation which is received at the earth's surface.

The experiments will investigate the loss of direct solar radiation at street level from approximately 100 meters in height in downtown New Haven, Connecticut.

Clock driven pyrheliometers with changeable filters will monitor the magnitude spectral quality and variation of the solar beam. Selected pollutants will be monitored concurrently and an attempt will be made to use solar radiation measurements as a means of monitoring pollution concentration.

SUPPORTED BY U.S. National Science Foundation

1.0690, ATTENUATION OF THE SOLAR BEAM BY POLLUTION IN THE BOUNDARY LAYER OF AN URBAN ATMOSPHERE
W E. REIFSNYDER, Yale University, School of Forestry, *New Haven, Connecticut* 06520

The problem is to describe the attenuation of direct beam solar radiation through the lowest layers of an urban atmosphere. Primarily through the processes of scatter and absorption, the intensity of the solar beam is reduced as gaseous and particulate atmospheric constituents are encountered. Solar radiation at normal incidence will be monitored by three matched pyroheliometers installed on clock-driven equatorial mounts at three elevations within urban New Haven, Connecticut. Filters will be used to break the solar spectrum into several wavebands, and the magnitude, spectral quality and temporal variability of the direct solar beam will be determined.

Several air pollutants will be monitored concomitantly with the radiation measurements; the relation between solar beam attenuation and air pollutant concentrations will then be examined. An attempt will be made to develop methods of continuously monitoring pollutant loading using measurements of solar beam attenuation in the surface layer.

SUPPORTED BY Connecticut State Government

1.0691, ANALYSIS OF CREW STATION BREATHING ATMOSPHERES
C.E. KUYATT, U.S. Dept of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Technical Objective: The analytical detection of trace gas contaminants in critical environments, such as manned missile silos and launch control centers, is continually frustrated by the need for remotely located, sensitive and stable instruments. Current technics utilize a variety of instruments; chromatography, mass and infrared spectrometry and combinations, each of which has its own vagaries and limitations. The purpose of this effort is to test and evaluate ESCA, (electron spectroscopy for chemical analysis), a new analytical tool for the combined analysis of not only major respiratory gases but also trace contaminants found in breathing gas mixtures.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0692, FEASIBILITY STUDIES TO DETERMINE THE USE OF VARIOUS MATERIALS AS STANDARD REFERENCES FOR AIR POLLUTION MEASUREMENTS
J. MARGESON, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Evaluate materials and means of generating atmospheres for use in evaluating and collaboratively testing of methods used in measuring sulfur compounds, particulates (filters, etc,), oxidants, CO , hydrocarbons, aldehydes, Pb, fluorides, and polynuclear aromatic compounds. These pollutants will be included in CPA-70-40 and NBS certification as needed by the contractor will be required to meet the needs for methods as established by the issuance of Air Quality Criteria Documents and the publication of Standards in the Federal Register. Priorities will be established by NAPCA to meet needs of the system being developed to evaluate and collaboratively test methods recommended for air pollution measurement.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0693, DETERMINE THE FEASIBILITY OF USING NO2 PERMEATION TUBES AS PRIMARY STANDARDS FOR TRACE GAS ANALYSIS
J. MARGESON, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Evaluate and establish NO2 permeation tubes as primary standards for trace analysis of nitrogen dioxide. Pursuant to this the contractor shall statistically evaluate permeation rates as in-

fluenced by environment and usable variables such as temperatures, relative humidity, storage, and hysterisis. Guidelines will be established from the analysis of previous data from a feasibility study for SO2 permeation tubes. Priorities and time schedules will be established by the NAPCA to meet requirements of the system being developed to evaluate and collaboratively test methods recommended for measuring NO2 by the SAC and the ISC. Certification of NO2 permeation tubes as standard reference materials for trace gas analysis is expected.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0694, AERONOMY AND OTHER ATMOSPHERIC STUDIES

A.E. GREEN, Univ. of Florida, School of Arts, *Gainesville, Florida* 32601

The development of photoelectric and photographic measurements of the sun's aureole will be continued to provide a simple basis for monitoring atmospheric aerosols. In particular it is proposed to expand the applicability of present methods to a wider range of atmospheric conditions, giving greater attention to multiple scattering. This might allow application of analysis to hazy or overcast days. The effect of light scattered by clouds in a otherwise clear sky will also be investigated.

Present aerosol models acould be improved considerably if a direct means of assessing aerosol structure at different altitudes were available. Passive sky brightness studies will be coordinated with (separately funded) studies under Prof. R. S. Sholtes of the Dept. of Environmental engineering at the University of Florida using an aircraft, equipped with a particle sizing-counting instrument. This research will also be coordinated with a (separately funded) program of assessing atmospheric aerosols by bistatic lidar under Prof. Gray D. Ward of the Department of Physics and Electrical Engineering. Correlation with other remote sensing techniques is also under consideration. Theoretical and experimental studies of the emission of the earth's atmosphere in the near infra-red will also be pursued.

Techniques for determining plasma transport velocity will be applied towards an extensive and systematic study of the diurnal and seasonal behavior of plasma transport including the effect of magnetically disturbed conditions.

SUPPORTED BY U.S. National Science Foundation

1.0695, MIXING DEPTH

R. MCCALDIN, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

Aircraft sampling of meteorological and air quality parameters will be made to describe synoptic scale weather features with respect to air pollution potential conditions. An evaluation of present techniques to determine mixing depth will be completed. A description of the time- space variation of pollutants suspended in a given air mass will be attempted from aerometric measurements.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0696, A NUMERICAL MODEL OF THE SEA-BREEZE CIRCULATION

J.E. GEISLER, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

It is anticipated that numerical models will become an indispensable tool in the study and control of urban air pollution. In coastal areas, a model which is intended to describe the dispersal of pollutants must also describe or reflect the sea-breeze circulation. Since such a general numerical model would be complex in other respects, the simplest possible scheme describing the sea-breeze circulation should be incorporated. An objective of the proposed research is to establish just what constitutes the simplest possible scheme. In the actual forecasting of urban pollution in a coastal area, the question of whether or not a sea breeze will flood the area on a given day is a crucial one. A further objective of the proposed research is to establish criteria which can be used to forecast when and where the sea- breeze circulation will develop and how far the sea breeze itself will penetrate inland.

The immediate objective of the proposed research is to develop a numerical model of the sea-breeze circulation. The model will be used in an effort to establish the dependence of the extent and intensity of the circulation upon the depth of the heated layer over the land; the degree of viscous drag over the land; the details of the thermal stratification of the atmosphere; and the prevailing synoptic-scale flow. As far as possible, the effects of each of these factors will be examined separately, with the explicit purpose of associating a particular type of sea-breeze circulation with a particular set of governing circumstances. Forecasting criteria will be inferred from this association, and the effect of progressively simplifying the model will be assessed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0697, ATMOSPHERIC CHEMISTRY OF BORON

R.C. HARRISS, Florida State University, School of Arts, *Tallahassee, Florida* 32306

Boron is potentially a major pollutant in the atmosphere. The few analyses available for boron in atmospheric precipitation show levels in highly traveled areas to be at least one order of magnitude higher than samples from remote locations. Because of the possible adverse biological effects of boron contamination of the atmosphere and the many potential applications of analytical data on atmospheric boron in meteorological and oceanographic studies research on the sources, distribution, and removal of boron from the atmosphere should be initiated. However, the available spectrographic and colorimetric analytical methods for boron are not suitable for the low levels of boron in atmospheric precipitation and aerosols and are too long and tedious for the large scale investigations required to elucidate the atmospheric chemistry of boron. The proposed investigation will have two specific objectives. These are: (1) To develop a specific ion electrode procedure for the analysis of boron in atmospheric precipitation and aerosol samples. The electrode when combined with preconcentration by ion exchange would be sufficiently sensitive, rapid, and relatively inexpensive. (2) To initiate studies on factors controlling the natural levels of boron in atmospheric precipitation with particular emphasis on the mechanism of transfer across the sea-air interface.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0698, USE OF SOLID-STATE DETECTORS FOR DETECTING ALPHA PARTICLE TRACKS - APPLICATION TO MEASUREMENT OF AIRBORNE CONTAMINATION

D. BLANC, Univ. De Toulouse, *Toulouse, France*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

1.0699, FIELD MEASUREMENTS OF ATMOSPHERIC TURBULENCE

P. FRENZEN, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

The structure of turbulence near the ground is being studied to develop simpler methods for measuring vertical turbulent exchanges of momentum, heat, and moisture. Turbulence mechanisms involved affect local problems such as pollutant dispersion and evaporation, while on the global scale they accomplish virtually all the atmosphere's useful energy imput and account of half the system's frictional losses. Thus, a further objective seeks to parameterize the fluxes in terms of ordinary meteorological variables to facilitate incorporation of these lower boundary conditions in numerical forecast models.

Turbulent fluctuations of wind, temperature, and humidity are recorded over uniform sites, using specially developed instrumentation. Vertical fluxes are evaluated indirectly by integration of high- frequency signal variance and directly by eddy correlation procedures. A portable digital computer has been developed to compute fluxes by both methods in real time. Because of relative insensitivity to platform motions, the indirect method is especially suited to the analysis of observations taken over large bodies of water.

1. AIR QUALITY

Results: Experiments conducted over extensive, uniform land sites in Australia and over the open sea during BOMEX have compared the methods and evaluated requisite numerical constants. Observations at sea, using an instrumented spar-buoy, have detected a marked difference in turbulent energy budgets over water as compared to those over land. Further observations over water (Lake Michigan) are being prepared.

SUPPORTED BY U.S. Atomic Energy Commission

1.0700, CONTINUOUS MEASUREMENT OF EFFECTIVE AIR POLLUTION MIXING DEPTH BY MEANS OF SOLAR RADIATION EQUIPMENT

H. MOSES, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

A technique is being developed which uses two pairs of pyrheliometers on equatorial mounts to measure the height of the aerosol layer. One pair is located on a tall building and another pair, on the ground. One pyrhelimoter of each pair has a 4000-4500 A filter and the other, a 5500-6000 angstrom units filter. Considering ratios of the solar radiation intensity recorded by combinations of the pyrheliometers, it is possible to determine the depth of the aerosol mixing layer under the assumption that the aerosols within it are approximately uniformly mixed. Variations from a uniform aerosol distribution can be handled when 3 or 4 pairs of instruments are used at various heights with the greatest height approaching 1,000 ft.

A correlation technique is also being considered involving the intersection of the fields of view of two pyranometers. One pyranometer has a conical field of view of about 1 degree which is directed upward. The second, also with a narrow field of view, is located about 1,000 to 2,000 ft. away. This pyranometer is designed to scan by changing its elevation angle so that the height of the common volume of the two intersecting fields of view varies from a level near the ground to several thousand feet above ground. The covariance between the signals recorded by the two instruments would change as the common volume passed from dirty to clean air. By noting the height at which changes occur, it should be possible to determine both the height of the aerosol mixing layer and the presence of aerosol layers above the primary ground-based layers.

Results: No measurements have been made to date. Equipment is being assembled to determine the mixing depth by the method using pairs of pyrheliometers with filter. The associated mathematics has been worked out.

SUPPORTED BY U.S. Atomic Energy Commission

1.0701, BENDIX MULTI-CHANNEL IR SPECTROPHOTOMETER DEVELOPMENT FOR LONGPATH MONITORING OF OZONE

J.S. NADER, Bendix Corporation, *South Bend, Indiana* 46620

This is a research instrument development for field utilization, designed for both longpath IR absorption spectroscopy (active mode of operation) and for remote IR emission spectroscopy (passive mode of operation). The instrument system is designed to operate by programmed instructions from built-in computer that also analyzes the spectral data collected and give a pollutant concentration readout. Programming also crrects for interfering pollutants. The instrument is capable of analyzing for any other pollutant having absorption spectra in its IR spectral range from 7 to 14 microns. However, to do so, it is necessary to have the computer programmed for the pollutant of interest. This development is designed with a computer program for measurement of ozone over a longpath. Number of channels of information collected and utilized can be arbitrarily set in the instructions to the computer to degrade performance of instrument to the minimum channel number consitent with the required accuracy of measurement required. Thus, for prototype field instrument development, optimization of design can be determined for relatively simple and inexpensive pollutant detection system.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0702, LOW LEVEL VERTICAL OZONE DETERMINED BY INVERSION OF BACKSCATTERED ULTRAVIOLET RADIATION

D.N. YARGER, Iowa State University, Graduate School, *Ames, Iowa* 50010

The purpose of this research is to develop and evaluate a practical means of determining and monitoring the vertical distribution of ozone from satellite measurements. Two methods for inverting the radiation transfer equation in order to determine the vertical distribution of ozone in the atmosphere will be investigated. Because the region of interest is below 10 mb, both multiple scattering and polarization will be considered in the numerical solution.

Numerical procedures will be used for the investigation using computers at Iowa State University and NCAR.

SUPPORTED BY U.S. National Science Foundation

1.0703, SPREADING OF LEAD IN RURAL AREAS

E.B. BUCHANAN, Univ. of Iowa, School of Arts, *Iowa City, Iowa* 52240

Trace concentrations of metallic components in suspended particulates and dustfall constitute a significant aspect of air pollution. In essentially rural areas the deposit of lead along well-travelled highways provides a unique, although neglected, opportunity for a gradient study of the degree and extent of lead pollution. This study correlated with an investigation of the absorption of lead by vegetation can serve to elucidate specific features of the life cycle of a metallic pollutant.

Studies of trace metals require analytical methods of high sensitivity. The first objective of this study, therefore, is to develop rapid, yet sensitive, analytical techniques employing (1) square wave polarography and (2) x-ray emission spectroscopy. Preliminary studies indicate that both the controlled potential square wave polarograph and the x-ray emission spectrograph have the requisite sensitivities for the determination of lead deposits along highways.

The second objective is to elaborate sampling techniques for the collection of particulate matter and vegetation. These techniques need to be related to the gradient nature of the study and to the types of instrumentation.

The third objective is to apply the above instrumentation and techniques for the determination of lead gradients in selected rural areas.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0704, THE VALUATION COEFFICIENT OWING TO ALTITUDE FOR VEHICULAR SMOKE IN TUNNELS

UNKNOWN, Express Highway Res. Found., *Tokyo, Japan*

The valuation coefficient for tunnel ventilation air volume owing to the altitude is being estimated.

Document provided by Highway Research Information Service.

SUPPORTED BY Japan Public Highway Corporation

1.0705, INSOLUBLE ION ASSOCIATION COMPOUNDS AS ANALYTICAL REAGENTS

J.L. LAMBERT, Kansas State University, Graduate School, *Manhattan, Kansas* 66502

Dr. Lambert will continue his research in chemistry on a new type of colorimetric reagent. The compounds being studied are insoluble ion association compounds in which at least one of the ions is highly colored and one is selectively reactive toward a particular ion or molecule in solution in low concentration. The reagents are compounds formed between dye cations or anions, metal complex cations or anions, or other large ions. The destruction or structural alteration of the reactive ion of the reagent releases the non-reactive colored ion into solution in direct proportion to the concentration of the substance being determined. Alternatively, chemical attack by a substance upon a colored reactive ion of an ion association reagent may expose a colored

counter ion. This effect is particularly useful in reagents for gas analysis on a cumulative basis, where color change in a dry reagent is produced. The research will consist of the development of new analytical reagents, and fundamental studies on the structures and properties of ion association compounds. Analytical methods based on these reagents are simple, and potentially sensitive and selective. They can easily be adapted to automated procedures for water and air pollution analysis.

SUPPORTED BY U.S. National Science Foundation

1.0706, NEW ANALYTICAL METHODS FOR SULFUR DIOXIDE
J.L. LAMBERT, Kansas State University, School of Arts, *Manhattan, Kansas* 66502

The objective of this research is the development of new reagents for sulfur dioxide in the concentrations normally encountered in air. We have found one class of compounds that appears to be specific for sulfur dioxide, and two compounds that react with several gases in addition to sulfur dioxide. The reaction of the compounds having specificity is reversible and releases sulfur dioxide slowly at room temperature from either the solid compound or its solution. This property has been found useful when the compound is used as a reagent on a quartz oscillator crystal. By means of the piezoelectric effect, a sampling crystal changes frequency linearly with gain in mass of the reagent compared to the frequency of a reference crystal. Concentrations below O.2 ppm sulfur dioxide have been detected by this method. The frequency change can serve as the basis for telemetry, so that signals from a number of remote sensing devices can be transmitted to a central receiving unit. The reversibility of the reagent-sulfur dioxide reaction makes the reagent self-renewing and thus would reduce maintenance on the sensing devices.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0707, THE DIRECT AND CONTINUOUS DETERMINATION OF METALS IN AIR
J.W. ROBINSON, Louisiana State University, School of Chemistry, *Baton Rouge, Louisiana* 70803

During the next twelve month period we intend to investigate the applicability of our equipment to the direct determination of mercury and cadmium in the atmosphere. Specifically, we intend to determine the analytical sensitivities of these elements and to study the effect of the chemical form of the metals in the atmosphere for possible interferences on the absorption signal. This directly affects the accuracy of the analytical method. In addition, we shall prepare calibration curves.

These problems are particularly difficult to deal with because of the very low concentrations of metals involved (10 to the minus 12th power g).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0708, SELECTIVE AND SENSITIVE METHODS FOR THE DETERMINATION OF SULFURIC ACID AEROSOLS
P.W. WEST, Louisiana State University, School of Science, *Baton Rouge, Louisiana* 70803

Dr. West will work on the development of improved methods for the determination of sulfuric acid aerosol and for sulfate particulates for application in air pollution studies. The principal effort will be directed toward the quantitative reduction of SO sub 3 to SO sub 2. The resultant sulfur dioxide will be trapped in the form of the stable sulfitodichloromercurate(II) complex and subsequently measured spactrophotometrically through the use of prosaniline hydrochloride. A secondary effort will be directed toward the complete reduction of sulfuric acid and sulfates to sulfide with subsequent conversion to methylene blue for quantitative measurement. In addition to chemical methods, electroanalytical procedures will be studied based on the development and use of ion selective sulfate electrodes.

SUPPORTED BY U.S. National Science Foundation

1.0709, USE OF SOLID STATE DETECTORS IN AIR POLLUTION RESEARCH
G.G. GUILBAULT, Louisiana State University, School of Science, *New Orleans, Louisiana* 70122

A study will be made of the use of solid state devices, such as the piezoelectric crystal and the contact potential detectors, for the detection and determination of inorganic and organic substances of importance in air pollution. Promising adsorbents will be placed as coating on the solid state devices, and each detector will be evaluated with respect to sensitivity and linearity of response, accuracy of response, speed of response, limits of detection, stability, simplicity of design and selectivity of response.

By use of these detectors with the choice of proper adsorbents, methods will be developed for the assay of HF, Osub3, SOsub2, NO, NOsub2, CO, trace metals (Pb, Ti, Ni, etc.), hydrocarbons and other atmospheric pollutants.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0710, SUBMARINE ATMOSPHERE MONITORING EQUIPMENT
N.L. HATFIELD, U.S. Navy, Ship Research & Dev. Lab., *Annapolis, Maryland* 21402

Technical Objective: To evaluate the performance of the Mark VI Atmosphere Analyzers under both laboratory and shipboard conditions. To conduct a reliability and maintainability study on this equipment. To recommend modifications, design improvements and operating procedures so as to achieve a high level of reliability and effectiveness. To investigate technological developments which may be utilized to improve atmosphere analyzer effectiveness in terms of fleet mission requirements.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0711, PORTABLE TOXIC VAPOR DETECTOR
N.L. HATFIELD, U.S. Navy, Ship Research & Dev. Lab., *Annapolis, Maryland* 21402

Technical Objective: Two prototype instruments have been built to detect leaks of missile fuel and oxidizer in shipboard missile storage compartments. The immediate objectives are to subject the instruments to: (1) a variety of controlled experiments to establish accuracy, sensitivity, response time, and susceptibility to false alarms, (2) environmental tests, such as shock, vibration and radio frequency interference; (3) tests under a realistic shipboard environment to determine reliability and effectiveness of operation.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0712, RADIO-FREQUENCY RADIATION FROM INTERSTELLAR ATOMS AND MOLECULES
B.M. ZUCKERMAN, Univ. of Maryland, Graduate School, *College Park, Maryland* 20740

The study will emphasize observations of radio-frequency spectral lines in HI and H II regions. The studies of emission from formaldehyde and other molecules will be continued as well as continuation of more general studies of dust clouds, isotopic abundance ratios, and the 2.8 degrees isotropic background radiation.

This is a continuation of work previously supported by GP-14302.

SUPPORTED BY U.S. National Science Foundation

1.0713, TRANSPORT, DEPOSITION, AND METEOROLOGICAL STUDIES OF NUCLEAR DEBRIS IN THE ATMOSPHERE
L. MACHTA, U.S. Dept. of Commerce, Air k sources Laboratory, *Silver Spring, Maryland* 20910 (AT(49-7))

The research aims at improving techniques for predicting the distribution, transport and deposition of radioactive debris in the atmosphere while simultaneously using these tracers to in-

vestigate atmospheric processes. Over the years, balloon, aircraft and surface sampling systems have provided data on various radioactive tracers resulting from nuclear testing, from other atmospheric inputs and from natural processes. These tracers have been used to construct models of the stratosphere circulation, of stratospheric-tropospheric exchange, of interhemispheric mixing and of the expected time and latitudinal distribution of the deposition of debris injected into the stratosphere. Recent French and Chinese megaton-range nuclear tests provide new information on the stratosphere and the rate of interhemispheric exchange. Tracer data is also being prepared for use in sophisticated numerical models of the atmosphere to test the validity of the model and to use the results for predictive purposes. A technique for estimating large-scale precipitation scavenging using data on the naturally produced cosmogenic radioisotopes, Ar-37, a noble gas and Be-7, a particulate, appears promising. Improvements in balloon technology and in high-altitude sampling capability continue. A molecular sieve C-14 sampler capable of obtaining CO2 samples up to 40 km is being developed and tested.

Results: Fission product ratios, used to identify French and Chinese debris, have provided new information on the structure of the Hadley cell and have suggested that the Hadley circulation extends into the stratosphere. The surface of maximum concentration of straospheric debris has been shown to slope downward from the equator to the pole, and to eventually attain similar slopes irrespective of the nature of the initial stratospheric input. The C-14 sampler is now available for operational use.

SUPPORTED BY U.S. Atomic Energy Commission

1.0714, NUMERICAL STUDY OF URBAN SCALE ATMOSPHERIC TRANSPORT
J.R. MAHONEY, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

Meteorological models appropriate for description of urban scale phenomena are developed as tools for air pollution prediction and analysis. The models require as input data distribution of pollutant emission rates and meteorological parameters (wind speeds and diffusion coefficients), and the models calculate patterns of concentrations based upon numerical integrations of advection-diffusion equations.

Specific topics considered in the research include: (1) development of appropriate mesometeorological models for the treatment of urban scale phenomena, (2) development of numerical integration techniques which are adequate approximations of the analytic equations, and (3) more accurate treatment of emission estimates in the model calculations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0715, DEVELOPMENT OF ANALYTICAL METHODS FOR AIR POLLUTION ANALYSIS
C.M. JANKOWSKI, Northeastern University, School of Liberal Arts, *Boston, Massachusetts* 02115

An investigation of methods of chemical analysis for ppb levels of CO, CO2, SO2, SO3 and selected particulates was made. Currently instrumentation design and development is being investigated for the study of background air pollution levels on Mt. Washington, N.H. The information obtained will be related to available trajectory analysis in order to develop a computer model for pollution projection.

SUPPORTED BY Northeastern University

1.0716, APPLICATION OF SOLID STATE DIODE LASERS TO VERY HIGH RESOLUTION SPECTROSCOPY OF GAS POLLUTANTS - SO2, CH2O, O3
J.S. NADER, Mass. Inst. of Technology, Lincoln Laboratory, *Cambridge, Massachusetts* 02139

Tunable IR diode lasers have been developed and offer resolution capabilities in excess of 10 to the 4th power times that of present high resolution dispersive and interferometric techniques. Tunability is limited to small region of central wavelength and diode lasers can be made only for the 7-14 micron IR window. Nonetheless, the capability offers a means of obtaining spectra and basic information on line broadening parameters due to pressure and temperature effects most effectively.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0717, STUDIES PREPARATORY TO GLOBAL ENVIRONMENTAL MONITORING
UNKNOWN, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139

For support of studies preparatory to global environmental monitoring. The grant to MIT will partially support a four-week summer study by forty scientists and other professionals who will preview procedures for understanding, monitoring, and abating pollution of the earth's air and water in preparation for 1972 United National Conference on the Human Environment.

SUPPORTED BY Ford Foundation - New York, N.Y.

1.0718, FEASIBILITY OF RAMAN SCATTER TECHNIQUE FOR REMOTE MONITORING OF NO AND SO2 IN STACK EMISSIONS
D. LEONARD, Avco Corporation, *Everett, Massachusetts*

A two phase study is underway to determine if Raman scatter technique is feasible for remote sensing of NO and SO2 in power plant stack emissions. It is aimed primarily at NO detection since IR techniques are not presently applicable due to the presence of water vapor as an interference. The method also lends itself to SO2 measurement which, however, can be measured by IR methods. The first phase is a laboratory study to determine Raman scatter cross-sections. The second phase is to assess the feasibility of the method with a breadboarded instrument system in the field under environmental conditions of actual power plant plumes. Results will be the basis of design and performance criteria to be set up for the development of a prototype instrument assuming the feasibility is within the current state-of-the-art in laser technology and Raman scatter detection.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0719, ENGINE EXHAUST EMISSIONS MEASUREMENT SYSTEM
D.A. LEONARD, Avco Corporation, *Everett, Massachusetts* (F33615-71-C-1875)

Technical Objective: Develop a system based on laser raman spectroscopy for simple, real time, non-interference measurement of carbon monoxide, carbon dioxide, oxides of nitrogen, organic and other exhaust emissions from aircraft gas turbine engines. Program is to produce an engineering prototype as a technology feasibility demonstrator.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0720, CONTINUOUS CHROMATOGRAPHIC MONITORING OF GAS STREAMS
M.V. SUSSMAN, Tufts University, School of Engineering, *Medford, Massachusetts* 02155

A new gas chromatography technique which permits continuous introduction of mixtures and simultaneous continuous withdrawal of purified fractions and which uses no packing has recently been demonstrated by the principal investigator. The technique has high capacity and fractional second response. Potentially it can monitor air or waste gas streams, both detect and isolate air pollutants.

An investigation aimed at adapting this technique to monitoring of gas streams for air pollutants is under way.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0721, KRYPTONATE-BASED INSTRUMENTATION DEVELOPMENT FOR AUTOMOBILE EXHAUST POLLUTANTS
P. GOODMAN, Panametrics Incorporated, *Waltham, Massachusetts* 02154 (AT(30-1)-4069)

Instrumentation for the analysis of automobile exhaust pollutant concentrations is required for a number of purposes, important among which is the determination of the efficiency of operation of installed emission control devices, i.e., an inspection function. Among the deficiencies of instrumentations currently in use is the fact that they are derivatives of instrumentations currently in use is the fact that they are derivatives of sophisticated laboratory-type instruments and consequently require trained personnel for operation. A program is in progress whose ultimate objective is the development of an instrument utilizing kryptonates for automobile exhaust pollutant analysis. Such an instrument would utilize a single principle for the detection of carbon monoxide, hydrocarbon and nitrous oxides and could be employed by service-type personnel during periodic or random inspection.

A second phase of this development program has recently been initiated which will involve construction of a breadboard instrument, optimization of instrumental design parameters, characterization and calibration of the instrument and testing of the instrument during field operation.

Results: An initial feasibility study of this instrumental concept has been completed. Shown in a laboratory test system was the capability for detection of 125 ppm of CO by means of a Pd c1 2 kryptonate and 2 ppm of nitrous oxide by means of a hydrogen clatrate. Hydrocarbons were detected by a Pt O2 kryptonate at the 13 ppm level for propane but with a sensitivity which increased with the hydro-carbon molecular weight. Detection thresholds are considerably below projected future national emission standards for automobile exhaust pollutant emissions. Interferences were absent.

SUPPORTED BY U.S. Atomic Energy Commission

1.0722, GAS CHROMATOGRAPHY AND AIR POLLUTION CONTROL
Y.H. MA, Worcester Polytechnic Inst., School of Engineering, *Worcester, Massachusetts* 01609

Since both adsorption of pollutants to harmless or readily absorbed forms are two methods proposed for control of pollution, and since the adsorption isotherms and effective diffusivities are primary factors for these processes, a rapid and simple technique for their determination would be of inestimable valuable. The proposed method of gas chromatography in obtaining simultaneously the adsorption and diffusion data is potentially much more rapid and the necessary equipment simpler than those currently in use. It should be emphasize that combining two measurementr in a single piece of equipment has not been attempted previously. It should also be emphasized that by its very nature the proposed method of measurements involves the competitive adsorption of the carrier gas and the adsorbate (pollutant) and the adsorbate concentration is small. Accurate data for such conditions are difficult to obtain by the usual vacuum technique and extremely important for pollution control.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0723, ANALYSIS OF QUARTZ AND OTHER MINERALS IN DUSTS BY DTA
E.A. BOETTNER, Univ of Michigan, School of Public Health, *Ann Arbor, Michigan* 48104

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0724, DIESEL IGNITION AND COMBUSTION ENGINE RESEARCH
J. BOLT, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan* 48104 (DAAE07)

Technical Objective: Research objective is to obtain basic information concerning critical parameters and durability on the combustion process under high temperature operating conditions. Areas of greatest interest are ignition delay, exhaust gas pollutant measurements and emission tests.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0725, THEORETICAL INVESTIGATION OF INFRARED RADIATIVE TRANSFER
S.R. DRAYSON, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106 (011742)

Progress: Detailed spectra of the CO2 15 band are being obtained at the Willow Run Laboratory of the University of Michigan with a resolution of about .06 cm super minus 1. From these spectra a table of line positions is being prepared and often shows significant departure from previously accepted measurements. Spectra of CO2 isotopes common in the atmosphere are also being evaluated. This data will be incorporated in future calculations of atmospheric transmittance.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0726, ADAPTATION OF OXIDES OF NITROGEN ANALYTICAL METHOD TO LIGHT DUTY VEHICLE EXHAUST EMISSION PROCEDURE
G. CAHILL, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ypsilanti, Michigan* 48197

Total nitrogen oxides instrumentation recommended by BEPS will be evaluated to determine its compatability with the 1972 Federal Test Procedure. Tests to determine correlation with the current California NQx test procedure will be run on uncontrolled vehicles. A draft of proposed regulations will be prepared.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0727, DEVELOPMENT OF PARTICULATE EMISSION PROCEDURE
R.E. KRUSE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ypsilanti, Michigan* 48197

Preliminary tests will be performed to determine the best sample point on a constant volume sampler and its acceptability by comparison to a total particulate sampling method. The need for specific vehicle preconditioning and the effect of exhaust system age will be investigated. A procedure compatible with the 1972 test procedure will be developed.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0728, COLD START SURVEILLANCE TESTS OF NEW VEHICLES
R.W. OLSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ypsilanti, Michigan* 48197

Conduct (1) cold-start surveillance tests of new vehicles to determine exhaust emissions differences between 'green' vehicles and 'broken-in' vehicles; (2) inspection tests on selected vehicles; (3) smokemeter tests on heavy-duty diesel trucks at idle and free-acceleration conditions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0729, CONDUCT EMISSION TESTS ON DEVICES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Ypsilanti, Michigan* 48197

Conduct emission tests on devices, engines, and vehicles to determine the ability to meet 1972, 75 or 1980 standards depending upon the contractual requirements. These evaluations require repetitive testing and in some cases they require adaptation of existing equipment and analytical methods to unique power sources.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0730, STUDY THE LEVELS OF POLYCYCLIC HYDROCARBONS IN AN URBAN ATMOSPHERE
UNKNOWN, Univ. of Minnesota, Graduate School, *Minneapolis, Minnesota* 55455 (NIH-70-2058)

Independently, and not as an agent of the Government, the Contractor will exert its best efforts to design and construct an air

sampler for the chemical detection of polycyclic hydrocarbons in the urban atmosphere. More, specifically, the Contractor shall: 1. Review literature concerning air sampler design and chemical detection of polycyclic hydrocarbons. 2. Design and construct an air sampler. 3. Determine the aerosol characteristics of an air sampler along with the efficiency in controlled atmosphere. 4. Evaluate the sampler's performance under ambient sampling conditions. 5. Set up atmospheric sampling program. 6. Maintain weather equipment so that weather information is available. 7. Develop chemical detection procedures. 8. Develop standards for quantitative chemical analysis. 9. Collect samples according to predetermined plan. 10. Analyze samples for polycyclic hydrocarbons present. 11. Analyze and correlate data.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0731, GENERATION AND DECAY OF SMALL IONS
K.T. WHITBY, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414

During the 71-72 project year the Minnesota Aerosol Analyzing System will be used by Mr. W.E. Clark to measure the changing aerosol size distributions and concentrations of aerosols produced by the photochemical oxidation of SO2. The MAAS will permit Mr. Clark to follow the aerosol from initial formation to sizes in the micron range produced by coagulation and condensation after several hours.

Mr. H. Hansen will use the MAAS to study the condensation and evaporation of water on submicron artificial and atmospheric aerosols.

Work will continue on the development of an aircraft and auto portable MAAS consisting of a Bausch & Lomb optical counter and a new small electrical aerosol analyzer currently being developed. This portable system will make possible the real time measurement of aerosols in 8 size ranges between O.OO7 and 15 microns.

During the early part of the project year Mr. R.B. Husar will finish his theoretical and experimental work on the coagulation Knudsen aerosols.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0732, AEROSOL MEASUREMENTS IN LOS ANGELES SMOG
K.T. WHITBY, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414

As of December, 1969, it now appears highly desirable to continue this project at a low level for two more years.

There are four main obectives for the work to be performed during the next two years. These are: 1. Completion of the data analysis and the proper reporting of this data through reports and papers. It should be noted that the chemical analysis being performed by Dr. Mueller will probably not be completed until the end of 1970. 2. The carrying out of a few supplementary laboratory experiments to provide data useful in the interpretation of the Los Angeles data. These will consist mostly of coagulation experiments with small aerosols under conditions designed to simulate the distributions observed in Los Angeles. 3. The principal investigators in the Los Angeles project, that is Dr. Friedlander, Dr. Hidy, Dr. Mueller, and Dr. Charlson, as well as others such as Dr. Jim Friend of New York University and Dr. Christian Junge of Germany, have all expressed an interest in participating in a further project of this sort to be carried out perhaps in 1972 or 1973. A portion of the time during the second year would be used to study the where, when, and how of such a project. If a decision is made to perform such a project, a separate proposal for it would be submitted. 4. After the humidity control system for the MAAS is developed and operating, we are planning on using the MAAS and the Lundgren impactor to make some further measurements of urban aerosol in Minneapolis, mostly as a means of exercising the new techniques in preparation for any larger project which may follow.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0733, CONTINUOUS PARTICULATE MONITORS FOR FOSSIL FUEL COMBUSTION SOURCES
G. SEM, Thermo Systems Incorporated, *Saint Paul, Minnesota* 55413

Objective: Completion of research program development and initiation of laboratory studies.

Description: Evaluation of the technical literature and critical review of instrument techniques for applicable techniques to be incorporated in two state-of-the-art reports. One report will be devoted to mass flow techniques and one report for size distribution - number average techniques. The best technique for mass flow measurement will be incorporated in the fabrication of a prototype device. Characterization of fossil fuel emission factors will be acquired as needed to determine instrument specifications.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0734, THE CLIMATIC RESOURCES OF THE NORTH CENTRAL REGION
D.G. BAKER, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-25-064)

OBJECTIVE: One objective is to quantitatively characterize the climate of this region for agriculture. The second objective is to delineate the atmospheric conditions conducive to air pollution.

APPROACH: The approach to the first objective will initially be directed toward the climatology of solar radiation. Spatial distribution of radiation will be obtained by analysis of the 19 radiation stations as a regional unit. Temporal distribution of radiation will be determined by the calculation of probabilities of radiation amounts received during each climatological week at the 19 stations. Work done earlier on derived climatic quantities such as growing degree days will be modified to better meet present requirements. The second objective will be dealt with principally by analyzing a special local site which provides meteorological data that will give a 3-dimensional picture of the atmosphere.

PROGRESS: The 2 manuscripts awaiting approval at this time last year have now been published. A third publication is being prepared which will contain information gleaned from the previous publications and the original data. Such things as the frequency of clear and overcast days at each station, probability of receiving given amounts of radiation, the regional distribution of atmospheric transmissivity, and other items will be carried.

SUPPORTED BY U.S. Dept. of Agriculture

1.0735, DETECTION AND ANALYSIS OF PARTICULATE AIR POLLUTION
R.L. REISBIG, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

Urban areas in America are at this moment being blanketed by clouds of man-made as well as natural dust and gaseous materials. The present effect of this pollution on human health is well established. The future effect of air pollution on the delicate thermal balance of the earth's atmosphere may destroy life as we know it today.

There is a need for accurate and reliable instrumentation to measure the concentration of dust. An instrument of this type might be used to monitor fly-ash in the stack gas from a coal burning power plant. Coal fired steam generators employing highly efficient dust arresting equipment must be controlled so that combustion products do not violate air pollution laws. There is presently no effective means for monitoring fly-ash concentrations in smoke stack gas. An instrument of this type could also be used to measure atmosphere pollution caused by dust and gaseous materials. Municipal governments need reliable scientific methods for determining when local air pollution codes are being violated.

The primary objective of the program will be the analytical and experimental evaluation of the radiative extinction properties of a two component system composed of non-reactive dust and air. Preliminary anaysis and experiments indicate that informa-

tion of this type can lead to instrumentation badly needed in the field of air pollution control.

SUPPORTED BY University of Missouri

1.0736, DEVELOPMENT OF ANALYTICAL TECHNIQUES BASED ON HOMOGENEOUS GAS PHASE LUMINESCENT REACTIONS
UNKNOWN, Monsanto Company, *Saint Louis, Missouri* 63166

Active inhouse and contractual research has led to the partial development of several gas phase chemiluminescent reaction devices, capable of measuring SO2, CO, oxides of nitrogen, singlet oxygen and ozone. Continued research in this area will provide working prototype analyzers for evaluation and comparison with classical methods of measuring these pollutants.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0737, ATOMIC ABSORPTION SPECTROSCOPY WITH A HIGH TEMPERATURE FURNACE
R. WOODRIFF, Montana State University, Graduate School, *Bozeman, Montana* 59715

Dr. Woodriff will continue his basic research on the development of atomic absorption spectroscopy using high temperature furnaces as a method for trace chemical analysis. To help eliminate problems with blanks and to remove more rapidly and completely the sample from the tube, a new furnace will be built which keeps the tube hot throughout its entire length. In addition, an attempt will be made to cause the plasma to give off sufficiently intense emission spectrum to allow the furnace to be used for simultaneous multi-element determinations. In addition to this basic research Dr. Woodriff will apply this new analytical method to important pollution problems. For example, the method is ideal for analysis of silver iodide in snowfall released by cloud seeding. If a sensitive procedure can be developed in this case, it also will be applied to monitoring air for other particulate contaminants. Finally these element contents of various water supplies in Montana will be determined, and attempts made to correlate results with statewide records of livestock deaths possessed by the Veterinary Department at Montana State University.

SUPPORTED BY U.S. National Science Foundation

1.0738, ESSO - INSTRUMENTATION PLAN DEVELOPMENT
R. BERTRAND, Standard Oil Co. of New Jersey, *Linden, New Jersey* 07036

This project will culminate in FY 1971 with a NAPCA 5-year R/D plan for air pollution instrumentation and related analytical techniques. The scope of the study encompasses a market analysis, needs assessment emphasizing the Federal Government sector and the delineation of an R/D plan to fill gaps. Movies are needed in FY 1971 for two modifications to support a NAPCA instrumentation task force and to reflect decisions of the task force in the final plan.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0739, ANALYTICAL METHODS FOR AROMATICS IN AUTO EXHAUST
E. SAWICKI, Standard Oil Co. of New Jersey, *Linden, New Jersey* 07036

Development of rapid methods of analysis for trace quantities of benzo(a) pyrene, polynuclear aromatic hydrocarbons, phenols, and related aromatic substances in automobile exhaust, with particular attention directed to carcinogens and co-carcinogens. By end of contract year hope to have a GC method for BaP plus a GC method for 6-12 polynuclear arenes.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0740, MONITOR LIGHT DUTY MOTOR VEHICLE EXHAUST EMISSIONS INSPECTION GRANT PROGRAMS
UNKNOWN, State Dept. of Health, *Trenton, New Jersey* 08618

Pilot exhaust emissions inspection programs will be conducted in Washington, D. C. by the Division of Motor Vehicles and Department of Public Health, and by the New Jersey State Department of Health. Data generated using a variety of inspection equipment, methods of inspection, and pass-fail criteria will be analyzed, as a related task, using automatic data processing equipment and appropriate statistical techniques to determine the optimum methods and types of equipment to be recommended in a uniform State inspection code.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0741, CONTROLLED CONVERSION OF GASES INTO DETECTABLE PARTICLES
V.A. MOHNEN, State University of New York, Atmospheric Sciences Res. Ctr., *Albany, New York* 12203

Establish the rate of particle formation from gas phase reactions under a variety of experimental conditions and for a variety of gases and gas mixtures. The particle formation is initiated by photochemical reactions as well as by ion-molecule reactions. This information is used to develop systems for the detection of trace gases by means of gas-to-particle conversion. Such a system consists principally of a converter and a small particle counter (Wilson type cloud chamber with expansion cycle). Special attention is devoted to the utilization of this technique as a new detection system in gas chromatography. The results of this research can be directly applied to gas-to-particle conversion that takes place in urban atmospheres as well as on a global scale (gas-to-particle conversion represents an important sink reaction of various atmospheric gases).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0742, INFRARED REMOTE SENSING OF AIR POLLUTANTS AND FOREST FIRES
S.H. CHAN, New York University, School of Engineering, *New York, New York* 10453

A combined theoretical and experimental program is proposed to monitor air pollutants and to detect forest fires by infrared remote sensing. The theoretical program will include a systematic analysis of the fundamental radiation transport through the nonhomogeneous, intervening atmosphere between a sensor and the object of interest, while the experimental program will employ a unique multiple-scan interferometer and a highly sensitive radiometer to provide data for use in conjunction with the theoretical work. The result of the present study will not only provide solutions which can be used to determine the concentration of gaseous pollutants and to effectively detect forest fires from the radiance measurement of a remote sensor, but also will provide the means for optimizing existing or future sensor performance.

SUPPORTED BY U.S. National Science Foundation

1.0743, SAE COMMITTEE ON DIESEL AND AIRCRAFT GAS TURBINE EMISSIONS MEASUREMENTS
UNKNOWN, Soc. of Automotive Engrs. Inc., *New York, New York*

Participate in joint activities with aircraft operators, powerplant manufacturers and other government agencies or development of acceptable methods for sampling and characterizing emissions from aircraft and design vehicles.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0744, RADIONUCLIDES IN STRATOSPHERIC AIR
E.P. HARDY, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

The sampling and analysis of stratospheric air involves two separate programs: A. Project Airstream is HASL's study of radioactivity in the lower stratosphere employing RB-57F aircraft. The missions are scheduled for early February, May, August, and November, and cover from 75 degrees N to 51 degrees S latitude in the Western Hemisphere. Air filter samples are collected from 12 to 19 km altitude. B. The High Altitude Balloon

Sampling Program uses balloon-borne filtering devices to collect nuclear debris at altitudes from 24-41 km. Balloon launches are conducted quarterly at 44 degrees N, 9 degrees N, 34 degrees S and semi-annually at 64 degrees N and 22 degrees S. Bi- monthly launches are made at 31 degrees N.

Selected filters from both projects are analyzed for Fe-55, Sr-89, Sr-90, Zr-95, Cs-137, Ce-144, Pu-238 and Pu-239, 240. These programs document concentrations of natural and artificial radionuclides in the stratosphere, establish the seasonal trends as a function of latitude and altitude, determine the removal rates of fission products from the stratosphere, and provide data to test existing models of atmospheric transport, to improve these models or develop new ones.

Results: By January 1, 1969, there were 330 kCi Sr-90 in the world stratosphere with roughly 2/3 in the northern hemisphere. By January 1, 1970, the northern hemisphere contained 250 kCi of Sr-90 and the southern hemisphere 57 kCi. The HASL model of atmospheric transport has been used successfully to compute the seasonal fallout in the northern hemisphere from the 1961-62 tests, but it is less effective in the southern hemisphere. Additional studies are planned to make the model latitude sensitive.

SUPPORTED BY U.S. Atomic Energy Commission

1.0745, RADIOACTIVITY AND TRACE ELEMENTS IN SURFACE AIR

H.L. VOLCHOK, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

The HASL surface air sampling program provides data on the latitudinal distribution of nuclear debris, arrival times of fresh debris, interhemispheric transfer, and differences in air concentrations over land and ocean bodies. Weekly surface air samples are collected at 17 stations approximately along the 80th meridian (west) from 86 degrees N to the South Pole and also at Hawaii and Easter Island. All surface air filters are composited on a monthly basis. One fraction is analyzed for Sr-90, Zr-95, Cs-137, Ce-144, Pu-238, Pu-239, 240, and stable Pb, while total gamma activity and gamma spectrum are measured on another, which is then stored for future reference. This project was started at HASL in January 1963, and is a direct outgrowth of a program initiated by the U.S. Naval Research Laboratory in 1957 and continued through 1962.

Results: An empirical relationship between the monthly average hemispheric surface air concentration of Sr-90 and the amount deposited has been developed. On the average, for every dpm per 1000 cubic meters in northern hemispheric surface air, 3.3 kCi, and in the southern hemisphere, 5.0 kCi, are deposited on ground. With these factors, the global deposition of any 'stratospheric fallout' radionuclide can be estimated, from a small number of surface air measurements.

SUPPORTED BY U.S. Atomic Energy Commission

1.0746, EXTENSION OF CAPABILITY OF AUTOMATED CHROMATOGRAPHIC ANALYZER TO MEASURE ACETYLENE AND ETHYLENE

UNKNOWN, Union Carbide Corporation, *New York, New York* 10017

For the past year, evaluation of an automated carbon monoxide and methane analyzer has demonstrated the practicality of utilizing gas chromatographs as routine air monitors. The proposed work in this element is to extend gas chromatographic techniques to include acetylene and ethylene as indicators of the contribution of vehicular exhaust emissions to air quality with respect to hydrocarbons.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0747, MEASUREMENT OF OZONE CONCENTRATIONS IN THE ATMOSPHERE

E.R. ALTWICKER, Rensselaer Polytechnic Inst., School of Engineering, *Troy, New York* 12181

I am interested in studying chemical reactions which take place in the atmosphere as a result of certain pollutants present in the atmosphere. In the case of the interaction of ozone with hydrocarbons, the objective would not only be to study these reactions themselves but to explore further the possibility of utilizing one of these reactions for the determination of ozone concentrations in the atmosphere. Furthermore, I am interested in the development of simple devices, such as polymer films, which might be utilized to measure specific pollutants.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0748, PREPARE AND PUBLISH ANALYTICAL REPORTS ON AEROMETRIC DATA

G. AKLAND, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To analyze in depth the trends and interactions of aerometric parameters and publish findings from these analyses.

Approach: Data will be analyzed for trends and cross interaction characteristics by using statistical techniques. Statistical checks will be used to confirm heuristical constructions involving multiple parameters.

Goal: Publish a journal of interpretive papers on high volume sampling precision, frequency of sampling, etc. and reports on backgrounds and trends in metals, 1957-1965 national air quality trends.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0749, PUBLISH REPORTS ON DEVELOPMENTS IN AEROMETRIC DATA ANALYSIS METHODS

G. AKLAND, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To inform Federal, State and local agencies on latest techniques of analyzing aerometric data.

Approach: Analysis techniques developed by DAQED as part of other projects will be described and published.

Goal: Papers on trends analysis of air quality data and automation of laboratory instrumentation will be prepared and published.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0750, PUBLISH BASIC AIR QUALITY DATA

G. AKLAND, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To summarize and disseminate basic air quality data.

Approach: Information in the National Aerometric Data Bank will be summarized in terms of averages and frequency distributions and published as annual air quality data reports. These reports will present data with a minimum of interpretation in order to disseminate them without delay.

Goal: Publish 1967 Air Quality Data and 1968 Air Quality Data and prepare for publication 1969 Air Quality Data and 1969 CAMP Data.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0751, FIELD PERFORMANCE EVALUATION AND APPLICATION OF BENDIX OZONE MONITOR TO SMOG ATMOSPHERE IN LOS ANGELES

H.M. BARNES, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Delivery of Bendix Ozone Monitor is expected by July or August. This will permit plans to conduct field performance evaluation and application during smog season in Los Angeles in September and October and in conjunction with planned field application of the Convair instrument at same time and location.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0752, START OF FIELD STUDY OF IR EMISSION SPECTRA FROM SO2 IN POWER PLANT PLUMES

H.M. BARNES, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Several research instruments capable of remote sensing of IR emission of pollutant stack gases will be available, Bendix multi-

channel spectrophotometer and Convair continuous scanning spectrophotometer. These will be used in the field to assess the IR emission spectra of SO2 and interfering gases from power plant plumes under various plant operations and environmental conditions. Data from this study will be used to establish design and performance criteria for the development of a prototype field instrument for remote monitoring of SO2 emissions by IR emission spectroscopy.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0753, DEFINITION AND ANALYSES OF HIGHER MOLECULAR WEIGHT ALDEHYDES
T.A. BELLAR, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

To create the analytical methodology to analyze higher molecular weight aldehydes. These aldehydes have defied a general analysis but in specific cases have been shown to have extremely high toxicological potential, i.e., benzaldehyde yields peroxybenyl nitrate. Therefore, the definition of the amounts produced and their method of production is critical. Analytical methodology must be developed to analyze automotive and other combustion sources for aldehydes, particularly aromatics of seven carbons and higher. Current technology only extends through eight carbons (DNPH) and does not perform adequately in this application. This information is desperately needed to answer public charges on eye irritation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0754, BIRMINGHAM SOILING STUDY
N. BELOIN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To support in-house building material soiling study with particulate level.

Approach: To take suspended particulate measurements by Hi-Vol every sixth day and dust fall measurements monthly.

Goal: To determine the particulate levels at three exposure sites in Birmingham, Alabama in order to correlate with soiling data.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0755, PROVIDE TECHNICAL ASSISTANCE TO STATE AND LOCAL AIR POLLUTION GROUPS IN THE OPERATION OF FIELD MONITORING EQUIPMENT
J. BRYANT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: The instrumentation and field evaluation unit of DAQED will provide information to any State or local air pollution agency on pollutant sensors both old and new.

Approach: Telephone and written communications as well as personal visits will be used to convey operating instruction and evaluation reports from on site evaluation of commercial instruments.

Goal: Provide information on some 5 new continuous air monitoring instruments that have been evaluated to requesting agencies. In addition, technical operating and maintenance assistance will be provided on prototype samples such as the NASN modified cascade impactor and a third-generation gas bubbler apparatus under development.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0756, PROVIDE TECHNICAL ASSISTANCE TO STATE AND LOCAL AGENCIES IN AIR QUALITY SURVEILLANCE ACTIVITIES
J. BRYANT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Provide non-federal agencies with information on calibration procedures sampling methods, data handling, and other guidance as required in the development of their surveillance programs.

Approach: Requesting state and local agencies will be assisted by telephone or written transmission of information. In some cases, on- site visits will be made by NASN and/or requesting agency personnel.

Goal: Process all requests for various types of air monitoring and technical services. It is estimated that approximately 500 requests will be received.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0757, MONITOR STATE, REGIONAL, AND LOCAL PARTICULATE SURVEILLANCE SYSTEMS
J. BRYANT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Monitor quality of performance of state, regional and local particulate surveillance programs.

Approach: Set up a particulate sampler at a minimum of one site and operate in parallel with a sampler of the state, regional, or local agency. Utilize Federally employed operators to avoid possible bias. Relocate existing particulate stations where necessary.

Goal: Develop a plan, acquire equipment, and make local arrangement for activation of monitoring network of 200 new stations by end of FY 71.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0758, EVALUATE IMPLEMENTATION PLANS WITH RESPECT TO SELECTION OF MONITORING SYSTEMS AND SITES IN AQCR'S
J. BRYANT, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Help in the evaluation of implementation plans of AQCR's as to adequacy of instrumentation, number of sites and/or regional coverage. Specifications for monitoring equipment, data handling, and analytical methods.

Approach: By personal contact prior to submission and review of submitted written requests and/or documents.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0759, DEMONSTRATION AND TRAINING ON CONTINUOUS AIR SAMPLING INSTRUMENTS
F. BURMANN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Operate a continuous air monitoring station using good procedures and practices for purposes of demonstration. Train students on operation, maintenance, and calibration of instruments, using the instruments set aside for this purpose. Develop operational guides, maintenance schedules, and training notes for specific instrumentation. The public and educational institutions will be invited to visit this facility. Displays and handouts will be prepared to describe the purpose and operation of air monitoring instruments.

Provide 20 trainee weeks of instruction.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0760, FORECAST SUPPORT
J. CLARKE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Evaluate air pollution potential forecasts and model's performance, using available meteorological and air quality data. Particular attention will be given to episode or potential episode conditions.

Provide consultant and special forecast services to NAPCA during episodes. Maintain liaison between NAPCA and Weather Bureau during episodes.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0761, APP-AIR QUALITY COMPARISON
J. CLARKE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Evaluate the performance of models used to forecast APP or predict pollutant concentration distributions, particularly during high APP, by comparing observed air quality data to calculated concentration distributions.

1. AIR QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0762, FORECAST DEVELOPMENT
J. CLARKE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Develop quantitative descriptions of air pollution potential through the improved forecasts and description of wind, temperature, moisture, mixing depth, turbulence, and other atmospheric parameters within the planetary boundary layer, and as a function of city size.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0763, DEVELOP A SEMI-AUTOMATED ANALYSIS FOR BENZO(A)PYRENE
J.B. CLEMENTS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To attempt to develop a semi-automated analysis for BaP which would eliminate costly and tedious hand work and facilitate automated data acquisition.

Approach: An attempt will be made to apply gas chromatography and/or high speed liquid chromatography for the separation and determination of BaP in BSO. Output from either method would be amenable to automatic data handling techniques.

Goal: Develop a rapid chromatographic method for separating and estimating BaP in BSO.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0764, DEVELOP AND EVALUATE A ROUTINE METHOD FOR MEASURING BENZANTHRONE
J.B. CLEMENTS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop and evaluate a routine manual method for the separation and estimation of the benzanthrone contained in the benzene soluble fraction (BSO) of organic particulate.

Approach: The procedures developed by DCP (Sawicki, Stanley, et al), which involves thin layer chromatographic separation of benzanthrone from the BSO and measurement by spectrophoto-fluorescence, will be routinized. Various methods of separation and efficiency of recovery will be investigated. Application of the developed method to samples collected in the NASN will be carried out.

Goal: To develop, routinize and evaluate a manual method for the analysis of BSO for benzanthrone content and to determine this constituent in quarterly composites from approximately 25 stations of the NASN for 1969.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0765, MEASUREMENT OF VISIBILITY REDUCTION BY PARTICULATES BASED ON OPTICAL PROPERTIES OF URBAN PARTICULATES (ABBREV)
W. CONNER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

A mobile optics laboratory is being equipped to conduct field measurements of optical properties of suspended urban particulates. Measurement will include number size distribution, angular lightscatter, volume lightscatter, mass concentration, and light attenuation. Data collected will be analyzed to provide design and performance criteria for prototype instrument to measure visibility reduction that most favorably relates to mass concentration. Information will also be obtained on a possible simple method of measuring number mean size of suspended particles.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0766, EEI-PHS STUDY ON REMOTE SENSING OF PARTICULATE EMISSIONS FROM POWER PLANT PLUMES--EVALUATION OF PLUME-LIDAR MONITORING SYSTEM (ABBREV)
W. CONNER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

A Lidar System to monitor, remotely, particulate content of Power Plant (and other) sources is being built on contract under EEI support, and is scheduled for delivery in late December, 1970. A field performance evaluation of the system will be conducted during the rest of the fiscal year for optical transmission measurement of plumes. This is a high powered laser system that will be used as a research instrument with capability to assess remote measurement of particulate by two different methods. One is the optical transmission property of the plume based on attenuation of laser radiation scattered by the background beyond the plume. This has been demonstrated to be feasible but requires a high powered, complex and expensive system. The other possible method is an evaluation of the radiation scattered back directly by the plume. Such a method, to be developed, will lend itself to relatively low-powered and inexpensive laser system for field use. This research instrument will serve to develop data for design and performance criteria of a prototype field instrument for control agency use.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0767, FIELD APPLICATION OF DIRECT LASER BACKSCATTER FROM PLUME PARTICULATE FOR DEVELOPING DESIGN & PERFORMANCE CRITERIA FOR FIELD INSTRUMENT (ABBREV)
W. CONNER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The Lidar backscatter research instrument of the EEI-PHS Cooperative Study will be modified or adapted as required to apply the direct backscatter technique, developed under contract, in the field. The field application study will be directed to collect data on power plants under a variety of operating and environmental conditions. The data will be analyzed to provide design and criteria for the development of a prototype field instrument for use by control agencies in remote monitoring of particulate emissions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0768, EMISSION INVENTORIES OF FEDERAL FACILITIES IN AQCR'S
J.E. FLANAGAN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Staff engineers, assisted by engineering aides, collect, verify and analyze emission data on fuel burning and refuse disposal practices at each individual Federal installation in designated AQCR's. The facilities listing is cross checked against the GSA real property listing to assure as complete an inventory as feasible. Collected data are coded, key punched and computer processed, utilizing appropriate factors, to calculate the emissions of particulates, SOx, NOx, HC and CO. Visits to installations are an essential part of this task.

The first 16 of the original listing of 57 AQCR's will be completed in FY 70, and the next 20 are planned for FY 71.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0769, TURBIDITY NETWORK
E. FLOWERS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Forty (40) observational stations, that measure atmospheric turbidity (at wave lengths of 3500 Angstrom units and 5000 Angstrom units as a measure of the aerosol content of the atmosphere, are maintained in the U.S.; additional observations are obtained from India, Israel, Australia and Hawaii.

Network measurements are analysed with respect to air quality and urban-rural differences in the attenuation of solar radiation by air pollutants. A continuing program since 1960 is providing data to help establish climatological trends in air quality.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0770, OPERATE NATIONAL PARTICULATE NETWORK AT AN INCREASED SAMPLING FREQUENCY
M. GEORGEVICH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Increase sampling frequency in all AQCR's who have implementation plans and standards accepted in compliance to air quality act as amended.

Approach: Sampling eventually will be at a frequency of 100 to 120 samples/year/site. Additional equipment will be provided so that samples can be taken every third day. Employ Federal operators to avoid complications.

Goal: Begin sampling every third day in 20 AQCR's which have established standards.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0771, OPERATE A SPECIAL PARTICULATE NETWORK UTILIZING MEMBRANE FILTER SAMPLERS

M. GEORGEVICH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Collect air samples in support of present and future criteria on trace metals, asbestos, and other special compounds that cannot be obtained from glass fiber filters. Provide air quality and background information on these elements and/or compounds.

Approach: Samples are collected on membrane filters at a sampling rate of 0.15 m3/sec.

Goal: Collect samples from approximately 55 sites 26 times per year.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0772, OPERATE A NATIONAL NETWORK FOR INTERMITTENT SAMPLING OF GASEOUS POLLUTANTS

M. GEORGEVICH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Collect gaseous pollutants nationwide to assess the air quality and for use in the publication of future and/or revised criteria documents. Data can also be used to determine compliance to standards in those regions where standards have been established.

Approach: Gases will be collected utilizing a gas-bubbler absorptive technique. Samples are collected over a 24-hr. period and returned to the laboratory for analysis.

Goal: SO2, NO2, and Hg (not at all sites) will be sampled 26 times per year at 190 sites throughout the nation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0773, OPERATE A NATIONAL GLASS-FIBER PARTICULATE NETWORK

M. GEORGEVICH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Collect total suspended particulate (TSP) for subsequent analysis. The TSP and other analytical information obtained from the filter will be used to help assess the air quality of the nation and for use in the publication of future criteria documents.

Approach: The TSP will be collected on a random statistical basis by hi-volume samples over the US and territories.

Goal: Collect 26 samples per year from each of 250 urban and non- urban sites over the U.S. and territories.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0774, APPLICATION OF REMOTE SENSING METHODS IN DETECTING AIR POLLUTION DAMAGE TO VEGETATION

D.G. GILLETTE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Develop and evaluate the use of remote sensing techniques in assessing air pollution damage to vegetation.

Approach: The techniques applied in assessing the damage through aerial photography and multispectral scanning devices in the San Bernardino Mountains will be applied in other areas where the pollutants causing the damage and the vegetation may be varied. Resources to conduct this work are supplied by the U.S. Forest Service which has had extensive experience in the use of remote sensing in assessing vegetative damage. In cooperation with TVA, the Forest Service will assess the feasibility of using remote sensing techniques in assessing vegetative damage from SOx around power plants.

Goal: Develop recommendations on the usefulness of various remote sensing techniques in assessing vegetative damage in the TVA area and the extension of this tool to estimate losses in other California Forests.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0775, LABORATORY SUPPORT TO AIR MONITORING OPERATIONS

S. HOCHHEISER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Consult with state and local agencies regarding analytical techniques and necessary laboratory support to air monitoring activities. perform routine sample analyses where such capability is not otherwise available in AQCR, instruct State and local personnel in operation, maintenance, and calibration of air monitoring instruments and in laboratory procedures for analysis of air pollution samples. The latter will be conducted in NAPCA facilities located in Durham and the Research Triangle.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0776, TECHNICAL SUPPORT TO FEDERAL FACILITIES - SOURCE SAMPLE ANALYSIS - AIR MONITORING - AND VEGETATION EFFECTS

S. HOCHHEISER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Review plans for establishing air monitoring networks. Provide guidance in selection, operation, maintenance, and calibration of air sampling instruments. Participates in source test conducted by the Engineering Branch and performs chemical analysis of source samples. Make field inspections to determine possible vegetation damage due to emissions from Federal facilities.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0777, MAINTAIN AND PROVIDE UP-TO-DATE INFORMATION ON AIR POLLUTANT EMISSION FACTORS

A. HOFFMAN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To continually collect all available source sampling data and establish new and update existing emission factors.

Approach: Through literature surveys and personal contact with internal and external organizations, collect all data on emission rates and develop emission factors.

Goal: Issue an addendum to the Emission Factor Book.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0778, DEVELOPMENT OF HEAVY HYDROCARBON ANALYZER AND EVALUATION OF CONTINUOUS OXIDES OF NITROGEN ANALYZER FOR ADVANCED POWER PLANT STUDIES

M.W. KORTH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Many of the advanced vehicle power plants being considered can burn heavier hydrocarbon fuels that produce a heavier molecular range of compounds in the combustion products. These hydrocarbons are difficult to sample and analyze and require the development of more suitable total hydrocarbon instrumentation for this purpose.

The more sensitive techniques for continuous measurement of oxides of nitrogen as required for advanced power plant studies will be evaluated.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0779, DEVELOPMENT OF IN-HOUSE INSTRUMENTAL METHODS

R.L. LARKIN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Continuing support as needed.

1. AIR QUALITY

Description: Investigate instrumental methods for application to in-house analytical problems. Apply automation to the needs of basic engineering studies and extend continuous measurement to other than present gaseous pollutants such as; C12, COCl2, HCL, HCN, etc. and instrument such analyses as; SO4 minus minus, NO2 minus, NO3 minus, SO3 minus minus, etc.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0780, PROVIDE TECHNICAL ASSISTANCE TO STATE AND LOCAL AGENCIES REGARDING SPECIAL AIR QUALITY SURVEILLANCE PROJECTS
R.E. LEE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To provide technical assistance to state and local agencies pertaining to unique and unusual surveillance problems of a non-routine nature.

Approach: By personal correspondence, either by telephone or written form, or by visits, guide non-federal agencies regarding surveillance projects. For example, requests in the past have been made concerning the construction of a low noise-level hi vol sampler for indoor use, and advice on determining the size distribution of hot iron oxide particles emanating from a smelting process.

Goal: Maintain contact with interested non-federal agencies and provide technical assistance where applicable.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0781, OPERATE A SPECIAL NETWORK FOR DETERMINING THE SIZE DISTRIBUTION OF PARTICULATES BY USE OF CASCADE IMPACTOR
R.E. LEE, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Determine the size distribution of particulates gravimetrically at selected locations in the nation and to quantitate their chemical composition.

Approach: A modified Andersen Cascade Impactor will be used to separate particulates into 5 fractions below 3 microns size. Mass particle size distributions will be determined by the NASNB while cation and anion species present in each fraction will be determined by the LSB.

Goal: In addition to the 6 cascade impactors now operating at CAMP cities, 5 additional impactors will be set up and operated at urban sites; all ll stations will be operated for a 24 hour period 26 times a year on the NASN schedule.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0782, MONITOR 1) CO-CH4 BY GC, 2) O3 BY CHEMILUMINESCENCE, 3) H2S BY ELECTROLYTIC DETECTORS, & 4) PARTICULATES BY SPOT EVALUATORS (ABBREV)
F. MCELROY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Contingent upon successfully meeting all field testing requirements, add nes sensors, and improve capabilities of continuous monitoring stations. Data to be collected on pollutants not previously monitored will be used in preparation of criteria documents.

Approach: New instruments and samplers will be installed in CAMP stations. These instruments will provide new data which is urgently needed to support criteria documents.

Goal: After completing laboratory evaluation of CO-CH4, O3, H2S, and particulate devices, install in CAMP stations, and initiate long- term monitoring.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0783, OPERATE A NETWORK OF CONTINUOUS MONITORING RESEARCH STATIONS (CAMP)
F. MCELROY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To operate continuous monitoring research stations for pollutant characterization, instrument development, demonstration projects, HAPP data.

Approach: Continue to operate CAMP with a research-oriented objective. On a long-term basis, obtain data for trend analysis, new pollutants, sensor development, criteria documents, and HAPP information.

Goal: Supply continuous data on pollutants emanating from industrial and automotive combustion processes. These will include SO2, NO2, CO, oxidants, methane, total hydrocarbons. CAMP stations will also be used as field testing sites for the evaluation of newly-developed monitoring devices for ozone, fluorides, lead, and H2S. On a limited basis use data to determine compliance with standards in AQCR's. Additional equipment to be used for accomplishment includes data-logger for back-up purposes.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0784, FIELD PERFORMANCE AND APPLICATION EVALUATION OF BARRINGER REMOTE SENSING AND INSTACK MEASUREMENT OF SO2 EMISSIONS BY CORRELATION SPECTROSCOPY
J.S. NADER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Barringer UV correlation instruments are being purchased for longpath/ remote and for instack measurement of SO2 emissions. A preliminary evaluation under contract study indicated favorable performance with limitations due to environmental conditions. A more detailed in-house study is planned in the field with independent simultaneous remote measurements using newly acquired field research instruments, Convair and Bendix Remote IR Scanning Spectrophotometers.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0785, EXPAND SAROAD TO SERVE THE NEEDS OF NADIS
G. NEHLS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To shorten the potential access time to the data files in the National Aerometric Data BAnk and expand the types of routine summaries and computations available through SAROAD and make SAROAD compatible with State and local agency data requirements.

Approach: A redesign of SAROAD considering the needs and uses of information by other NAPCA components and State and local agencies will be undertaken. Concurrently, expansion of the existing system to include more summaries such as pollution roses and graphical presentation will be started. Transfer of SAROAD to a large third generation system will be initiated to take advantage of the increased capabilities and speed these machines offer.

Goal: Redesign SAROAD, initiate transfer to a third generation computer, increase the reports available through SAROAD.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0786, PERFORM INTERNATIONAL STUDIES IN SELECTED NATO COUNTRIES TO ASSESS ATMOSPHERIC POLLUTANT CONCENTRATIONS AND EMISSIONS
G. OZOLINS, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To procure data for predicting emissions to the year 2000, in selected NATO countries. Data will be used as primary input for the diffusion model being coordinated by the Office of Science and Technology.

Approach: By installing various samplers and monitoring stations at selected sites in the area to be studied, obtain continuous and integrated data which may be used to verify diffusion models developed from source information.

Goal: Perform an inter-divisional study in Ankara, Turkey to obtain SO2 and particulate concentrations at 10 selected locations within the city.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0787, SAMPLING OF SO2 CONCENTRATIONS AND RELATED METEOROLOGY
F. POOLER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Complete data acquisition for Keystone and Homer City Power Plants, by aircraft and ground sampling of SO2 concentrations and related meteorology. Small particle (nuclei) count and tracers in plumes may be used for assessing plume transport and dispersion.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0788, ANALYZE THE CYCLICAL VARIATION OF AIR QUALITY
J. REAGAN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To assess the underlying cyclical variation n air quality levels and develop standard curves for expected time fluctuations.

Approach: time series analysis along with auto-correlation can be used to estimate the major weekly and seasonal changes. More attention will be required to tease out a standard diurnal variation that is independent of weekly or seasonal characteristics. Moreover, the analysis will attempt to identify predictable cycles which are tied to events which occur randomly in time. Standard curves will be developed which can be used to remove known cyclical components and the resulting data would be similar to the adjusted economic indices.

Goal: Identify and quantify in standard curves the expected cyclical variation of particulates and sulfur dioxide.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0789, MEASUREMENT TECHNIQUES FOR THE NUCLEIC ACIDS AND THEIR BREAKDOWN PRODUCTS
E. SAWICKI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

These methods are being assembled and developed. The first compound under investigation is 2-deoxyribose. Since some of the heterocyclic products are potent oncogens, methods for their analysis will be looked into. In the first phase, methods of analysis for 2- deoxyribose, a key component of DNA, are being assembled, preparatory to investigation of airborne particles in terms of these compounds.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0790, CONSOLIDATION & IMPROVEMENT OF ASSAY METHODS FOR THE CARCINOGEN FAMILY
E. SAWICKI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Consolidation of the large number of methods which have been developed for the determination of the airborne carcinogen family. An attempt will be made to modify and improve the key methodology and then assemble it for future use in criteria documents.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0791, MEASUREMENT TECHNIQUES FOR PRE-ALLERGENS
E. SAWICKI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Airborne dusts are known which, when fresh, are non-allergenic, and aged are allergenic. It is believed that a chemical reaction takes place in these dusts. Some evidence indicates that polyhydroxyaldehydes and peptides containing the lysine group may be implicated in one such reaction. First phase involves literature survey followed by organization and development of methods of assay for the appropriate components and then eventual application to various airborne dusts.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0792, ANALYSIS OF FLAVONOLS AND OTHER PHENOLS
E. SAWICKI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

These colored compounds are prominent components of many types of airborne bioparticles. Phenols could serve as indicators of pollen pollution and also indicators of certain types of natural and man-made pollutions. Work is proceeding on measuring these compounds in various types of airborne particles.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0793, LIQUID CHROMATOGRAPHY STUDIES
E. SAWICKI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Two types of investigations will be pursued. These include the feasibility of substituting this type of instrumentation for the column chromatographic techniques now used in assaying carcinogens and research on the use of this instrumentation in separating and assaying many of the biologically important chemicals present in the atmosphere.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0794, CONTACT MONITORING OF INSTRUMENTATION DEVELOPMENTS FOR MOBILE SOURCES
J. SIGSBY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Develop and monitor contracts to provide practical instrumentation for the monitoring of combustion effluents. Aldehydes in general and formaldehyde are of immediate concern. A mass spectrometer has been developed and is being evaluated in the first instance and a further method for formaldehyde will be developed in the latter case.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0795, EVALUATION OF METHODS FOR DETERMINATION OF NITROGEN OXIDES IN AUTOMOTIVE EMISSIONS
J. SIGSBY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

This project is in direct response to a request from the Office of Criteria and Standards. All currently available instrumental methods of measuring oxides of nitrogen will be utilized. These include direct opticals such as NDIR, NDUV, chemiluminescent, electrochemical, wet chemical and others if available.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0796, DEFINITION OF OXIDE OF NITROGEN STANDARD
J. SIGSBY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

A standard method(s) must be promulgated for the measurement of the oxides of nitrogen. It is to be enforced in the 1973 regulations.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0797, STANDARDIZATION OF METHOD FOR PARTICULATE EMISSIONS FROM MOBILE SOURCES
J. SIGSBY, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The sampling technique and instrumentation for particulate emissions from vehicles will be subjected to standardization procedures.

1. AIR QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0798, OPERATE PORTABLE AND MOBILE METEOROLOGICAL EQUIPMENT IN POTENTIAL EPISODE SITUATIONS
H.H. SLATER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Maintain, deploy, operate meteorological equipment to obtain auxiliary weather information during potential or actual air pollution episode conditions. Analyze data in field and transmit data to meteorologists serving air pollution control agencies and NAPCA's EOCC. Calibrate, refurbish and maintain equipment in constant state of readiness.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0799, PROVIDE METEOROLOGICAL SUPPORT TO EMERGENCY EPISODE PLANNING
H.H. SLATER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Develop background meteorological and topographic reference material for areas most susceptible to air pollution episodes. Serve on NAPCA-ESSA Environmental Meteorological Service Unit Advisory Committee. Review and test atmospheric models for assessing the effect of meteorological factors on air quality during episodic situations.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0800, DEVELOP IMPROVED METHODS OF CALCULATING AND ANALYZING SURVEY DATA
J. SMITH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To obtain better methods of collecting, compiling, and analyzing emission data obtained from metropolitan inventory surveys.

Approach: Information gathered during previous surveys is analyzed with respect to improving existing means for use of computer in calculating emissions, selection of point sources, determination of grid sizes and averaging times. This activity is accomplished independently and in liason with DA and DM.

Goal: Develop a method for estimating emissions on a shorter averaging time basis (daily and, if possible, hourly).

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0801, ANALYZE SAMPLES FOR SO2 AND NO2
R.J. THOMPSON, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine SO2 and NO2 content of ambient air.

Approach: SO2 and NO2 concentrations are determined by metering ambient air through appropriate absorbing reagents and returning the exposed solutions to the contractor's laboratory for analysis. LSB will verify results with control samples. The pollutant concentrations determined by the contractor will be furnished to the DAAB and the tabulations prepared by them will be verified.

Goal: To determine the SO2 and NO2 concentrations of ambient air from samples collected biweekly at 250 NASN stations during the first and second quarters of 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0802, DEVELOP EPISODE AIR MONITORING CAPABILITY
D. TYLER, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The purpose of this task is to develop a nation-wide episode air monitoring capability. This capability will enable the EOCC to acquire AQ data at any location in the nation that is threatened by an air pollution episode. In some areas this will be the only available source of date; for other areas it will be used to supplement local data.

The development of this monitoring capability will include the evaluation and purchase of portable air monitoring equipment and the organization and training of field crews in the use of the equipment. The field crews will be on-call at all times to respond to any episode situation.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0803, INSTRUMENT DEVELOPMENT AND EVALUATION FOR PARTICULATES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Development and evaluation of new types of monitoring instruments to measure particulates and the key physiologically harmful components of these mixtures.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0804, EVALUATION OF ADVANCED SPECTROSCOPIC TECHNIQUES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

For the past five years, a variety of spectroscopic techniques have been developed which tend to improve resolution and sensitivity to the measurement of complex mixtures of organic and inorganic compounds.

Among these techniques are microwave, correlation, Fourier transform and second derivative spectroscopy. In addition, development of monochromatic light sources could lead to a new generation of spectrometers. This task will select one or more of the above approaches to develop a working spectrometer for the simultaneous measurement of several pollutants such as SO2, CO, HCHO, NO and NO2.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0805, DEVELOP TECHNIQUES FOR STORING CHEMICAL INFORMATION PROPORTIONAL TO 24-HOUR AVERAGE CONCENTRATIONS OF SO2 AND NOX
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

A substrate (e.g., PbO2) will be sought that will a) absorb SO2 and NOX from a metered air sample passed therethrough, and b) desorb each of these gases separately during programmed thermal (or other) regeneration. Suitable readout mechanism will be selected from available known laboratory or instrumental methods.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0806, DEVELOPMENT AND TESTING OF A FLAME PHOTOMETRIC DETECTOR DESIGNED TO MEASURE OXIDES OF NITROGEN
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

It is known that oxides of nitrogen produces an intense luminescence, proportional to concentration, in hydrogen rich flames. Studies are in progress to determine the applicability of photometric monitoring of this light to the real-time monitoring of NOx.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0807, FRABRICATION AND EVALUATION OF A PORTABLE FLAME PHOTOMETRIC DETECTOR DESIGNED TO MEASURE SO2 AND NOX IN STACK PLUMES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

For the past two years we have evaluated the performance of the flame photometric detector as a monitor for ambient concentrations of SO2. This monitor has real time response, therefore would serve as an ideal measuring tool for determining plume dimensions and concentrations. Within this task a special portable, battery operated FPD will be fabricated and tested as a plume monitor for both SO2 and NOX.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0808, EVALUATION OF ELECTROCHEMICAL SENSORS FOR SOURCE CONCENTRATIONS OF SO2 AND NOX
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Several commercial devices are available to measure emissions from mobile and stationary sources. NAPCA has funded development of electrochemical sensors designed to measure SO2 and NOX. These sensors will be evaluated in conjunction with special accessory sample handling equipment under conditions simulating those encountered in stack sampling. Gas samples will be provided similar to the gases emanating from stacks to determine reliability and accuracy of these new sensors.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0809, ANALYTICAL METHODS EVALUATION SERVICE
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

The SAC in cooperation with the Intersociety Committee selects tentative methods for analysis of pollutants. AMES then evaluates the methods in the laboratory and conducts collaborative tests to determine bias and reproducibility. Following the study, the results are published. Collaborative testing of methods is necessary before adoption as standard methods, and air pollution control is dependent upon methods which have been found to have acceptable and known reproducibility. This is a continuing operation to provide established analytical methods for NAPCA use.

In conducting a collaborative testing program, as in CP-70-40, presently in progress; it is of primary importance that the laboratories selected be technically competent. Although competent, all of the laboratories may not be fully equipped to follow the method in every required detail. Therefore, it will be necessary to provide certain equipment on loan to these laboratories, as well as materials necessary to collaborative testing of the methods. These are: primary standard positive displacement meters, orifice calibration units, and filters for measurement of particulates. General items: flowmeters, standard thermometers, standard reagents (at least two for each ten methods) will also be required. Additionally, instruments for measuring hydrocarbons and CO, ozone generators, sources of CO and hydrocarbons (for calibration) will be needed.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0810, COMPLETE A REPORT ON INDOOR-OUTDOOR AIR QUALITY FOR SOX - TSP AND OTHER AIR POLLUTANTS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Although ambient levels of air pollution in many of our major cities are quite high, only a small percentage of the citizenry spend a significant portion of their time outdoors and thus are exposed directly to it. It is imperative for this reason, that techniques be developed for determining the relationship between outdoor air pollution levels and those found within homes or other occupied situations. A study of this type relative to SO sub X and particulate levels will be completed during the current fiscal year.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0811, DEVELOP NOX MEASUREMENT PROCEDURE FOR FEDERAL REGISTER
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Based on evaluation of present NO sub x measurement methods, recommend procedures for subsequent publication in Federal Register.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0812, DEVELOP EMISSION RATES FOR MOBILE SOURCES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Using certification, durability and surveillance data, determine periodically the emission rates for mobile sources relative to HC, CO, NOx, total particulates, lead, SOx and polycyclic organic matter.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0813, DETERMINE TIME-CONCENTRATION-FREQUENCY RELATIONSHIPS IN AQCR'S FOR SOX, PARTICULATES, NO, HC, CO AND OXIDANTS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Conversion of raw aerometric data into a statistically useable form. This will permit existing air quality data to be related to the reference air quality standards established in the criteria documents.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0814, ANALYZE SAMPLES OBTAINED FROM THE COOPERATIVE STUDY CONDUCTED IN ENGLAND
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To analyze suspended particulate samples collected in the England smoke-shade-U.S. particulate study for selected pollutants.

Approach: Appropriate analytical methods will be used to analyze the samples for inorganic, organic and trace metals constituents.

Goal: To analyze the approximately 2000 samples collected in England for total suspended particulate. Some 220 selected samples will be analyzed for some 30 trace metals and non-metal inorganics. Some ten composites of the samples collected will be analyzed for benzene soluble organics and benzo(a)pyrene.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0815, OPERATE A SPECIAL NETWORK FOR THE COLLECTION OF ARSENIC AND SELENIUM
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Sample the ambient air to be able to determine the air quality for Hg and As. Information would be of use in publishing criteria documents and in prescribing standards.

Approach: By using gas bubblers collecting 24-hour air samples and by a mobile van utilizing a continuous analyzer.

Goal: Establish samplers at approximately 50 sites where large manufacturers or users of arsenials and selenium containing materials are located.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0816, OPERATE A NATIONAL NETWORK FOR SAMPLING GASEOUS POLLUTANTS AT AN INCREASED FREQUENCY
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Increase the sampling frequency to obtain a higher degree of statistical accuracy for the determination 24 hour averages and maximum values for the pollutants emitted into the atmosphere in major quantities.

Approach: Increase the sampling frequency of the present gas- bubbler sampler network to determine concentration levels of SO2, NO2, and at specific locations Hg, Cl2, HCl, etc.

Goal: Collect air samples for subsequent analysis for SO2, NO2, Hg, (not at all sites) and others at a frequency of 120 times per year at approximately 200 sites.

1. AIR QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0817, ANALYZE COLLECTED PARTICULATE POLLUTANT FOR SOLUBLE NON-METAL IONS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine the ammonium, fluoride, nitrate, and sulfate ion concentration of selected NASN samples.

Approach: Samples of particulate matter collected in glass-fiber filters are extracted with water and the ammonium, fluoride, nitrate and sulfate ion contents determined. The ambient air concentrations of these ions are calculated and tabulations of these data prepared by DAAB are verified.

Goal: To analyze some 3,000 selected samples collected in 1969 and 1970 for ammonium, fluoride, nitrate and sulfate ions and to calculate the ambient air concentration of these ions.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0818, DEVELOP A PROCEDURE FOR THE COLLECTION OF AND ANALYSIS FOR FILTERABLE ('ORGANIC') LEAD FROM AMBIENT AIR
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To develop a procedure for the collection of and analysis for filterable ('organic') lead from ambient air.

Approach: Appropriate absorbing reagents will be used to collect the lead from filtered ambient air and appropriate analytical methods will be used to determine the lead concentration of the exposed reagent. An evaluation of collection and analytical efficiency and of analytical precision will be made.

Goal: To develop and evaluate a method for the collection of and analysis for filterable ('organic') lead from ambient air.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0819, ESTABLISH THE EFFICIENCY OF RECOVERY OF BERYLLIUM FROM SAMPLES OF COLLECTED PARTICULATE MATTER
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine the efficiency of recovery of beryllium from particulate matter using LSB analytical procedure.

Approach: Beryllium compounds, including 'high-fired' beryllium oxide (a refractory substance which may defy chemical procedures amenable to routine analysis), thought to be in the atmosphere will be added as known spikes to samples of collected particulate pollutants and then subjected to our analytical procedure which is based on optical emission spectrometry. In this manner the efficiency of recovery can be determined.

Goal: To establish the efficiency of recovery of beryllium from samples of collected ambient air particulate matter.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0820, CONSULT WITH LOCAL, STATE, REGIONAL, AND OTHER FEDERAL AGENCIES ON ANALYTICAL METHODOLOGY AND PROCEDURES
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To consult with personnel of appropriate organizations internal and external to NAPCA on analytical methodology relative to measuring air pollution. This assures use and acceptance of NAPCA's methodologies.

Approach: Consultation on procedures and methodology by LSB personnel will be provided by conferences, phone conversations and by correspondence. A member of the LSB staff serves as member of the Standardization Advisory Committee and all professional staff members serve as consultants to the SAC as requested. Other consulting by LSB personnel includes lecturing at training courses and task force assignments.

Goal: To provide this service as requested when mutually agreed upon.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0821, ON-THE-JOB TRAINING FOR PERSONNEL OF REGIONAL, STATE, LOCAL AND OTHER FEDERAL AGENCIES OR OTHER NAPCA PROGRAMS (ABBREV)
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To assist personnel of appropriate outside organizations by providing on-the-job training to their chemists in the methods used within LSB to assure comparability of methodologies used and to assure quality control of the data engendered.

Approach: The chemist of the outside organization works in the Branch laboratory under the guidance and direction of branch personnel and in this manner learns in detail how methods used here operate and how he can best adapt them to his needs.

Goal: To provide this service when requested as mutually agreed upon.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0822, PROVIDE ANALYTICAL SERVICES TO REGIONAL, STATE, LOCAL & OTHER FEDERAL AGENCIES, TO OTHER NAPCA PROGRAMS & OTHER APPROPRIATE ORGANIZATIONS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To analyze samples of air pollutants received from appropriate organizations outside DAQED; in order to assure comparability of data and to render technical assistance to state, local, and other federal agencies.

Approach: As the workload permits, LSB personnel, who have broad experience in analyzing for a wide variety of air pollutants, will use the methods within their capability to analyze air pollution samples received from outside organizations. Technical support to the Measurement Standardization Services Section of DCP will be provided. Participate in NAPCA's collaborative testing study program.

Goal: To provide these services when requested as mutually agreed upon.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0823, ANALYZE SAMPLES FOR SO2 AND NO2
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine SO2 and NO2 content of ambient air.

Approach: SO2 and NO2 concentrations are determined by metering ambient air through appropriate absorbing reagents and returning the exposed solutions to the contractor's laboratory for analysis. LSB will verify results with control samples. The pollutant concentrations determined by the contractor will be furnished to the DAAB and the tabulations prepared by them will be verified.

Goal: To determine the SO2 and NO2 concentrations of ambient air from samples collected every third day at 200 NASN stations during the first and second quarters of 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0824, WEIGH AND COMPUTE CONCENTRATION OF SUSPENDED PARTICULATE MATTER IN SAMPLES COLLECTED BY THE NASN
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To prepare for field use glass-fiber and membrane filters and to compute total suspended particulate concentration and prepare for fractional analysis these filters after samples have been collected in the NASN.

Approach: Glass-fiber and membrane filters are screened, numbered, equilibrated with a controlled (temperature and humidity) atmosphere, weighed, packaged and furnished to th.

NASN for field use. The filters received from the NASN loaded with collected particulate matter are equilibrated, reweighed and divided for fractional analysis. The total suspended particulate concentration is calculated and tabulations of these data prepared by DAAB are verified.

Goal: To process for field use some 45,000 glass-fiber and 6,000 membrane filters and to reweigh, calculate total suspended particulate concentration and prepare for fractional analysis all particulate samples received from the NASN.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0825, ANALYZE COLLECTED SAMPLES OF SUSPENDED PARTICULATE MATTER FOR BENZENE SOLUBLE ORGANICS AND FOR BENZO(A)PYRENE

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine the benzene soluble fraction and benzo(a)pyrene concentrations of ambient air for evaluation of air quality.

Approach: Quarterly composites of portions of particulate matter collected on glass-fiber in the regular NASNO are extracted with benzene and the benzene soluble fraction (BSO) determined. The benzo(a)pyrene (BaP) is separated from the BSO by thin-layer chromatography and determined by spectrophotofluorescence. The ambient air concentrations of BSO and BaP are calculated and the tabulations of these data prepared by DAAB are verified.

Goal: To determine the BSO and BaP concentrations of ambient air from quarterly composites of samples of suspended particulate matter received from the regular NASN March 31, 1970 through March 31, 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0826, FIELD INVESTIGATION IN A NEW ABATEMENT CASE

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Plan and conduct a field investigation designed to delineate the nature and extent of air pollution in the area. Employ survey technique and measurement procedures consistent with definition of the air pollution problem. Commit the necessary manpower and material resources in the area of pollution and effects monitoring. Prepare a pre- conference abatement report.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0827, AQCR ASSISTANCE - AIR QUALITY DATA

UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Assist the States in the design and operation of air monitor systems. Such assistance will include consultation on procedures for reducing and analyzing air quality data.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0828, AIR MONITORING INSTRUMENT LOAN AND CONSULTATION TO ESTABLISH DATA BASE IN AQAR'S

R.T. WALSH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Loan equipment to agencies on a short-term basis to establish existing air quality. Assistance will be provided in the selection of monitoring sites and the installation and calibration of instruments. In FY-71, emphasis will be placed on about 80 AQCR's for which initial plans are due from October '70 through December '71. The instruments will be used to measure concentrations of sulfur oxides, particulates, oxidants, hydro-carbons, carbon monoxide, and nitrogen oxides.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0829, ANALYSIS OF LIPIDS IN AEROBIOLOGICAL PARTICLES

E. WITTGENSTEIN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Development of methods of assay for aerolipids. These would include steroids, esters, and many other ether-soluble compounds. Urban particles would also be analyzed for these materials.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0830, DEVELOPMENT OF AIR SAMPLING METHODOLOGY

B.E. SALTZMAN, Univ. of Cincinnati, School of Medicine, *Cincinnati, Ohio* 45221

The objectives of this study are to examine critically and improve the present technology for air sampling and analysis. More sensitive and specific analytical methods are being sought in order to make possible accurate measurements of low levels of pollutants. Improved and simplified means for calibrating, standardizing and automating these system are sought.

The work for the current year will be conducted in the followed areas: a) Monitoring systems for determining reactive hydrocarbons in the air by use of absorbent chemicals for removing classes of compounds. b) Stoichiometry of nitrogen dioxide analytical methods and use of solid absorbents for sampling. c) Sampling of gases with chemically impregnated filters. d) Sampling of aerosols with size selective samplers.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0831, ANALYZE SAMPLES COLLECTED FROM AMBIENT AIR FOR TOTAL MERCURY

W. HENRY, Battelle Memorial Institute, *Columbus, Ohio* 43201

Objective: To determine total mercury content of ambient air.

Approach: Total atmospheric mercury concentrations are determined by metering ambient air through an absorbing reagent and delivering the exposed solutions to the contractor for analysis. Deliveries will be made once per quarter. LSB will verify results with control samples. The pollutant concentrations determined by the contractor will be furnished to the DAAB and the tabulations prepared by them will be verified.

Goal: To determine the total mercury concentration of ambient air from approximately 1,000 samples collected biweekly at 60 NASN sites through March 31, 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0832, ANALYSIS OF SUSPENDED PARTICULATE SAMPLES (ABBREV)

W. HENRY, Battelle Memorial Institute, *Columbus, Ohio* 43201

Objective: To determine the elemental composition of collected suspended particulate matter and to determine the ions, molecules and compounds present in high enough concentration for their measurement.

Approach: The following analytical techniques will be used to make the above determinations: classical wet chemistry, X-ray crystallography, microscopy, microprobe analysis, emission, flame and atomic absorption spectrophotometry, spark-source mass spectrometry, etc. Virtually every tool available to the analytical chemist will be utilized.

Goal: To determine the elemental composition and to determine the ions, molecules and compounds present in high enough concentration in some 25 samples of collected suspended particulate matter.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0833, IMPROVE AND QUANTITATE A TENTATIVE METHOD FOR ASBESTOS

W. HENRY, Battelle Memorial Institute, *Columbus, Ohio* 43201

Objective: To improve and quantitate a tentative method for asbestos developed previously and to evaluate the improved method using field samples.

Approach: The routine method developed for the analysis of asbestos in collected particulate samples will be quantitated using chamber studies and will be improved by appropriate modification. The improved method will be proven by use on samples collected at source and background sites by NAPCA.

1. AIR QUALITY

Goal: To improve and quantitate the tentative method for asbestos and to prove the improved method using field samples.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0834, DEVELOPMENT OF A WORKING MODEL FOR MEASUREMENT OF SULFUR DIOXIDE IN STACK GASES
R. PHEIFER, Industrial Nucleonics Corp., *Columbus, Ohio* 43202 (AT(30-1)-3882)

Despite the emergence of nuclear energy as a major source of energy for industrial and commerical use, utilization of fossil fuels will increase significantly in the future due to numerous economic advantages of fossil fuels in many localities. However, federal and local regulations will soon become widespread concerning the control of air pollution, particularly sulfur dioxide pollution, resulting from the burning of fossil fuels. In conjunction with such regulations, adequate monitoring of smokestack emissions may become necessary for control and regulation compliance functions. Since no sulfur dioxide measuring instrument currently available meets requirements of low cost, high reliability, and easy maintainability over long periods of time, the Atomic Energy Commission has embarked upon a program to develop a suitable monitor.

The program is currently in its second year. Initial effort was spent on a study of the feasible techniques for monitoring the sulfur dioxide. Recent effort has been devoted to the development of a working model of the most promising monitoring method, the mercury substitution- nucleonic detection method. Currently, this program is in a field testing phase. Contingent on satisfactory performance of the working model in the testing, further effort will be expended on the development of a prototype instrument.

The instrument currently being developed is based on a mercury substitution-nucleonic detection principle. In the reaction cell of the instrument, sulfur dioxide reacts with solid mercurous chloride in a buffered aqueous medium to produce a soluble mercury complex, the bis- sulfitomercurate ion. This complex flows through a filter and passes into a measurement cell where the transmission of low energy cadmium-109 X-rays (22 kev) is measured with a scintillator-multiplier phototube combination and digital electronics.

Maintenance-free operation has been provided for periods of several days; the design goal of performance is one to two weeks. Maintainability of the instrument is easy; the disposable reaction cell with a charge of mercurous chloride is changed at weekly intervals. Due to the wet chemical measurement technique, the gas sample need not be cleaned or dried prior to analysis. Future development work will depend on the total results of the testing program.

SUPPORTED BY U.S. Atomic Energy Commission

1.0835, MICROANALYTICAL METHODS FOR AIR FORCE MATERIALS IN TOXICOLOGICAL AND ENVIRONMENTAL POLLUTION INVESTIGATION
E.L. ARNOLD, U.S. Air Force, Aerospace Med. Res. Lab. 6570, *Dayton, Ohio* 45433

Toxicological and environmental pollution investigation requires microanalytical methods for the materials of interest and for substances that are involved in the biological response. This work unit is directed to the development of rapid analytical techniques for halogenated derivatives of beryllium and catecholamines in biological and environmental samples and will provide the Air Force with sensitive methods for studies of beryllium propellant toxicity and potential pollution attendant with beryllium propellant testing and use.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0836, SINGLE COMBUSTOR RIG INVESTIGATION OF TURBINE ENGINE EXHAUST EMISSIONS
D. CHAMPAGNE, U.S. Air Force, Aerospace Propulsion Lab., *Dayton, Ohio*

Technical Objective: Upgrade and use the existing T56 engine single combustor rig as a readily available testbed to investigate phenomena related to turbine engine exhaust (mass) emissions, such as: determining the characteristics (response times, specificity, etc.) of some state-of-the-art exhaust species measurement instrumentation and evaluating fuel additives proposed for exhaust emissions control.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0837, THE CLIMATOLOGICAL BASIS FOR MANAGEMENT OF OREGON'S AIR RESOURCES
W.P. LOWRY, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00814)

OBJECTIVE: Develop methods of identifying periods of time when atmospheric conditions are conducive to poor air quality conditions and to good air quality conditions in the major airsheds of Oregon. Employ existing weather records in describing time and space patterns of occurrence of conditions in Oregon as identified by the methods developed under Objective 1.

APPROACH: Climatological and air quality data will be assembled from all regions of Oregon. Studies will then be carried out to identify those combinations of weather variables most consistently linked with known occurrences of very poor and very good air quality, taking into account information on forest slash burning, field burning, and domestic heating.

PROGRESS: Devised and reported on an index number to be calculated each day from radiosonde temperature values and from visibility values obtained at Weather Bureau stations, the number to be used as a guide in decisions whether or not to permit open burning, or other air pollution control measures. Also, obtained field data with which to assess the utility of the ratio (Flux of diffuse shortwave radiation/Flux of direct shortwave radiation) as an indicator of total particulate loading in the atmospheric column between the radiometer and the sun.

SUPPORTED BY Oregon State Government

1.0838, DEVELOPMENT OF A MULTICOMPONENT DEVICE FOR 24-HOUR CUMULATIVE MEASUREMENTS OF SO2 AND NOX
R. CHAND, Dynasciences Corporation, *Blue Bell, Pennsylvania* 19422

For the past year the Division of Chemistry and Physics has supported research to develop electrochemical sensors capable of measuring source concentrations of SO sub 2 and NO sub x. An extension of this work will be the fabrication of an inexpensive multicomponent analyzer which measures ambient concentrations of SO sub 2 and NO sub x and accumulates an electrical signal in proportion thereto.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0839, IMPLEMENTATION OF A LASER AS AN AIR POLLUTION PROBE
F. MEZGER, State Div. of Air Pol. Control, *Harrisburg, Pennsylvania*

Objectives and Procedures: The purpose of the study is to develop, build, test, and evaluate--both technically and economically--the effectiveness of a laser as an air pollution probe from a single point for a large area. The technique has only had laboratory testing, and this would be the first filed application for a new type of air pollution monitoring program. It is hoped that the costs of the laser technique will be significantly less than methods now employed and would provide better and more continuous data.

SUPPORTED BY U.S. Dept. of Commerce - Econ. Dev. Admin.

1.0840, ASTM SUBCOMMITTEE ON SENSORY METHODS OF MEASUREMENT
UNKNOWN, Amer. Soc. for Testing Mat., *Philadelphia, Pennsylvania* 19103

Participate in joint activities with industry and other government representatives on methods for classifying air pollutants from mobile systems in terms of sensory effects to human subjects.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0841, IMPLEMENTATION OF A LASER AS AN AIR POLLUTION PROBE
UNKNOWN, Drexel University, Graduate School, *Philadelphia, Pennsylvania* 19140

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Dept. of Commerce - Econ. Dev. Admin.

1.0842, AIR POLLUTION FROM MINING, PROCESSING, AND UTILIZATION OF MINERALS AND FUELS
W.P. HAYNES, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

To develop the expertise needed to efficiently apply remote sensing techniques to environmental program. Specific goals are to determine feasibility of correlating SO2 and NO sub X concentrations with photographically detectable effects on vegetation and to ascertain the capabilities of multispectral scanning techniques for atmospheric monitoring.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0843, DEVELOP & IMPLEMENT OPERATIONAL SYSTEM FOR EVALUATING & COLLABORATIVELY TESTING METHODS RECOMMENDED FOR AIR POLLUTION MEASUREMENT (ABBREV)
H.C. MCKEE, Southwest Research Institute, *Houston, Texas* 77006

Develop a system for evaluating and collaboratively testing methods recommended for air pollution measurements. The contractor shall develop the system and then prove the system by evaluating and conducting collaborative tests for 20 methods recommended by the Standardization Advisory Committee of NAPCA and the Intersociety Committee of the Private Sector. Pollutants, or classes, will include suspended particulates, sulfur dioxide, carbon monoxide, oxidants (ozone), methane and total hydrocarbons, carcinogens (Benzo (a)pyrene, etc.), aliphatic aldehydes, nitrogen dioxide, lead, and fluorides.

Priorities will be established by the present and/or anticipated issuance of Air Quality Criteria Documents and publication of Standards in the Federal Register.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0844, FIELD EVALUATION OF METHODS RECOMMENDED FOR COLLABORATIVE TESTING AND ADOPTION AS STANDARDS FOR AIR POLLUTION MEASUREMENTS
H.C. MCKEE, Southwest Research Institute, *Houston, Texas* 77006

Tentative methods, as approved by SAC, for 10 air pollutants will be evaluated under field conditions (mobile trailer) prior to subjecting the methods to collaborative testing. This dynamic evaluation of methods in ambient air prior to and/or concurrent with testing will allow the collaborative testing program (Contract No. CPA 70-40) to be much more meaningful and provide quantitative data under actual field operating conditions which can be used to determine utility and future requirements. Guidelines will be established by the SAC and its subcommittees responsible for technical review and revision of methods. Priorities, in terms of methods to be tested, will be established by the present and/or anticipated issuance of Air Quality Criteria Documents and Publication of Standards in the Federal Register.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0845, MEASUREMENT OF AIR AND WATER QUALITY
H.C. MCKEE, Southwest Research Institute, *Houston, Texas* 77006

No summary has been provided to the Science Information Exchange.

SUPPORTED BY No Formal Support Reported

1.0846, POLLUTANTS IN CHIMNEY STACK PLUMES
H.W. PRENGLE, Univ. of Houston, School of Engineering, *Houston, Texas* 77004

This is part of a 3-year program; the overall objective is to determine pollutants by remotely sensing the infrared emission signals from individual chemical species in hot gas plumes.

Specific objectives for the third year are: 1) Complete the assembly of the equipment system, and laboratory calibrate and test. 2) Start field measurements. 3) Extend and refine system and evaluate field measurements.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0847, IONIZATION METHODS OF GAS ANALYSIS
A. ZLATKIS, Univ. of Houston, Graduate School, *Houston, Texas* 77004

The purpose of this research will be to study and develop existing and new ionization detectors bearing in mind their application to atmospheric contamination problems. In particular, the research will be concentrated on the further development of the photoionization detector, micro cross section detector and helium ionization detector. The use of ultrapure helium as the discharge gas in the photoionization detector should make it responsive to all organic and inorganic gases and vapors. Further, air will be used as the carrier gas. The helium ionization and micro cross section detectors will also be used with ultrapure helium to effect sensitivity increases. In addition, a concentrating device (gas transmodulator) which will remove most of the carrier gas just prior to the detector, will be used to make these concentration sensitive detectors operate at their maxima.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0848, DEVELOPMENT OF ANALYTICAL TECHNIQUES FOR THE MEASUREMENT OF TRACE CONTAMINANTS IN AIR FORCE MANNED WEAPON SYSTEMS
K.G. IKELS, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: This effort will provide technics and instrumentation for the detection of atmospheric contaminants in Air Force operational environments. In current aircraft using lox convertors, contamination of oxygen is a recurring problem with excessive time delay between suspected contamination and actual proof. Additionally, in closed or semi-closed cycle breathing systems, the accumulation of gaseous contaminants produced by men and equipment compounds the problem. The objective of this effort to develop analytical technics to quantitate in a reliable and technically simple manner, the gaseous contaminants present in the breathing atmosphere. This effort supports ATC surgeon's requirement for a rapid means of measuring lox contaminants.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0849, METEOROLOGICAL TRACER TECHNIQUES - SERVICE AND METHOD IMPROVEMENT
A.E. OKEEFFE, Victoria Univ. of Manchester, *Manchester, England, United Kingdom*

The activities within this task are directed towards the development of gas chromatographic procedures to simplify and improve sensitivity of the technique to classical meteorological tracer gases such as SF 6 and to provide technical consultation to the Division of Meteorology as needed. Through contractual research, one or more alternate tracer gases will be synthesized for plume and air mass dispersion experiments.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0850, ATMOSPHERIC POLLUTION BY DIESEL ENGINES
R.A. FOSBERRY, Motor Indus. Res. Assoc., *Warwickshire, England, United Kingdom* (005078)

Methods of measuring diesel exhaust smoke are being studied. Investigations were carried out to determine (1) the relation

between subjective assessments of diesel exhaust smoke and objective measurements, and (2) the correlation between exhaust-smoke measurements made by different types of smokemeters. Results from the first part of the work show that the smoke levels at which observers object depend on both density and volume of smoke. They are higher for small engines than for larger ones and are lower for light colored than for dark colored vehicles. In the second part of the work, correlation was established between readings obtained with two commercially available smokemeters. Smoke readings obtained under steady-speed conditions are compared with readings obtained from free-acceleration and controlled acceleration tests on vehicles.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

1.0851, AIR POLLUTION SENSING

C.H. NELSON, U.S. Natl. Aero. & Space Adm., Langley Research Center, *Hampton, Virginia* 23365

The objective of this work is to develop techniques and systems for the remote detection and measurement of atmospheric pollutants from aircraft and orbital spacecraft. A nondispersive radiometric sensor for use in aircraft is being developed to verify a promising sensing technique for carbon monoxide, and will be expanded for flight measurements of other gaseous atmospheric pollutants. Ground measurements of the spectral characteristics of highly polluted urban atmospheres are being obtained from a mobile van containing an infrared monochrometer which views the sun's spectrum through a long atmospheric path. The development of instrumentation and technology on this RTOP will provide the basic design information for satellite systems or monitor air pollution levels and provide data on temporal and spatial distributions of pollutants wich are needed to allow development of analytical models to predict pollution levels and establish pollution controls. The investigator shown above is the Project Monitor whose telephone is 703-827-3825.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0852, DETECTION OF SMALL AMOUNTS OF SO2 IN ATMOSPHERE

J. BECHER, Old Dominion University, Graduate School, *Norfolk, Virginia* 23508

A study to determine the feasibility of detecting pollutants in a controlled atmosphere is proposed. The method to determine the species and quantity of pollutants consists of condensing the pollutants onto a cooled total internal reflection crystal. Data are then obtained from the absorption spectra. A method relying on condensating small quantities of gases in multicomponent mixtures has been reported by Rochking.

Since the absorption coefficients of many of the gaseous pollutants ore large in the middle UV region (1200 Å degrees - 3000A degrees) of the spectrum, we propose to direct our investigations into that area.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0853, NAVY ENVIRONMENT SUITABILITY OF SALIVA SAMPLING FOR MONITORING BLOOD LEVELS OF INHALED POISONS AND OF ADMINISTERED MEDICATION

J.F. BORZELLECA, Virginia Commonwealth Univ., School of Medicine, *Richmond, Virginia* 23219 (N00014-68-A-0510-0001)

Technical Objective: The monitoring of blood concentrations of various materials, particularly toxic substances in the atmosphere, medication used to control or prevent disease and disability, and metabolic products which can serve as indices to fitness for duty, becomes a special Naval problem in many situations imposed by advancing Naval technology. In particular, the drawing of blood samples at intervals is difficult or impossible in closed, isolated quarters such as undersea habitats. Saliva offers promise of yielding the same information without need for skilled technical assistance in collecting samples, and without debilitating effects on the monitored individual. It is the purpose of this research to establish the knowledge needed to make such medical management feasible and reliable.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0854, EVALUATION OF A NEW 'CRYOGENIC SAMPLER' FOR FIELD USE

R.A. RASMUSSEN, Washington State University, School of Engineering, *Pullman, Washington* 99163

The major objective of the proposed investigation is to evaluate quantitatively a new environmental sampler, concentrator, and sample storage system for trace organics. The emphasis of the study is to refine the field use procedures to obtain maximum field utility and collection precision within the design criteria. The weakness of present cryogenic freeze-out systems in use in the laboratory is their restricted field utility and performance. The sampler developed is a compact, portable, self-powered unit for remote area operation, constructed of electropolished stainless steel and cleaned of organics in a high vacuum at 400 degrees C. The sampler is easily operated, has a high intake volume controlled by a critical orifice with a repeatibility of plus or minus 2%. Operation is very dependable and simple, with no frost-clogged lines, and has a first stage enrichment factor of 1000 fold. The development of a usable field collection system for trace organics would be a major asset in the study of the composition of natural clean atmospheres and polluted atmospheres.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0855, ATMOSPHERIC BOUNDARY LAYER TURBULENCE

T.W. HORST, Battelle Memorial Institute, *Richland, Washington* 99352 (AT)

The structure and dynamics of atmospheric turbulence and organized convective motions in the planetary boundary layer are being studied with the goal of prediction turbulence levels and parameterizing their role in the horizontal diffusion and vertical transport of atmospheric contaminates as a function of mean meteorological conditions. Experimental measurements utilize fast-response instrumentation mounted on towers, buoys, and aircraft for the simultaneous measurement of turbulent fluctuations of wind velocity, temperature, and humidity over both land and water surfaces. The mean meteorological conditions and their changes with time are simultaneously recorded with additional instrumentation. Various statistics and spectral distributions of these measured quantities and their auto- and cross-correlations are computed and studied along with the actual turbulence records in order to determine, as a function of height and thermal stability, the relative magnitudes of the several terms in the turbulent energy budget and the variation of the vertical fluxes of momentum, heat, and moisture.

Results: Turbulent fluctuations of temperature and wind were measured simultaneously at heights of 4 m, 16 m, and 58 m along with mean vertical profiles of temperature and wind. Steps necessary for the derivation of the surface Reynolds stress from cup anemometer wind profiles measured over nonideal terrain have been outlined and the vertical gradient of momentum transport resulting from the synoptic scale horizontal pressure gradient has been demonstrated. Turbulence data were also collected from the Florida State University's TRITON buoy as part of the BNW participation in BOMEX and reduction of this data begun.

SUPPORTED BY U.S. Atomic Energy Commission

1.0856, INFLUENCE OF AEROSOL CHARACTERISTICS ON VISIBILITY

R.J. CHARLSON, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

We propose to continue this research project, concerned with the effects of atmospheric aerosols and their properties on visibility, by investigating several directly related areas. Activities to date include the development of the integrating nephelometer, and studies with it related to mass concentration, wavelength dependence of light scattering, spatial distribution of aerosol and humidity dependence of visibility. Since this last area has only

been examined briefly, and because it depends on a better knowledge of aerosol chemistry, it will be studied much more extensively.

The role of the chemical composition of aerosols to their physical and optical response to increased humidity remains as an important and relatively unexplored problem. Preliminary work has shown that the nephelometer can be used for in situ studies at humidities approaching 100%. Field experiments at the sea-shore and at Pasadena have shown interesting but, as yet, unexplained effects at high (70-90%) and low (20-40%) RH respectively. The main thrust of the proposed renewal will be to examine the interrelationships of the three basic variables: 1) the amount, composition and size distribution of particulate matter, 2) humidity, 3) optical properties. In order to do this, it will be necessary to develop techniques for determining the necessary chemical properties. It is also desirable to continue to study methods for evaluation of the appropriate optical quantities. Extensive field experiments are envisaged in keeping with our approach in the past, including joint experiments with the Whitby team.

The past three years of research have had practical significance based on both scientific and technical results. An integrating nephelometer based on our drawings is being manufactured and used widely in both research and monitoring of visibility degradation. Perhaps more significance should be attached to the use of the (mass).(visual range) product as the basis of Chapter 3 of 'Air Quality Criteria for Particulate Matter.' The proposed research should have the same sort of significance. Specifically, criteria relating mass concentration and visibility as a function of composition and humidity can be anticipated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0857, NUCLEAR METHODS OF ANALYSIS
R.F. STEWART, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia*

Purpose: Continue development of nuclear methods of analysis for process control in the coal industry; tests of a neutron moisture meter have been completed and emphasis will be placed on testing a sulfur meter for coal.

Development of a continuous sulfur meter for coal is needed because of the national interest in air pollution from coal burning and because of the steel industry's emphasis on low-sulfur metallurgical coal.

A nuclear method has been developed for monitoring sulfur in coal samples as large as 4,000 pounds. Confirming tests with high sulfur oils and water solution indicate a sensitivity better than 0.05 percent sulfur. However, tests with moving coals are required to solve problems in material handling and bulk density changes. A coal recycle pilot plant has been completed for further testing of a sulfur meter. Initial operation demonstrated the need for lined buckets and density compensation and further tests are planned on completion of equipment modification.

The project was started in fiscal year 1961. A neutron moisture meter was completed in fiscal year 1969. Testing of a relatively slow sulfur meter will be completed in fiscal year 1970 and development of a fast sulfur meter in fiscal year 1971.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0858, AN INTEGRATED SYSTEM FOR SAMPLING STACK EMISSIONS
R.F. STEWART, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia*

This is a packaged system capable of automatic, continuous, and unattended operation for (1) sampling stack gases, (2) recording the concentration and size of particles in the gases, and (3) recording the various types and amounts of gases.

Work in F.Y. 1971 will be to continue the development of the EGD dust moniter in the laboratory. Work in the three previous fiscal years has shown that EGD can be applied to the simultaneous determination of the mass flow of dust and particle size in a gas stream. Work in F.Y 1971 will be with air as the carrier gas through the EGD channel and with the simultaneous feeding of two or more size fractions of fly ash in the air. Factorial experiments are employed in these tests to relate the variables to current outputs from the EGD monitor. If this work can be completed in F.Y. 1971, the next step will be similar tests in the laboratory using stack gas instead of air. The final step would be field tests of the EGD unit and the isokinetic sampling package.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

1.0859, SATELLITE PLATFORM
V.E. SOUMI, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

Demonstrate the feasibility of measuring total atmospheric pollution by measuring electromagnetic transmittance through the atmospheric limb, by indirect sensing techniques, using ground and co- orbiting satellite-borne electromagnetic energy receivers and sources.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0860, SURVEILLANCE - LOW TEMPERATURE PROPERTIES OF ELECTRONIC MATERIALS FOR DETECTION DEVICES
C. TERRY, Univ. of Wyoming, School of Arts, *Laramie, Wyoming* 82070 (N00014-71-C-0388)

Technical Objective: The work performed at low temperatures will characterize the behavior of prototype materials and assess suitability of certain physical effects which have technological importance for surveillance and communications. Effects in materials finding application in infrared systems, low loss radar waveguides, thermoelectric devices, and fast response detectors are studied down to 0.003 K.

SUPPORTED BY U.S. Dept. of Defense - Navy

H. BASIC RESEARCH

Basic Chemical and Physical Properties of Pollutants. Theoretical And Laboratory Studies Concerned With Air Pollution Formation, Identity, and Effects.

1.0861, HETEOGENEOUS REACTIONS IN AIR POLLUTION
G.D. BLYHOLDER, Univ. of Arkansas, Graduate School, *Fayetteville, Arkansas* 72701

It is the overall objective of this project to determine the role of particulate matter in chemical reactions occurring in the atmosphere. In the coming year we hope to: 1. determine the mechanism of the moderate temperature photochemical oxidation of CO by O2 on ZnO. 2. get started examining the photocatalytic and thermal catalytic oxidation of hydrocarbons on ZnO. 3. establish the structure of the species produced by NO2 on iron oxide and the products of reaction of these species with propylene and isopropanol. 4. establish the nature of the interaction of SO2 with iron oxide and the products of the reactions of alcohols and unsaturated hydrocarbons over iron oxide. 5. determine adsorption properties and reactions of atmospherically important molecules with CaSO4 as a start to examining the role of salts in the atmosphere.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0862, PHOTOCHEMISTRY OF SUBSTANCES PRESENT IN URBAN AIR
H.S. JOHNSON, Univ. of California, Graduate School, *Berkeley, California* 94720

In an effort to identify the organic peroxyl (or other) radicals that rapidly convert NO to NO2 in photochemical smog, we have studied the kinetics of the formaton of nitrous acid vapor, HNO2, from H2O, NO, and NO2; and we have studied the spectra and kinetics of the HOO and ClOO free radicals. Further work is in progress where we specifically look for CH3OO and CH3(CO)OO free radicals and where we scan the spectrum of the mixture NO2, O2, and simple olefins to see what free radical or other fast intermediates are present. Also, we are seeking to effect a substantial improvement in the performance of our new 'molecular modulation' methods.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0863, CATALYTIC REDUCTION OF OXIDES OF NITROGEN
E.E. PETERSEN, Univ. of California, School of Engineering, *Berkeley, California* 94720

Work on the catalytic reduction of nitric oxide by carbon monoxide will be continued during the next grant year.

Studies of nitric oxide reduction with carbon monoxide over a copper chromite catalyst have shown that at low temperatures or high space velocities N2O is formed as a final product rather than N2. During the next project period it is proposed to examine this phenomenon as it relates to fundamental phenomena occurring at the catalyst surface. For this purpose infrared absorption will be used to identify the form of the adsorbed reactants and the nature of the reaction intermediates on the catalyst surface.

A second area which will be examined is the relation of catalyst oxidation or reduction to its activity for the NO-CO reaction. In this study a single pellet reactor will be used. In addition to examining the effects of operating with reactant mixtures which are overall oxidizing or reducing, it is proposed to study the effects of small amounts of oxygen on the ability of the catalyst to reduce NO.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0864, PHOTOLYTIC OXIDATION IN THE PRESENCE OF NO2
S. JAFFE, Calif. State College, School of Letters, *Los Angeles, California* 90032

The photolytic oxidation of olefins in the presence of NO2 is under study in this laboratory. It has been found that simple epoxides, aldehydes and ketones are among the products of the reactions of oxygen atoms with olefins. We have recently investigated the reactions of propionaldehyde and ethylene oxide in the presence of NO2 and light with the objective of determining mechanisms and rate constants that would indicate that these secondary reactions are of importance in the photochemistry of air pollution. The objective of the proposed work is to investigate the reactions of acetone, propylene oxide, methyl ethyl ketone and butyl aldehydes in the presence of NO2 and light to extend our knowledge of the effect of these compounds on the total process.

In addition, butenes will be irradiated in the presence of NO2 and varying quantities of O2 to determine the effect of molecular oxygen on the process. Earlier work has indicated that as the O2 pressure is increased, the competition for O atoms by O2 to form ozone is important. The subsequent oxidation rate of the olefin is then reduced since the oxidation rate with O2 is slower than that with O atoms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0865, POLARIZATION OF E.M. RADIATION IN A POLLUTED ATMOSPHERE
Z. SEKERA, Univ. of California, Graduate School, *Los Angeles, California* 90024

The proper evaluation of the relative importance of the various photo-chemical processes which occur in a polluted atmosphere is greatly facilitated by an understanding of the physical laws governing the interaction of the incoming radiation with the pollutant. It has been well established that the polarization features of the ambient radiation field exhibit a very sensitive dependence on these physical laws. Hence it is proposed to make multicolor measurements of the polarization features of the ambient radiation field in the near ultraviolet and visible regions of the spectrum from aboard a helicopter at various levels in and outside the pollutant layer over the Los Angeles basin. The results of these measurements will be of relevance in estimating how pollutant layers with different profiles define the resultant radiation field. Such an estimation is possible since theoretical solutions to the problem of radiative transfer in a turbid atmosphere are available.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0866, CATALYSTS FOR AUTOXIDATION OF TOXIC GASES
J.P. COLLMAN, Stanford University, Graduate School, *Palo Alto, California* 94305

Sulfur dioxide has been found to react with oxygen in the coordination sphere of transition-metal compounds to form coordinated sulfate. Similar reactions occur between carbon monoxide and oxygen to yield carbonate. Transition-metal clusters have been shown to be active catalysts when nitric oxide is present as a ligand.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0867, CONDENSATION NUCLEI AND AEROSOL POPULATIONS RELATED TO FOG FORMATION
E. ROBINSON, Stanford University, Graduate School, *Palo Alto, California* 94305 (DAHC04)

To determine the origins of sulfur compounds found in Pacific maritime aerosols and their relation to condensation processes, discover whether chloride ions are removed from fog droplets by reactions proposed by Robbins (1959) and whether removal depends on droplet size, and determine the effects of mixed populations of condensation nuclei on cloud condensation processes. Fog is one of the most important atmospheric conditions affecting Army operations. It influences military functions as detection and communications and directly affects the mobility of ground troops, and especially Army air operations. This project aims at increased knowledge about the initial stages of fog formation through a field study in a section of California where fog is being frequently formed to the west of the coast.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0868, CHEMICAL AND SPECTROSCOPIC INVESTIGATION OF AIR POLLUTANTS
D.P. BURCHAM, U.S. Natl. Aero. & Space Adm., Jet Propulsion Laboratory, *Pasadena, California*

To contribute to the elimination of air pollution by investigating the chemical processes occurring in air pollution using the techniques of photochemistry and spectroscopy. Chemical studies will focus primarily on the photochemical production of air pollutants. Information from these studies is necessary in order to formulate realistic models of the chemical interactions occurring in the pollution process and to provide a meaningful basis for the establisment of acceptable pollutant concentrations in the atmosphere and in emission sources. studies by providing information of the detection, identification, and measurement of abundance and variation of pollutant molecules or radicals in the atmosphere. This part of the program utilizes the existing facilities for high resolution UV, visible and infrared spectroscopy at the Jet Propulsion Laboratory. This research can lead to effective control of pollutants by understanding their origin and production. The investigator shown above is the Project Monitor whose telephone is 213-354-3028.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0869, MECHANISMS OF PHOTOCHEMICAL REACTIONS IN URBAN AIR
J.N. PITTS, Univ. of California, School of Letters, *Riverside, California* 95606

Reactions of possible importance in photochemical air pollution are being investigated. Photochemical studies include: (1) reactions of lead halides, both as finely dispersed particles and in aerosols, with other atmospheric pollutants such as ethylene, etc., and (2) reactions involving olefins and aromatics in the presence of oxygen, systems which are photochemically active due to oxygen-enhanced absorption which allows light in the actinic region (lambda greater than 300 nm) to be absorbed. Studies of the thermal (dark) chemistry of the reactive 'high energy' products of photochemical smog, ozone, nitrogen dioxide and peroxyacyl nitrates, are in progress.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0870, SINGLET MOLECULAR OXYGEN - OXIDATION IN POLLUTED AIR
J.N. PITTS, Univ. of California, School of Letters, *Riverside, California* 95606

Research is under way to elucidate the role of singlet molecular oxygen as an environmental oxidant. Specifically, the importance in photochemical smog of reactions which produce O2(1 delta) and which consume it will be evaluated. Spectroscopic techniques using a germanium photodiode detector sensitive at 1.27 microns are being used to determine the production of O2(1 delta) by four paths possible in real atmospheres: 1) direct absorption of actinic light, 2) oxygen- enhanced absorption of organic pollutants, 3) gas phase photosensitized reactions and 4) exothermic chemical reaction of ozone.

Absolute rate constants and mechanistic information are being obtained for the reactions of O2(1 delta) in the mm range with a variety of pollutants including olefins. The rates of total quenching of O2(1 delta) are followed by means of the germanium photodiode detector. In the ppm range, which simulates actual atmospheric conditions, long path length infrared (LPIR) techniques are being employed using chemical 'traps'. Studies on the possible effect of externally generated O2 (1 delta) on biologically significant molecules, bacteria, plants and plant tissue are being carried out.

Concurrently with the laboratory studies the relative importance of singlet oxygen, ozone and oxygen atoms as environmental oxidants will be evaluated. The results of this research will be applied directly to the problem of developing models for photochemical smog in real systems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0871, PHOTOCHEMICAL REACTIONS IN A FLOW REACTOR
E.R. STEPHENS, Univ. of California, Air Pollution Research Center, *Riverside, California* 92507

This project is designed to investigate and compare synthetic and natural aerosols. Synthetic aerosols are prepared by a variety of techniques in a tube flow reactor which can be operated with or without ultraviolet irradiation. Techniques of aerosol generation range from simple vaporization of fuming sulfuric acid to irradiation of multicomponent mixtures such as olefin nitrogen oxides sulfur dioxide in air. In addition to gas chromatography and other techniques for measurement of gases and vapors, two major techniques are available for characterizing the aerosols. These are particle counting by light scattering and infrared study of impacted aerosol. The latter technique uses an impactor especially designed to maximize the efficiency of infrared analysis. Both techniques are applied to the natural aerosol of polluted air and to synthetic aerosol.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0872, IMPLEMENTATION OF A LABORATORY AUTOMATION SYSTEM
J. KRAUT, Univ. of California, Graduate School, *San Diego, California* 92038

The objective of this project is to assemble a versatile laboratory automation system. A general purpose digital computer owned by the Department of Chemistry of the University of California, San Diego, has been interfaced in a time sharing mode to several laboratory instruments. This will allow automatic control of several experiments and result in efficient accumulation and processing of large amounts of data. The automated system will greatly increase the power and scope of our experiments in high resolution X-ray structure of proteins, molecular beam studies of the chemical reactions of air pollution, and magnetic resonance studies of protein denaturation, which projects are funded by several individual research awards.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0873, AIR POLLUTION CHEMISTRY BY PHOTOFRAGMENT SPECTROSCOPY
K.R. WILSON, Univ. of California, Graduate School, *San Diego, California* 92038

By use of a new form of molecular spectroscopy which we have developed, photofragment spectroscopy, we propose to study in detail the photodissociation steps in air pollution. Specifically, we propose to determine, as a function of photon energy, the symmetries of the excited molecular states leading to dissociation, and the identities, translational and internal energies, and often the detailed distribution among internal states of the photodissociation fragments.

The technique of photofragment spectroscopy involves crossing a molecular beam of the molecules to be studied with pulses of polarized light from a laser and detecting the photodissociation fragments with a mass-spectrometer. The molecules which we propose to study are nitrogen dioxide, alkyl nitrites, ozone and various carbonyls.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0874, THE CHEMISTRY AND PHOTOCHEMISTRY OF AIR POLLUTANTS
A. HASSNER, Univ. of Colorado, School of Arts, *Boulder, Colorado* 80304

Nitro compounds and alkyl nitrates are recognized as contributors to air pollution. We propose to study the basic chemistry of representative nitro olefins and alkyl nitrates with emphasis on synthesis, reactions, photochemistry, stereochemistry and isomerizations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0875, TRACER STUDIES IN AIR POLLUTION - SULFUR DIOXIDE
P. URONE, Uni.. of Colorado, Graduate School, *Boulder, Colorado* 80302

The photochemical reactions of sulfur dioxide in controlled atmospheres in the presence of moisture, nitrogen oxides, and hydrocarbons have not been unequivocally established as to reaction rates or reaction products. The relative roles of particulate matter and aqueous aerosols in the catalysis of the thermal heterogeneous reactions of sulfur dioxide in polluted atmospheres have also not been clearly established and in particular with respect to the reaction products formed. The possibilities of secondary or long-term sulfur dioxide reactions, as could happen in stagnant polluted atmospheres, need to be carefully checked.

It is desired to investigate these types of reactions in some detail. Radio-chemical tracer techniques using 35SO2 or 14C tagged compounds in combination with microchemical and specialized gas chromatographic methods will give valuable information both as to rates of reaction as well as type of reaction products formed. Such information is of value in establishing air quality criteria and emission standards.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0876, STUDIES OF O ATOM REACTIONS OF ATMOSPHERIC IMPORTANCE
R.B. TIMMONS, Catholic University of America, Graduate School, *Washington, District of Columbia* 20017

Work will continue on the reactions of oxygen atoms with low molecular weight organic compounds. Major emphasis will be focused on the oxidation of aromatic compounds, such as benzene and toluene. The absolute rate constants for these reactions will be determined by the measurement of the atom decay signals of the oxygen atom as followed by its electron spin resonance absorption. In addition product analysis of the reactant stream will be attempted using gas chromatographic and mass spectrometer techniques. There are at present virtually no data available on the chemical kinetics and mechanismsm of the reaction of oxygen atoms with aromatic compounds.

We also intend to employ the ESR technique to investigate the chemical kinetics of the reactions of O2(1 delta g) with various compounds. At present, the most promising reactions would appear to involve unsaturated molecules containing the methoxy group. It is hoped that these studies will lead to a better appreciation of the factors involved in the reactions of O2(1 delta g).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0877, THEORETICAL AERONOMY

A.E. GREEN, Univ. of Florida, Graduate School, *Gainesville, Florida* 32601

Support is provided for theoretical studies of aeronomic phenomena, including 1) ionospheric heating and ionic composition, 2) nighttime F-region transport loss and airglow effects, 3) aerosol scattering, and 4) radiative transfer.

SUPPORTED BY U.S. National Science Foundation

1.0878, STATISTICAL METHODS IN AEROSOL STUDIES

R.A. BRADLEY, Florida State University, School of Arts, *Tallahassee, Florida* 32306

The literature on air pollution will be surveyed to collect statistical distributions of aerosols (inorganic as well as organic aerosols). The statistical validity, interrelationships, properties of these distributions and their applicability to descriptions of aerosol systems will be discussed. Emphasis will be placed on distributions involving both aerosol size and number of particles as random variables. The material will be prepared in a form suitable for publication as a review paper in one of the air pollution journals.

The effect of 'filtration' on statistical distributions will be studied. Filtration is defined to be any process that alters the statistical properties of an aerosol 'system'. For a given statistical description of such an aerosol system we will study the form of the distribution as modified by filters whose efficiency depends on (1) aerosol size, (2) aerosol velocity and (3) filtration duration. A second category of problems involves determining confidence limits on filter efficiency. Finally, the optimally efficient arrangement of sequences of filters will be studied. Some of this work will involve computer simulation.

The deposition of aerosols under coalescence will be considered as a stochastic process. A stochastic model with random aerosol input and settling effects will be studied. The statistical distribution of aerosols will be used as a measure of air pollution.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0879, PHOTOCHEMICAL STUDIES BY ESR SPIN TRAPPING TECHNIQUES

E.G. JANZEN, Univ. of Georgia, School of Arts, *Athens, Georgia* 30332

A technique is being developed for the detection and identification of gas phase free radicals. This involves having the radicals add to a nitrone function which produces a relatively stable nitroxide radical. The nitroxides give esr spectra which are characteristic of the radical trapped and can be detected at very low concentrations (approximately 10 to minus 7 M) due to the high sensitivities of esr spectrometers. Radicals can be detected at low pressures (approximately 10 to minus 3 mm Hg) by having the radicals flow over solid phenyl N-t-butyl nitrone in a vacuum line. The radicals add to the nitrone and produce the nitroxide. However at these pressures at room temperature the nitroxide volatilizes off the surface of the solid nitroxide and can be trapped in a liquid nitrogen down stream. We are using an esr tube for this trap and detecting the nitroxides produced by esr techniques. By this method methyl radicals have been detected from the photolysis of acetone, trifluoromethyl and pentafluoromethyl radicals from photolysis of the corresponding iodides, and 2-hydroxypropyl from the photolysis of 1:1 mixtures of acetone and isopropyl alcohol.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0880, CHEMISTRY AND PROPERTIES OF OZONIDES

P.R. STORY, Univ. of Georgia, Graduate School, *Athens, Georgia* 30601

The purpose of this research project is to investigate several aspects of the chemistry and properties of ozonides. Investigations concerning the mechanisms of ozonide reductions, photo- and thermochemistry of ozonides, and the photo- and thermochemistry of ketone peroxides will be continued. This research project is also concerned with gas phase photolyses and thermolyses of ozonides and peroxides. Examination of ozonide hydrolysis, both acid and base catalyzed, will continue.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0881, FORMATION OF NONVOLATILE PARTICULATES FROM ORGANIC VAPORS

C. ORR, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332

This investigation is seeking (1) to establish the parameters under which particulates of low volatility are formed from low concentrations of a variety of organic vapors in air when exposed individually to X- rays or ultraviolet light, (2) to determine the chemical (polymeric) composition of particulates so formed, and (3) to elucidate the mechanism of the formation. Such physical parameters as time of exposure, vapor composition, and the resulting particulate size distributions have been inter-related; some tests for composition have been completed, but these results are not yet inclusive or conclusive; and the reaction mechanism, or mechanisms, remains to be established.

Since the atmosphere contains traces of organic vapors coming from many sources and is exposed to both X-ray and ultraviolet radiation, it seems inescapable that the experiments being conducted duplicate natural processes that contribute to air pollution.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0882, HOMOGENEOUS NUCLEATION IN CONTAMINATED ATMOSPHERES

C. ORR, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332

The behavior in inert atmospheres of submicron condensation nuclei under changing humidities has been described in previous publications from this group. Current research is endeavoring to describe the influence of contaminating vapors on nuclei behavior. These vaporous contaminants are either condensed as molecular layers on particulate surfaces or absorbed by droplets into a homogeneous solution. The transport of moisture to or from the particulates during the processes of condensation or evaporation will thus be altered.

Several experimental procedures are being utilized so that particulates of a wide range of sizes can be studied. The relationships among droplet size, properties of the nuclei, relative humidity, the time required for the formation and disappearance of the droplets, and the composition of the atmospheric contaminations are being studied under conditions of changing relative humidity. The experimental results will be analyzed in accordance with theoretical considerations for the widest possible application.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0883, PHYSICAL CHEMISTRY OF AEROSOLS

F.T. GUCKER, Indiana University, School of Arts, *Bloomington, Indiana* 47401

Experimental studies involve rapid methods of determining light- scattering diagrams from single aerosol particles in milliseconds rather than minutes. For the diagrams, we will study both analog display on an oscilloscope and digital readout for storage in the the memory of a computer interfaced to the apparatus.

The theoretical studies involve calculations of light-scattering diagrams for particles of various refractive indices and sizes, for which our new methods are faster than the classical Mie equa-

tions. The matching of the measured and calculated diagrams will be studied for the number and angular positions of extrema and for intensity readings at different angular intervals in order to determine the size and eventually other parameters such as refractive index and shape of individual particles from the measurements.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0884, OXIDATION MECHANISMS ON SUPPORTED CHROMIA CATALYSTS
R.G. SQUIRES, Purdue University, School of Engineering, *Lafayette, Indiana* 47907

The long range goal of the proposed research is to simultaneously apply spectral, gravimetric and kinetic analysis to heterogeneous catalytic systems in order to gain a better understanding of the mechanism of the processes occurring on the surface of a catalyst during a chemical reaction. In this study we propose to make simultaneous gravimetric and infrared spectral studies during adsorption and also simultaneous kinetic and infrared spectral studies at reaction conditions during the oxidation of carbon monoxide and light hydrocarbons on a supported chromia catalyst.

Automobile exhaust emissions are a major source of hydrocarbons and oxides of nitrogen which react photochemically in the atmosphere to produce smog. Thus, our choice of catalyst and reactions was made because of the practical importance of catalytically reducing the emission of hydrocarbons and carbon monoxide in automobile exhaust, thereby eliminating our major source of air pollution in many of our cities. However, in addition to giving us a better insight into the oxidation mechanisms on supported chromia catalysts, the proposed study should result in techniques which will be applicable to many other catalytic systems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0885, ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THE REACTION KINETICS OF MAJOR AIR POLLUTANTS
S.L. WITTIG, Purdue University, School of Mechanical Engin., *Lafayette, Indiana* 47907

The proposed study is a combined analytical and experimental effort to determine the kinetic data, i.e., frequency factors and activation energies, and the mechanisms of the gas phase reactions of major air pollutants. Based on studies currently under way, the decomposition of selected hydrocarbons and their reactions with nitric oxides in particular will be investigated.

A new experimental approach will be applied by using a single pulse shock tube in combination with a time-of-flight mass spectrometer and spectroscopic and interferometric methods. Thus inherent limitations of the classical physical-chemical methods can be avoided. Also the experimental parameters, especially temperature and pressure, can be varied in almost unlimited ranges. A comparison with the list of Air Pollution Control Research Grants, NAPCA, and the literature shows that the approach suggested is unique.

With the data obtained by the proposed research, a gap should be closed, which is the main barrier for successful work in pollution control and in related areas of human medicine, botany, meteorology, and design of industrial plants.

SUPPORTED BY Purdue University - Lafayette, Ind.

1.0886, DIFFUSION IN TURBULENT SURFACE LAYERS
V.W. NEE, Univ. of Notre Dame, School of Engineering, *Notre Dame, Indiana* 46556

The research proposed here is a combined study of analytical and experimental investigation on the turbulent diffusion of pollutants in a surface layer. The primary objectives of this research are: 1. To develope, with experimental verifications, a general theory of turbulent transport of mass and heat in the surface layer based on a new differential field turbulent theory of the principal investigator. 2. To establish a general computing program which can be used for - ground or elevated point, line, multiple points and area source -stable, neutral and unstable atmosphere, - smooth, rough and built-up surface, to obtain the pollutant distribution at all downstream locations, and serve as a realistic model for air pollution system analysis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0887, NUMERICAL MODELING OF OXIDATION REACTION SCHEMES
J.T. DEHN, U.S. Army, Ballistic Research Labs., *Aberdeen Proving Ground, Maryland* 21005

Technical Objective: To model some of the sub-reaction in the general hydrocarbon oxidation problem. Not only will the carbon monoxide scheme be modelled but the effect of the addition of hydrocarbons to carbon-monoxide oxygen mixtures and the role of carbon- monoxide in hydrocarbon oxidations will be modelled.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0888, TOXIC MATERIALS IN NUCLEAR SUBMARINES
P.P. DEMAS, U.S. Navy, Ship Research & Dev. Lab., *Annapolis, Maryland* 21402

Technical Objective: Conduct fundamental research studies to determine the outgassing properties and degradation characteristics of nonmetallic materials and to assess their contribution to atmosphere contamination in closed ecological systems. Information from these studies will generate the technical basis for the selection of submarine materials which will contribute minimally to the contamination of the atmosphere and hence effect a means of source contamination control.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0889, PHOTOSENSITIZED OXYGENATIONS
A. NICKON, Johns Hopkins University, School of Arts, *Baltimore, Maryland* 21218

Photosensitized oxygenation of mono-olefins is known to produce allylic hydroperoxides with the double bond adjacent to its original location. The reaction is attractive as a tool for organic synthesis and as a possible pathway for certain biological oxidations. By working with molecules of rigid geometry (e.g., steroids) and with deuterium labeled substrates we hope to get detailed information on the mechanism of the reaction including its geometric aspects. Through a study of secondary isotope effects we hope to define the geometry of the transition state and thereby to discriminate between a one-step cyclic mechanism and a two-step process involving discrete intermediates. The oxygenation reaction will be extended to hetero-containing systems (e.g., azines) to explore their behavior. Experiments are planned that could reveal how some sensitizers transfer energy to oxygen to produce excited oxygenating species. In view of the potential implication of excited oxygen in atmospheric reactions that create air pollutants and in pathways for biological oxidations, fundamental studies of all aspects of the properties and behavior of excited oxygen are particularly important.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0890, LABORATORY STUDIES OF NON-THERMAL ENERGY TRANSFER PROCESSES BETWEEN ATMOSPHERIC MOLECULES
R.E. MURPHY, U.S. Air Force, Cambridge Research Labs., *Bedford, Massachusetts*

Technical Objective: AF function - detection, surveillance, early warning, reconnaissance, and homing. Deficiency - optical infrared backgrounds interfere with detection systems, particularly during and after atmospheric nuclear explosions. Inadequate information concerning molecular/atomic processes contributing to the radiative character of the atmosphere. Research - laboratory studies of phenomena contributing to the generation, transfer, degradation and radiation of internal molecular energy. How research contributes - permits sensors to detect targets against a nuclear-induced optical/infrared background. The objective is to conduct controlled laboratory studies to determine the

mechanisms and character of excitation of atmospheric species, perform theoretical studies to describe the dynamic state, population, and spectral character of both equilibrium and non-equilibrium gases. Basic parameters are measured to allow the radiative condition of the atmosphere to be predicted and calculated under a variety of circumstances, particularly when disturbed by nuclear detonations

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0891, THE RELATION BETWEEN IONIC AND RADICAL BOND CLEAVAGE
P.D. BARTLETT, Harvard University, School of Arts, *Cambridge, Massachusetts* 02138

New ways of generating singlet oxygen from ozone and from oxidation of secondary hydroperoxides are under investigation. An isotope-effect study is being made of competing or merging mechanisms in the ene and cycloaddition reactions of singlet oxygen. The special conditions under which biradicals may be captured are being studied. New free-radical initiators of azo and peroxy type are being made for controlled introduction of free radicals at low temperatures. The behavior of a monoallylic biradical which may close to a 6-ring is being scrutinized.

Syntheses involving cycloadditions of chloroketenes involve some characteristic rearrangements which are being further studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0892, DISPERSION OF AIR POLLUTANTS
J.A. FAY, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

A continuation of a theoretical and experimental study of the motion of buoyant plumes in a stratified atmosphere. The theoretical study incorporates fluid mechanical models of plume motion and leads to methods for correlating field observations of plume rise as well as laboratory model experiments. The laboratory experiments are measurements of mean plume motion in a small scale stratified flow wind tunnel (1' x 1' x 5'). The tunnel flow is thermally stably stratified.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0893, ELECTRICAL CHARGING OF SMALL PARTICLES AT LOW PRESSURES
B.Y. LIU, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414 (AT)

Objectives. The objectives of the proposed work for the coming year include: (1) to study the statistics of the particle charging process in the transition and the free molecular regimes and the effect of the image force on the charging process. (2) To study the inertial deposition of aerosol particles in turbulent pipe flow with particular reference to the effect of the roughness of the pipe. (3) To study the filtration of aerosol particles by fibrous filters at low pressures.

Procedure. The charging studies will involve generating a monodisperse polystyrene latex aerosol, charging it under conditions of known ion concentration and charging time and precipitating the particles in a cylindrical mobility analyzer of high resolution. The resulting charge distribution will be measured by counting the deposited particles in a microscope. The results will be compared with values predicted by theory. The filtration studies will involve predicting the filter performance using the Kuwabara-Happel flow field and comparing with experimentally measured filter efficiencies at low pressures. The turbulent deposition studies will involve measuring the deposition velocities of aerosol particles as a function of particle size and comparing the results with a new deposition theory being developed.

Some preliminary data on the charging studies have been obtained. The results show that for the 0.5 micron diameter particles charged under conditions of diffusion charging the charge distribution is approximately log-normal with a geometrical standard deviation of approximately 1.1. This compares well with the theoretically predicted value of 1.08 for the geometrical standard deviation.

SUPPORTED BY U.S. Atomic Energy Commission

1.0894, CHEMISTRY OF SINGLET OXYGEN FROM OZONE SOURCES
R.W. MURRAY, Univ. of Missouri, School of Arts, *Saint Louis, Missouri* 63121

It has been shown that ozone reacts with a variety of organic substrates to generate singlet oxygen. This observation is of importance to the air pollution problem since ozone is a common and highly toxic pollutant. The reactions of singlet oxygen with various organic substrates will be studied. The substrates will include those which will permit us to study photodynamic action by comparing our reaction products with those obtained from photosensitized oxidation. Oxidation of simple disulfides using the triphenyl phosphite ozonide has been shown to give thiolsulfinates and thiolsulfonates. These products as well as the relative reaction rates will be compared to those obtained using photosensitized oxidation. The oxidation of alpha-lipoic acid and suitable derivatives of the DNA bases with singlet oxygen will also be studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0895, E.P.R. STUDY OF PHOTOREACTIONS IN THE ATMOSPHERE
E. WASSERMAN, Rutgers the State University, School of Chemistry, *New Brunswick, New Jersey* 08903

We are studying the transformation of NO to NO2 by molecular oxygen using e.p.r. techniques. metastable excited states of oxygen may be important in the process. We are also concerned with products, and the mechanism of their formation, which may arise on reaction of nitrogen oxides and oxygen with organic species present in the vapor phase.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0896, NAVY ENVIRONMENT - EFFECT OF ATMOSPHERIC CORONA ON ION SPECTRA AND WEATHER
S. CHAPMAN, Unknown Inst. Or Indiv. Grant, *New York* (N00014-71-C-0324)

Technical Objective: It is the objective of this research to determine the extent to which natural corona changes the mobility spectrum by changing natural atmospheric particulates and also pollutants in the atmosphere. This additional slower moving material can shift the mobility spectrum sufficiently to affect thunderstorm development and consequently becomes a factor in the naval weather forecast. Additionally, the information would provide reference data on any detection system dependent on the observation of ion mobility spectra.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0897, REACTIONS OF SO2 WITH HYDROCARBONS, CO AND H2
S.H. BAUER, Cornell University, School of Arts, *Ithaca, New York* 14850

Studies of homogeneous reactions in the gas phase at high temperatures between the pollutant SO2, which is a strong oxidizing agent, and reducing agents, of which CO and C2H2 are type representatives, have uncovered several interesting facts, as detailed below. During the coming year the single-pulse shock tube technique which has proved effective for the above investigations will also be used for exploring the SO2 plus H2 reaction. However, it appears that in this case single-pulse data will have to be augmented with spectroscopic data recorded during shock conditions, so that quantitative estimates of the instantaneous concentrations of SO2, OH, and S2 will be available to complement the analytical results on the quenched product gases.

The kinetic results obtained during the past twenty (20) months show that due to its great stability SO2 reacts only slowly with carbon monoxide or hydrocarbons at temperatures below 1700 degrees K and that the end products of such reactions are not the ones calculated by statistical thermodynamics. To

facilitate the low temperature conversion of CO to CO2, or C2H2 to H2O and CO2, while the SO2 is reduced to elementary sulfur heterogeneous catalysis will have to be used. At sufficiently high temperatures, when the SO2 does react, the expected products are obtained and plausible mechanisms for these processes have been developed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0898, PERACETOXYL RECOMBINATION
M.J. GOLDSTEIN, Cornell University, School of Arts, *Ithaca, New York* 14850

The mechanism of peracetoxy radical recombination in the gas phase is being investigated by studying photo-initiated oxidation of 18 O- acetaldehyde. The behavior of acetoxy radicals in the gas phase is concurrently under investigation using 18 O-labeled acetyl peroxide.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0899, STUDIES OF AIRBORNE PARTICULATES OF SUBMICRON SIZE
G.H. KUBIE, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)-49)

The formation of many air pollutants is influenced by the presence of sub-micron sized particles acting as condensation nuclei. The object of this project is the study of the conditions of formation and of the properties of sub-micron particles formed in gaseous systems. Its aim is the development and testing of equipment for the controlled production of sub-micron sized aerosols and their study under a variety of conditions with special reference to their behavior as condensation nuclei and their assay by diffusion measurements. In this connection the formation of nuclei by the action of ionizing radiation on gases provide a model for their formation under natural conditions. The production of particles formed by the action of thoron gas on air and other gases will be a major object of study in this respect. The design and use of a thoron source giving dry gas uncontaminated by organic and other volatile components is a prerequisite for the scheduled work.

RESULTS: A method for the production of condensation nuclei by air blast atomization has been described (mean particle size 0.01 - 0.02 micron) and their measurement by the diffusion method has been studied with the use of a G.E. condensation nuclei counter. The effect of the pulsatory conditions imposed by the use of this counter have been analyzed and they have been shown to be of minor importance with the use of a parallel plate diffusion battery.

SUPPORTED BY U.S. Atomic Energy Commission

1.0900, ASPECTS OF CHEMICAL REACTIONS OF AIR POLLUTANTS
K. MOROKUMA, Univ. of Rochester, School of Arts, *Rochester, New York* 14627

Though it is well known that the photochemical smog formation is initiated by photodecomposition of nitrogen dioxide and partly of organic aldehydes or ketones, the nature of these primary photodissociation processes is not well understood or is rather confused experimentally. The object of the proposed research is to establish details of the kinetics of the processes theoretically.

The objectives of theoretical works are (1) calculation of the potential energy surfaces relevant to photochemical primary processes and (2) calculation of trajectories of the systems on these potential energy surfaces.

The first system we plan to study is formaldehyde. The excitation energy dependence of quantum yield or rate of two competing photodissociation processes leading to H plus HCO and H sub 2 plus CO, respectively, is to be studied. First, the potential surfaces of ground and excited states are calculated with an ab initio SCFCI method. Once the potential surfaces are obtained, trajectory studies on these surface will be carried out, which will clarify the mechanisms and energetical dependence of two processes as well as the product energy distribution.

Nitrogen dioxide and nitrous oxide will be next systems. For the former the shape of the reaction path and its relationship to the product energy and momentum distribution will be studied, and for the latter the identification of the actual photodissociation mechanism out of several possibilities will be emphasized.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0901, STUDY OF THE EFFECT OF CARBON MONOXIDE ON THE RATE OF PHOTOOXIDATION OF HYDROCARBONS IN THE PRESENCE OF ULTRAVIOLET LIGHT & OXIDES OF NITROGEN
J.J. BUFALINI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Preliminary work in our laboratory has shown that the rate of nitric oxide oxidation in the presence of hydrocarbon-NOx and ultraviolet light is enhanced when CO is added to the system. Since urban atmospheres always contain considerable quantities of CO it is mandatory that the role of CO is understood in these systems. This study will cover the broad range of hydrocarbons and oxygenated hydrocarbons to determine the role of CO in these systems. Such factors as hydrocarbon consumption rate, NO oxidation, product formation, NO2 dosage, and oxidant dosage will be investigated in the presence and absence of carbon monoxide.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0902, EVALUATION OF THE EFFECTS OF SO2 AND NO ON THE PHOTOCHEMICAL REACTIVITY OF AIR PARCELS OF THE N.Y.C. - N.J. AREA
S.L. KOPCZYNSKI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Dual air samples will be collected in large plastic bags, with one serving as the control sample and the other charged with a known amount of NO or SO2. The two bag samples will be irradiated simultaneously under identical conditions, except for the NO or SO2 concentration. The reactions will be followed with analyses for NO, NO2, SO2, individual hydrocarbons, peroxyacetyl nitrate, aldehydes, total oxidant, and ozone. The effects of NO and SO2 will be evaluated on the basis of rate of oxidation of NO, rate of loss of hydrocarbons, and production of total oxidant, ozone and other products of the reaction.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0903, MEASURE AND COMPARE REACTIVITIES AND COMPOSITION OF AIR PARCELS FROM BAYONNE, LINDEN, WILLOWBROOK, AND BRONX (ABBREV)
S.L. KOPCZYNSKI, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Parcels of air from the various localities will be collected in large plastic bags and irradiated in situ with sunlight. Quantitative analyses will be made for specific reactants and products during the course of the irradiation. Ozone, total oxidant, NO2 and peroxyacetyl nitrate concentrations, dosages, and rates of formation will be related to initial concentrations of specific hydrocarbons, nitric oxide, SO2 and to ultraviolet light intensity.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

1.0904, TRANSITION METAL CHEMISTRY OF TWO COMMON AIR POLLUTANTS
W.A. MCALLISTER, East Carolina University, School of Arts, *Greenville, North Carolina* 27834

The principal purpose of this study is to examine the relationship between bonding to a transition metal and the metal's activity as a catalyst. I propose to use far infrared spectroscopy to investigate this bonding in some model compounds. I have chosen carbonyl, nitrosyl, and mixed carbonyl nitrosyl complexes because of their possible usefulness as catalysts in anti-pollution devices, and because of their interesting bonding. The far infrared spectra will yield data on the force constants for the M-CO and M-NO bonds, an these force constants should be related to the metal's activity as a catalyst for the oxidation of CO to COsub2 and reduction of NO to nitrogen.

1. AIR QUALITY

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0905, ELEMENTARY REACTIONS IN POLLUTED ATMOSPHERES
G.R. MCMILLAN, Case Western Reserve Univ., School of Science, *Cleveland, Ohio* 44106

Certain elementary free radical processes occurring during photoinitiated oxidation in polluted air will be studied using the methods of photochemical kinetics. The reactions of alkoxy radicals with oxygen and nitrogen dioxide will be studied by photolysis of an appropriate alkyl nitrite in the presence of nitrogen dioxide and oxygen, and the competition followed by long path infrared spectrophotometry. The alkoxy-oxygen reaction has been suggested to be an important chain propagating step in the nitric oxide to nitrogen dioxide conversion and in the carbon monoxide cleanup cycle. This research may lead to assessment of the importance of this and other fates of alkoxy radicals in exhaust-polluted atmospheres.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0906, PHOTOCHEMICAL GAS-PARTICLE INTERACTIONS
G.R. MCMILLAN, Case Western Reserve Univ., School of Science, *Cleveland, Ohio* 44106

The work examines the chemical effects on gases following light absorption by solid particulates in contact with the gases. Electronic energy transfer to the gas at the gas-solid interface will be examined to determine the mechanism of the transfer, to define some of the experimental parameters in heterogeneous photochemical systems, and to determine possible chemical consequences of absorption of light by surfaces in contact with oxygen and typical pollutants.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0907, ELEMENTARY REACTIONS IN PHOTOCHEMICAL SMOG
W.E. WILSON, Battelle Memorial Institute, *Columbus, Ohio* 43201

The objective of this grant program is to contribute to the quantitative understanding of photochemical smog by measuring the reaction rates of some of the important elementary reactions. This involves four steps: (1) Measuring rate constants of elementary reactions thought to be important, (2) discovering new elementary reactions which are important, (3) developing techniques for measuring rates involving species such as OH, HO sub 2, delta O sub 2, RO sub 2, RO, R(CO)O sub 2, R(CO)O, (4) using the rates and mechanisms obtained in the program to predict the smog reaction path. The efforts of past years have been devoted largely to developing methods for measuring OH reactions and identifying new reactions and species which are important in photochemical smog.

Accomplishments during the first year include (1) development of techniques for measuring OH reactions; (2) experimental evidence for the conversion of NO to NO sub 2 by the chain reaction CO plus OH yields CO sub 2 plus H, H plus O sub 2 yields HO sub 2, HO sub 2 plus NO yields NO sub 2 plus OH; (3) discovery of a long lived radical which converts NO to NO sub 2 in the dark and which reacts with SO sub 2; (4) discovery of the reaction of SO sub 2 with the product of the NO sub 2 plus O sub 3 reaction; (5) the discovery that water vapor apparently plays an important role in the gas phase chemistry of photochemical smog; (6) development and use of a kinetic computer code for prediction of the smog reaction path.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0908, MECHANISMS OF PHOTOCHEMICALLY INITIATED OXIDATION
J.G. CALVERT, Ohio State University, School of Mathematics, *Columbus, Ohio* 43212

The major research objective of this investigation is the elucidation of the chemical reactions which occur in the usual polluted atmosphere. Three distinct areas of research contribute to the program: 1) The study of the mechanism of the photooxidation of various organic and inorganic compounds which are common contaminants of the various urban atmospheres (sulfur dioxide, formaldehyde, nitric oxide in olefin mixtures, etc.). 2) The characterization of the reactive intermediates and transients formed in these systems, and the quantitative determination of the rate constants for their various thermal reactions. 3) The use of these rate constant data, together with other available kinetic data, to test possible models of the reaction mechanisms operative in the real atmospheres using computer techniques.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0909, MATRIX-ISOLATED SPECTRA OF NITROGEN OXIDES
W.A. GUILLORY, Drexel University, School of Engineering, *Philadelphia, Pennsylvania* 19104

It is proposed to continue using the method of matrix-isolation to make a systemic study and identification of the stable and unstable oxides of nitrogen trapped in various environments at liquid helium/hydrogen temperature. The results of this study will not only prove valuable to the fields of spectroscopy and kinetics, but also to the problem of photochemical air pollution. It is well known that reactions involving oxides of nitrogen play an integral role in the production of air pollutants, however, the elementary processes and intermediates have proven difficult to ascertain. Our studies to date have indicated that this method is ideal in identifying some of these proposed intermediates. We have further observed that ultraviolet photolysis of selected stable molecules produces atomic species which are mobile in matrices, allowing characterization of elementary atomic mechanisms which occur in the atmosphere.

Therefore, investigation of these two facets of photochemical air pollution, i.e. identification of stable and unstable pollutants and the characterization of elementary processes resulting from photochemical absorption, is proposed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0910, ATMOSPHERIC DIFFUSION OF RADON
H. NEWSTEIN, Drexel University, Graduate School, *Philadelphia, Pennsylvania* 19140

An understanding of the nature of the variability of the turbulent diffusion coefficients both in elevation and in time is essential for a rational program of effective air pollution control. To this end, a 1000 ft. TV tower has been instrumented and is currently in operation. Measurements of wind direction and speed, temperature, and concentrations of SO sub 2 and Radon are being made and recorded continuously and automatically at various elevations above the ground. Drexel Institute of Technology proposes to continue to measure these parameters over a sustained period of time so that statistically meaningful data may be obtained and used as the basis for the development of models of turbulent diffusion that will be more applicable to urban areas than are at present available. Intercomparisons will be made of the diffusion coefficients derived using different parameters so as to optimize the coefficients developed. A sufficiently long period of observations will permit the study of how these diffusion coefficients are related to a variety of synoptic situations, conditions of stability of the air and directions from which the wind is blowing in relation to the city and rural and urban areas.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0911, THE KINETICS OF GAS-SOLID SURFACE REACTIONS AT ELEVATED TEMPERATURES
W.L. WORRELL, Univ. of Pennsylvania, Materials Science Center, *Philadelphia, Pennsylvania* 19104 (DAHC-15-65-C-0215)

Technical Objective: The objectives of this research are to measure the rate and to determine the mechanism of the surface reaction of H2S(G) with iron and iron sulfide. The results are essential for a detailed understanding of the corrosion of iron in sulfur atmospheres at elevated temperatures.

SUPPORTED BY U.S. Dept. of Defense - A.R.P.A.

1.0912, CONVERSION OF NO TO NO2 IN POLLUTED ATMOSPHERES

J.P. HEICKLEN, Penn. State University, School of Science, *University Park, Pennsylvania* 16802

We are attempting to find paths which convert NO to NO2 in urban atmospheres. We believe that two paths of importance are: (1) RO2 plus NO yields RO plus NO2, where RO2 is an alkylperoxy radical and (2) RO plus O2 yields R'O plus HO2; (3) HO2 plus NO yields HO plus NO2, where RO an an alkoxyl radical and R'O is an aldehyde or ketone.

Two systems have been examined. In one, CH3N2CH3 has been photo- oxidized to produce CH3O2 radicals. In the presence of NO, NO2 is produced. The pertinent reactions are: (1) CH3O2 plus NO yields CH3O plus NO2, and (2) 2CH3O2 yields 2CH3O plus O2. The predicted rate law for the quantum yield of NO2 production, phi(NO2), is phi(NO2) equals k6(NO/(k7Ia) to the one-half power, where Ia is the rate of absorption by CH3N2CH3 of the radiation. This law was obeyed and K4/k5 to the one- half power, was found to be (6.5 M to the minus one-half power) (sec to the minus one-half power). Rotating sector experiments will be done to obtain absolute values for the k4 and k5. Then azoethane will be examined to obtain the same information for C2H5O2 radicals.

In the second system, CH3ONO was photolyzed to produce CH3O radicals. In the presence of both O2 and NO, NO2 was produced in a manner consistent with reactions 2 and 3. Higher analogs of CH3ONO will be examined. Also the reactions of alkoxy radicals with CO, NO2 and SO2 will be studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0913, THE REACTON OF METALLOPORPHYRINS WITH AIR POLLUTANTS

J.C. FANNING, Clemson University, School of Arts, *Clemson, South Carolina* 29631

Metalloporphyrins play a vital role in biochemical processes of living matter. The metalloporphyrin molecules are planar, or nearly so, and their biochemical reactivity is, in many cases, due to their ability to add at least one molecule to the perpendicular positions about the molecular plane. Common air pollutants, nitrogen dioxide, nitric oxide, or sulfur dioxide, may react with, or add to, the metalloporphyrin and prevent it from functioning in its normal manner.

Solid metalloporphyrins, or related compounds, are to be reacted with the above gases at various temperatures and pressures, with and without the presence of moisture, and the products studied. The spectral and magnetic properties of the products will be measured. The reactions will be carried out in solution and comparisons made between the solid state and solution reactions. Of especial interest will be those metalloporphyrins which react in a reversible manner. The decomposition pressures of these adducts will be measured. This study should contribute to the understanding of the reactivity of common air pollutants with, and their bonding to, metalloporphyrins.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0914, TURBOPROPULSION AUGMENTOR EXHAUST EMISSIONS INVESTIGATION

L. CRAWFORD, Univ. of Tennessee, School of Engineering, *Knoxville, Tennessee* 37916 (F33615-71-C-1125)

Technical Objective: This effort will develop an analytical model of the combustion process in the afterburning system of a turbine engine, to predict its exhaust emission characteristics. The model will be capable of describing specifically the formation and extinction characteristics and the concentration levels of the undesirable and toxic exhaust products.

SUPPORTED BY U.S. Dept. of Defense - Air Force

1.0915, DYNAMICAL THEORIES OF KNUDSEN AEROSOLS

J.R. BROCK, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

The objective of work done under AP00479 is to describe in as rigorous manner as possible the processes involved in the nucleation, growth, and transport of aerosol particles in the submicron size range. Two important areas are receiving particular attention. One is concerned with accurate descriptions of the changing rates and total change as a function of time of submicron aerosol particles in the presence as well as in the absence of external electric fields. The effects on the charging rate of the image force, polarization, and non- equilibrium ion velocity distribution functions are all under consideration in the theoretical description. The other area receiving extensive investigation concerns the size distributions of aerosols and of the atmospheric aerosol in particular. Stochastic models yielding the so-called Junge distribution for the size of continental aerosols are being studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0916, THE REACTION OF O('D) ATOMS WITH WATER VAPOR

B.A. DEGRAFF, Univ. of Virginia, School of Arts, *Charlottesville, Virginia* 22903

The objectives of this research are to determine the relative rates of reaction for the various reactions of O('D) atoms in the photolysis of moist ozone, to test which of the several possible mechanisms is responsible for the chain decomposition of moist ozone, and finally to learn as much other detailed information about the system as the techniques of flash and kinetic spectroscopy will allow.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

1.0917, LASER ANEMOMETER STUDY OF TURBULENT DIFFUSION AND TURBULENT SHEAR FLOWS

J.B. MORTON, Univ. of Virginia, School of Engineering, *Charlottesville, Virginia* 22903

The primary aim of this research project is to advance the basic understanding of inhomogeneous turbulence and the turbulent diffusion process. A laser anemometer will be used to measure statistical properties of turbulent shear flow in a wind tunnel and to measure local, instantaneous particle concentrations.

SUPPORTED BY U.S. National Science Foundation

DESCRIPTION OF RESEARCH TASKS

2. WATER QUALITY

A. SOURCES OF POLLUTION

Projects Concerned Primarily With the Origin of A Water Pollutant (e.g., Eutrophication, Environmental Cycling, Runoff, Erosion, and Sedimentation). Includes Unusual Pollutant Sources Or Special Interest Sources (e.g., Oil Spills, Trace Element Pollution, Dredging, Rain-atmosphere Washout, Radioactive Fallout).

2.0001, DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS

J.M. LAWRENCE, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00287)

OBJECTIVE: Determine the seasonal abundance of various algae in ponds with different levels of fertility. Determine the seasonal macro and micro nutrient composition of filterable suspended matter, the filtered water, and the hydrosol from ponds with different levels of fertility. Determine changes in nutrient and algal species composition associated with different algal control practices. Investigate techniques for management of algal species in ponds with different levels of fertility.

APPROACH: Samples of water, suspended matter and hydrosol will be collected from unfertilized, fertilized and fed fish ponds at various times throughout the year. Algae will be identified and its inorganic chemical composition determined. Inorganic composition of waters and hydrosols will also be determined. Changes in algal associations and chemical composition resulting from chemical and biological control practices will be investigated. Data accumulated in above investigations will be evaluated by appropriate statistical methods. Based upon data accumulated above, techniques for selected desirable phytoplankton and subsequent seeding into ponds will be investigated.

PROGRESS: Techniques to estimate the standing crop of major plant nutrients (N,P,K) in a farm pond were employed on a number of experimental ponds. The standing crop of nutrients within a 22-acre pond, which had received 51,500 lbs. of organic fish feed in the prior 7-month growing season are given below. Of the total 150 lbs/a N added in feed, 8.5 lbs/a was in solution, 15.6 lbs/a was in suspended matter (phytoplankton), and 46.9 lbs/a was in catfish. The other 79 lbs/a N was lost to air and soil. Of the total 18 lbs/a P added in feed, 1.2 lbs/a was in solution, 4.3 lbs/a was in suspended matter, and 17.3 lbs/a was in catfish. The 4.8 lbs/a P deficit was apparently supplied by the soil. A total of 26 lbs/a K was added in feed, but 48 lbs/a was in solution, 4.5 lbs/a was in suspended matter, and 2.6 lbs/a was in catfish. The 29.1 lbs/a K deficit was apparently supplied by soils in pond and watershed. The suspended matter (phytoplankton) was 95% Microcystis sp., with Rhaphidiopsis sp., Oscillatoria sp., and Spirulina sp. making up the other 5%.

SUPPORTED BY U.S. Dept. of Agriculture

2.0002, ENTERIC VIRUS SURVIVAL IN ESTUARINE WATERS

E.W. AKIN, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Dauphin Island, Alabama* 36528

This project is concerned with determining the survival characteristics of human enteric viruses in the hydrosphere. This includes, but is not limited to, drinking water, recreation waters, and reclamation waters. The fact that enteric viruses continuously pollute the waters and waterways of our nation is not only empirical but also has been substantiated by experimental observations. Sound judgements regarding the role of water in the transmission of diseases by viruses is virtually impossible without critical knowledge of their survival in the water environment. The intent of this project is to provide definitive information on virus survival so that a realistic indication of the health hazards of viruses in water may be intelligently assessed. Initially, survival characteristics of four human enteric viruses (coxsackie virus B-1, echo virus 6, reovirus 1, and polio virus 1) will be compared in laboratory studies with waters having various characteristics. Consideration will be given to such factors as adsorption, aggregation, temperature, and salinity, to name a few. Survival studies of selected enteric viruses will also be conducted under quasi-natural conditions of estuaries. This project was started in January 1969 and is continuing.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0003, DEVELOPMENT OF A HYDROLOGICAL CONCEPT FOR THE GREATER MOBILE METROPOLITAN-URBAN ENVIRONMENT

G.M. LAMB, Univ. of South Alabama, School of Arts, *Mobile, Alabama* 36608

The specific objectives of the research proposed are to study the hydrologic system, both the surface and the groundwater systems, of the greater Mobile metropolitan-urban area and its environs. The information gained will assist in the formulation of adequate procedures for the orderly development and management of the water resources of the area. Qualitative and quantitative hydrologic methods of study will be used to provide data necessary to evaluate the amounts of surface and ground water available for development. Existing salt water encroachment problems will be studied and potential areas of these problems will be defined and evaluated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0004, FATE OF TRACE-METALS (IMPURITIES) IN SUBSOILS AS RELATED TO THE QUALITY OF GROUND WATER

W.E. NELSON, Tuskegee Institute, Graduate School, *Tuskegee Institute, Alabama* 36088

The proposed research involves laboratory and field studies directed at securing information linking the interaction of fertilizers applied to agricultural lands and the movement of the applied cations in run-off and ground water, the quality of drainage water, and the physicochemical properties of soils. Leaching columns will be used in the laboratory in simulating field conditions to study the following variables in relation to the movement of metal ions: (1) soils of different texture, cation exchange status, organic matter content, and pH; (2) different moisture regimes-continuous leaching with cation free water and solutions containing the metal ions in increments, after equilibrium has been established. The content of metal ions in surface (run-off) water and the water which reappears in streams, creeks, lakes, and wells will be determined. This will be correlated with the content of metals in the soils at varying depths of the watersheds associated with the sampled waters.

Laboratory and field data will be compared for final interpretation of the fate of trace-metals in subsoils, and their relationship to the quality of ground water.

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2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0005, FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS
W.E. NELSON, Tuskegee Institute, George W. Carver Res. Found., *Tuskegee Institute, Alabama* 36088

Laboratory observations have suggested that the interactions of zinc ions with the organic matter of two soils varying widely in genesis, and physical and chemical properties were ion-exchange, surface absorption, coagulation, precipitation, and chelation. Further observations have also shown that the mechanism of retention for part of the metal in the soil was similar to a molecular sieving action observed for Sephadex. The investigation proposed herein is prompted by the idea that all metal ions can undergo a similar entrapment by molecular sieving. Thus the experiments are especially designed to shed more light on this mechanism, and thereby to subsequently make recommendations for its use as a means of suppressing the uptake of radioactive metals by plants. The proposed program has the more specific goals: (1) To secure more evidence on the formation and nature of organic-metal compounds in soil; (2) To investigate more thoroughly the molecular sieving action of soil, Sephadex, and other organic substances in retaining metals in an insoluble, non-displaceable, or unavailable state; (3) To observe the rate of breakdown of the organic- metal insoluble systems by micro-organisms usually present in the soil environment.

To meet these objectives a thorough study will be made of the reactions of different soils, Sephadex, water insoluble chelating and complexing agents, and sequestering agents with metal ions. It is proposed to relate the mechanisms of metal absorption to the structures of the ligand molecules and in so doing these structure correlations can be extended to other systems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0006, CONTROL OF IRON BACTERIA IN WATER WELL SYSTEMS
R.M. ALVERSON, State Geol. Survey, *University, Alabama* 35486

The purpose of the project is to study the sources and accumulation of iron bacteria in water well systems and to experiment with mechanical, physical, chemical, and biological control systems. The studies are being undertaken in an area having a known iron bacteria problem. Various types of well screens will be installed and an attempt will be made to isolate and identify iron bacteria from field samples. A model laboratory system will be developed in an attempt to duplicate field conditions.

SUPPORTED BY Alabama State Government

2.0007, TOTAL ORGANIC CARBON AS A POLLUTION CONTROL PARAMETER IN SUB-ARCTIC WATERS
E.W. MUELLER, U.S. Dept. of the Interior, Federal Water Quality Admin., *College, Alaska* 99701

Organic materials are one of the major sources of natural pollutants in arctic waters. The scope of this research is to evaluate a number of methods for determining the concentration of organic materials in the natural waters of Alaska. The approach will involve a series of experiments with oxidation of the organics to carbon dioxide and measurement of the carbon dioxide in a non-dispersive infrared analyzer. Combustion will be accomplished both at high temperatures in a stream of oxygen, and through wet chemical oxidations. Typical compounds will be used as standards to determine the effectiveness of the method. Comparison will be made between chemical oxygen demand of field samples and the values found by total carbon determination.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0008, PATHWAYS OF TRACE ELEMENTS IN ARCTIC LAKE ECOSYSTEMS
R.J. BARSDATE, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735 (AT(04-3-310.PROJ.04)

This project is concerned with the geochemical cycling of metals, the effect of biological activity on this cycling and the relationship between the forms in which metals occur and their ecological significance.

The metals under study are copper, cobalt, iron, manganese and zinc, and, to a lesser extent, the more abundant cations of natural waters. The objectives are to identify or define chemically distinct metal compartments (which consist of the various species in the water and particulate phases), to measure the amount and rate of transfer of metals in these compartments, and to determine the factors and processes responsible for the observed distributions.

Quantitative determinations of trace metals are made by anodic stripping voltammetry (for Cu and Zn) and by atomic absorption (Cu, Co, Zn and some Mn and Fe samples are preconcentrated). Dialysis, gel filtration, radioactive tracers and electrochemical methods are used in combination with the quantitative determinations for the study of metal binding by organic ligands, and when necessary, organic complexes are destroyed by photochemical (UV) oxidation or persulfuric acid digestion. The distribution of exchangible metal between dissolved and particulate (e.g. clay) phases is measured with tracer techniques.

Dissolved organic complexes of transition metals have been detected in all high latitude lakes so far examined, but they are dominant only in colored, organic-rich waters. Other recent findings indicate that the processes of complexation by organics and sorption by clays interact through competition for dissolved metals present in simple inorganic forms.

SUPPORTED BY U.S. Atomic Energy Commission

2.0009, DYNAMICS OF THE NITROGEN CYCLE IN LAKES
V.A. BILLAUD, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The transformation rates within the freshwater biological nitrogen cycle are under investigation using the stable isotope of nitrogen, 15N as a tracer. The role of the nitrogen cycle in the productivity regimes of lakes, in bloom development, in under-ice winter metabolism are all included. The role of denitrification is emphasized, as well as nitrogen fixation, both under aerobic and anaerobic conditions. Possible heterotrophy or mixotrophy under winter and spring ice-cover are investigated using tritium labeled organic compounds. Gas chromatography is being used to study gas production during anerobic metabolism in lake waters. Detailed limnological studies of lakes in the subarctic are concurrently being carried out.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0010, THE INFLUENCE OF DECOMPOSING SALMON ON WATER CHEMISTRY
J.J. GOERING, Univ. of Alaska, Inst. of Water Resources, *College, Alaska* 99735

Waters of high ammonia content have been observed in the vicinity of seafood processing plants. High ammonia levels have also been observed in the estuaries of Southeast Alaska following the entrance of the salmon into the freshwater streams to spawn. Approximately fifty per cent of the Pacific salmon (Oncorhynchus sp.) biomass returns to the estuaries in the form of organic decomposition products. The decomposition and remineralization of these waste products can alter the nutrient chemistry and ecological environment of the estuary, and possibly of larger water masses. This project shall study the biological and chemical dynamics of the decomposition of salmon carcasses, both in fresh water and in an estuary. Studying this decomposition phenomenon in a natural environment will, hopefully, elucidate the rates and mechanisms of the chemical transformations that accompany the breakdown of fish flesh. It might also reveal the capacity of the ecosystem to handle quantities of organic seafood wastes without presenting a pollution problem.

The high protein content of fish flesh suggests that nitrogen studies would be an effective method for following the decomposition. Water chemistry studies on nutrient concentrations and additions will be performed prior to, during, and following spawning. In vitro studies on the products of decomposition of fish flesh will be carried out in the laboratory. Marine productivity and fertility experiments will be conducted using C14/labeled bicarbonate, chlorophyll determinations, and N15 labeled compounds. An attempt will be made to correlate metabolite concentrations of freshwater with the survival of salmon eggs. The infor-

mation should be directly applicable to the potential problem of pollution by seafood waste disposal.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0011, DISTRIBUTION OF ORGANICS FROM SALMON DECOMPOSITION

J.J. GOERING, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

This investigation will be concerned with the distribution and fate of the organic material resulting from salmon-carcass decomposition. Preliminary studies were concerned with rates and mechanisms of the chemical transformations that accompany the breakdown of fish flesh, and the resultant effects on the water chemistry of the receiving estuary where decomposition and deposition take place. At this time, it is proposed to determine remineralization rates and transport mechanisms for the organic compounds resulting from the step-wise decomposition process. Attention will also be directed to an investigation of the estuary sediment to determine its composition. The approach will be through the use of 15N-labeled compounds and the 12C/13C isotope ratio and tracer technique, as well as through an intensive water-chemistry study.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0012, DOMESTIC WASTE DISCHARGE INTO A SILT LADEN ESTUARY

R.S. MURPHY, Univ. of Alaska, Inst. of Water Resources, *College, Alaska* 99735

Waste discharges into Cook Inlet, Alaska will be studied to determine their effect upon waters of a far-northern, glacial silt laden, partially ice covered estuary. Existing raw waste outfalls will serve to define the extent of pollution in these waters as compared to nearby but unpolluted regions of the inlet.

Extensive physical, chemical, and biological information is to be gathered and analyzed, its ultimate use to be predictive efforts on the ability of far-northern glacial fed estuaries to assimilate domestic wastes and to determine the degree of treatment which these wastes must be subjected.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0013, CONTROL OF EROSION AND SEDIMENTATION FROM ROAD BUILDING AND LOGGING--ALASKA COASTAL FORESTS

A.E. HELMERS, U.S. Dept. of Agriculture, Pac. N.W. For. & Rg. Exp. Sta., *Juneau, Alaska* 99801 (PNW1604)

OBJECTIVE: Determine factors related to erosion and soil mass movement, streambed characteristics, and water quality and yield; develop measures to improve these elements and salmon spawning habitat.

APPROACH: Studies will be made on salmon streams: effects of watershed characteristics and forest management practices on stream temperature, stream bottom fauna, and fish populations; soil stability: plant-soil stability relationships, effect of timber management on soil movement, and evaluation of stabilizing treatments; hydrology: soil moisture flux, precipitation, and potential evapotranspiration.

PROGRESS: Evidence of two late-Pleistocene glacial advances was found in Maybeso Creek valley. The younger till was deposited by glaciation of regional extent representing the last major glacial advance of classical Wisconsin age in southeast Alaska. The older till may also represent a regional glaciation, tentatively correlated with an intermediate to early-late Wisconsin age. Numerous debris avalanches have occurred in the younger till, many of them accelerated by timber harvesting. Shade is an important factor in maintaining the coolness of streams on clear sunny summer days. On clear sunny summer days the stream temperature increase per 20-yard reach without shade ranged from 0.02 C. to 0.21 C. and in shaded reaches the stream temperature decreased from 0.03 C. to 0.18 C. On overcast summer days the mean temperature increase per 20-yard reach in several streams in each of two areas was 0.011 C. and 0.009 C. Climatic data for 315 stations were analyzed by Thornthwaite's methods to characterize the climates of Alaska and develop a generalized map of potential evapotranspiration. The climates of Alaska range from perhumid warm microthermal in the coastal belt, semiarid warm microthermal in the central interior basin, which is the 'typical' Alaska climate, to semiarid tundra along the Arctic coast. The distribution of natural vegetation coincides reasonably well with estimated potential evapotranspiration.

SUPPORTED BY U.S. Dept. of Agriculture

2.0014, BEHAVIOUR OF RADIONUCLIDES IN MARINE BIOTA

D. BENINSON, Comision Nac. De Energia Atom., *Buenos Aires, Argentina*

Work carried out so far refers to the quantitative determination of the upttake of radiostrontium and radiocesium by several marine species. In the present period it is proposed to extend the work to other species, measuring the Cs-137 concentration factors in laboratory conditions and the strontium-to- calcium discrimination factors through determinations of stable strontium contents in field conditions.

In addition, it is proposed to initiate laboratory work for the determination of concentration factors of other fission products (Ce-144 and Ru-106) and of an activation nuclide (Co-60).

The following species will be studied: Fishes--Austromenidia argentinensis, Percophis brasiliensis, Nautopaedium porosissimus, Merluccius merluccius hubbsi, Eugralis anchoita, Scomper japonicus marplatensis, Cynoscion striatus, Micropogon opercularis. Crustacea-- Hymenopenaeus mulleri, Artemesia longinaris, Pagurus sp, Platixantus crenulatus. Mollusks--Mytilus platensis, Mesodesma mactroides. Algae-- Codium decorticatum, Rhodymenia, Jania rubens, Ulva lactuca.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0015, BLUE-GREEN ALGAE AS A SOURCE OF WATER CONTAMINATION

T.J. MCMICHAEL, State Game & Fish Department, *Phoenix, Arizona* 85023

Objectives: To describe the distribution of blue-green algae on the Three Bar Wildlife area. 1. Collect and preserve samples of algae from water sources on the Three Bar during the summer months. 2. Identify the algae to determine if any of them are known toxin producers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0016, SEDIMENT YEILD FROM RANGELAND WATERSHEDS IN THE SOUTHWEST

K.G. RENARD, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Tucson, Arizona* (SWC-014-GTU-1)

OBJECTIVE: Develop methods for predicting sediment amounts, types, and delivery characteristics from agricultural watersheds of varying sizes, physiography, land use and management.

APPROACH: Establish factors governing amounts and types of sediments produced and their transport. Determine sediment loads in streams and deposited in reservoirs, relating these to rainfall, runoff, topography, geology, soils, land use, and cultural practices. Identify and evaluate production of various types of sediment sources areas, and determine and characterize sediment delivery processes to derive improved equations for estimating sediment yields.

PROGRESS: Observations have shown that the water yield of semiarid areas is greatly affected by sediment deposition in the channels of the watershed as well as in the channels of the major streams to which the watershed may be tributary. Erosion control and sediment movement control into major tributary channels from semiarid watersheds is of great importance to sustained downstream water supplies, as well as to the sustained capability of semiarid rangelands to produce forage. Quantitative changes in the dissolved solids carried in the runoff water on the Walnut Gulch watershed in southeastern Arizona can be accounted for and predicted by knowledge of the source areas receiving rainfall

and possibly by the rainfall itself. Primary soils and the alluvium derived from recent igneous rocks yield runoff higher in potassium and phosphate. One area high in dolomitic material yields a magnesium-rich water. Partitioning of runoff from complex areas is accomplished by a computer program. Investigations on a sediment concentration rating curve in ephemeral streams have been only partly satisfactory. Using purely statistical techniques, the concentration at any time was related to a number of independent parameters descriptive of the flow conditions. Coefficients of determination of about 0.5 to 0.75 were obtained for multiple equations in this work.

SUPPORTED BY U.S. Dept. of Agriculture

2.0017, TRACE AND TRACER ELEMENTS IN GROUND WATER: PHASE III

G.R. DUTT, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-5301-952-149)

OBJECTIVE: Determine the Fe, Mn, Cr6, Ni, Cu, Zn, Pb, Cd, Co, Sr and L concentration in groundwater and effluents from cites, industry and agriculture, study changes in concentration of the above during groundwater recharge, determine factors in soil effecting the concentration of the above and evaluate the above as tracer ions in groundwater.

APPROACH: Water from groundwater and waste effluent sources will be analyzed for the above ions using atomic absorption techniques. Water moving through soils during recharge will be analyzed. Lysimeters will be used to study changes in concentrations. Solubility products for different minerals will be compared to those found in groundwater and soil extracts. A map of iso-chemical classes based on different criteria will be prepared to see if flow regimen in Tucson Basin can be characterized.

PROGRESS: The trace element composition in groundwaters in Arizona was studied. The effect of recharge on the composition of water was determined. The distribution and movement of ions in the Tucson Basin was investigated.

SUPPORTED BY Arizona State Government

2.0018, LIMNOLOGICAL EFFECTS OF ORGANIC WATERSHED LITTER

W.J. MCCONNELL, Univ. of Arizona, Graduate School, *Tucson, Arizona* 85721

An understanding of some important and unique watershed effects on small impoundments in the semi-arid Southwest is sought. The effects for which elucidation is proposed relate to the interaction of a flashflood drainage regime, great seasonal differences in rainfall and the intensely cyclical deposition of organic watershed litter in lakes of the region.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0019, HYDROLOGICAL AND ENVIRONMENTAL CONTROLS ON WATER MANAGEMENT IN SEMIARID URBAN AREAS

S.D. RESNICK, Univ. of Arizona, Water Resources Research Ctr., *Tucson, Arizona* 85721

The objectives of the proposed study are as follows: 1. To initiate and continue rainfall and runoff studies for selected semiarid urban and suburban watersheds relative to differing development intensities and types (residential, commercial and industrial) and to analyze the quantitative effects of various catchment surface properties on runoff under various intensities and duration of rainfall. 2. On a preliminary basis, to establish appropriate sampling criteria, and to sample and analyze the urban runoff for dissolved and suspended organic and inorganic material in order to provide a basis for the evaluation of potential pollutional effects on ground waters of the basin; and to initiate exploratory studies for treatment methods, such as filtration through natural soil or laterally through stands of grass, in the control and management of urban runoff waters. 3. To evaluate the environmental influences on water yield and quality as a basis for investigation of feasible design criteria for storm sewers, water control structures, or drainage and treatment facilities, in order to effect salvage and use of urban runoff and possibly to alleviate existing or potential hazards to public health or safety.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0020, MECHANISMS OF BIOLOGICAL LUXURY PHOSPHATE UPTAKE

I. YALL, Univ. of Arizona, School of Liberal Arts, *Tucson, Arizona* 85721

The objectives of the project are to study the factors and mechanisms involved in the luxury uptake and retention of phosphorus by activated sludge and its bacterial population.

It is proposed to deal with four main aspects of the problem. The first aspect involves studies on the phosphorus uptake, retention, and metabolism of Tucson sludge. This will involve isolating and identifying the radioactive compounds from the sludge exposed to P32 for up to six hours under 'fill and draw' conditions. High voltage electrophoresis, paper chromatography, column chromatography with various ion exchange and ion exclusion resins, and linear gradient centrifugation procedures will be employed.

Other aspects include: 2) Studies on a known strain of 'Zoogloea ramigera', a bacterium which has been reported in various activated sludges; 3) a study of isolated sludge bacteria. We have isolated 85 pure cultures and have developed a screening procedure wh ich compares and classifies an organism's ability to take up P32 from sewage; 4) a survey of sludges from other parts of the country. The screening procedure will permit testing the phosphorus uptake capability of about 40 isolates per week. A computer program will be developed to aid in classifying these bacteria.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0021, LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY

P.M. JOHNSTON, Univ. of Arkansas, Water Resources Research Ctr., *Fayetteville, Arkansas* 72701

The overall objective of this investigation is to evaluate the effects of impoundment and ageing and/or eutrophication of selected Arkansas impoundments on limnological, ichthyological and parasitological water qualities during the past 30 years.

The limnological investigation is to monitor physico-chemical and plankton parameters and to compare with those of the past 30 years. Qualitative and quantitative fluctuations of the plankters will be correlated with the abiotic factors to understand the seasonal cycles. Standardized methods will be employed in the determination of the physico-chemical factors.

The ichthyological study is to determine qualitative and quantitative aspects of te feeding biology of largemouth bass in relation to available food. Seasonal and annual growth rates, length- weight relationship, and condition factor will be studied in relation to abiotic and biotic factors. Standing crops of fish will be evaluated in relaton to physico-chemical factors and plankton.

The parasitological investigation is to study the qualitative and quantitative aspects of the helminth and crustacean parasites of selected game fishes. Effects of parasitism on the fish's condition factor and the overall interrelationships between these aspects and the abiotic and biotic factors will be evaluated to understand the decline in fishing success with the aging of reservoirs.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0022, A STUDY OF PHYTOPLANKTON DYNAMICS IN LAKE FAYETTEVILLE AS A MEANS OF ASSESSING WATER QUALITY

R.L. MEYER, Univ. of Arkansas, Graduate School, *Fayetteville, Arkansas* 72701

The proposed research plan involves an investigation of the algae as primary producers in a lake typical to northwestern Arkansas, Lake Fayetteville. The investigation will include field and laboratory analysis of the chemical, physical and biological factors effecting algal biomass, primary productivity and algal succession.

Field investigations include observation on: 1. The abiotic and biotic factors effecting primary productivity in an intensively studied lake. 2. Samplings from similar lakes will be compared with base lake.

Laboratory investigation would employ isolated and cultured naturally occurring algal species: 1. To identify the parameters to which influence the presence or absence and growth rate. 2. To identify those factors which determine its life cycle.

Field and laboratory data would be correlated to determine which parameter are the most applicable in influencing primary productivity and water quality.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0023, A PRELIMINARY ECOLOGICAL SURVEY OF DARDANELLE RESERVOIR PRIOR TO NUCLEAR FACILITY EFFLUENT DISCHARGE

C.B. SINCLAIR, Univ. of Arkansas, Water Resources Research Ctr., *Little Rock, Arkansas* 72204

The proposed research plan involves laboratory and field investigations directed at the determination of biotic and abiotic parameters of Dardanelle lake water before its utilization as condenser coolant in a nuclear power station. The main approach in the investigation is to observe and analyze the thermal, chemical, and some biological qualities of the water adjacent to the nuclear facility.

Field investigations at the lake would include observations from the following operations: 1. On site measurements of D.O., temperature, pH, and conductivity. 2. Collection of plankton by use of plankton nets. 3. Collection of invertebrate organisms using dredges, multiple plate samplers, and emergence traps.

Laboratory investigations in the University laboratory would employ the following methods: 1. Chloride ion, nitrate ion, phosphate ion, and chemical oxygen demand using specific ion and/or spectrophotometric methods. 2. Qualitative and quantitative determinations of plankton. 3. Qualitative and quantitative determinations for the benthnic fauna.

The laboratory and field data would be correlated to show base line values for the physico-chemical parameters of Dardanelle Reservoir prior to plant activation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0024, THE LIMNOLOGY OF LAKES FORMED BY BAUXITE STRIP-MINING OPERATIONS

G.L. HARP, Arkansas State University, Graduate School, *State University, Arkansas* 72467

The process of strip-mining coal commonly leaves pits which subsequently fill with water. These strip-mine lakes occupy over 65,000 acres of land in Arkansas, Missouri, Oklahoma, Kansas, and Iowa. Initially, many such lakes contain water contaminated with sulfuric acid formed from the oxidation of sulfur compounds associated with the coal. High concentrations of hydrogen ions severely limit the biota in such waters. The acid pollution may render the water and surrounding lands unproductive as regards fish, crops or grazing of domestic animals, for in excess of 50 years.

In contrast to the extensive literature concerning strip-mining for coal, no investigation has been conducted to date concerning the physicochemical or biological characteristics of strip-mine lakes resulting from bauxite mining. This process also results in acid water and polluted landscape.

The purposes of this study are to qualitatively and quantitatively describe the physicochemical characteristics and the aquatic flora and fauna of strip-mine lakes resulting from bauxite mining. Further, this information will be compared with that known concerning coal strip-mine lakes.

SUPPORTED BY Arkansas State University

2.0025, RIVER MURRAY SALINITY (SPECIAL PROGRAMME)

UNKNOWN, Australian Dept. of Engin., *Adelaide, South Australia, Australia*

Origin and Objective of Project: Find location and extent of salt intrusions into the River Murray to show where salinity control may be possible. Stream flow and salinity data have been collected, and computer time is available if required.

SUPPORTED BY Australian Government

2.0026, THE GEOLOGY, HYDROLOGY AND CONTAMINATION OF SHALLOW COASTAL AQUIFERS IN THE ROCKINGHAM DISTRICT, WESTERN AUSTRALIA

J.R. PASSMORE, Univ. of Western Australia, *Nedlands, Western Australia, Australia*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Australian Government

2.0027, STUDY AND IMPROVEMENT OF BIOSPHERE RESOURCES. 1. INFLUENCE OF MERCURY IONS ON DNA-REPAIR AND RECOVERY OF ALGAE

H. ALTMANN, Austrian Atom. En. Study Group, *Vienna, Austria*

Mercury pollution has now become a dangerous problem in some areas. Industrial wastes containing inorganic mercury find their way into lakes, in which it is converted by anaerobes to methylmercury. This highly toxic substance can also produce mutations. Direct interaction of mercury is known with DNA, but it can also block SH-groups and therefore interferes with the repair enzyme system. In this case other mutagenic substances or irradiation can cause irreparable DNA-damage. In our DNA-repair studies we are using synchronous Chlorella culture. For mercury determinations in cells and macromolecules, n-activation analysis is the most sensitive method. Gradient centrifugation in alkaline sucrose is used for DNA repair investigations and berberine sulfate staining to follow the recovery process of cells after irradiation and/or different mercury treatments.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0028, STUDY OF TRACES OF RADIOISOTOPE POLLUTANTS IN THE NORTH SEA AND THE SCHELDT ESTUARY

E. PEETERS, Inst. Royal Des Sciences Nat., *Brussels, Belgium*

During this year, the research will be oriented to the study of trace elements in the waters of the North Sea and in the Scheldt estuary.

This research was conducted to determine dispersion of the radio- elements in the sea environment.

The level of the trace elements will indicate the importance of chemical pollution which is a crucial problem in organic pollutions.

Generally the sequential analysis of phosphates is a very useful indicator of organic pollution and also of the content of nitrites and nitrates.

At the same time, we intend to study the percentage of copper and zinc in the marine organisms localized in a typical coastal biota.

Concerning the analysis of the metallic pollutions in the water, the samples have been taken during the mission of December 1970, January and February 1971 in the North Sea.

The analysis of the phosphates, nitrates and nitrites and also the study of the bacterial pollution is provided for in the present year.

Draggings would be executed for the harvest of marine organisms in the areas where important radioactive pollution has been noted.

During this year an attempt has been made to show the correlation between the bacterial pollution of the sea environment and the chemical factors.

Seawater samples will be analyzed by atomic absorption spectrophotometry for the greater elements or by neutron activation for 12 to 15 elements. Concerning the marine organisms, we shall study the distribution of copper and zinc in the different organs.

Copper and lead will be analysed in molluscs and in the edible fishes of the coast. This analysis will be made first on contemporary samples and afterwards we propose to do comparative work by the study of the samples we have possessed at the Museum for 30 or 40 years.

2. WATER QUALITY

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0029, EXPLOSIVES RESEARCH AND SAFETY--SURVEY OF POLLUTANTS
J.F. GRYTING, U.S. Navy, Weapons Center, *China Lake, California* 93555

Technical Objective: To survey the pollution caused by Navy activities from explosives, propellants and pyrotechnic materials (PEP) and to identify major problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0030, SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL
J.W. BIGGAR, Univ. of California, School of Agriculture, *Davis, California* 95616

Necessary information linking the reactions between pesticide and soil, and pesticide and plants, to the characteristics of each other, the soil solution environment, temperature and water movement is very spotty and incomplete. Thus this proposal is for a project to obtain a reasonable amount of related information on typical soils and selected pesticides related to fixation and movement. Depending upon the type of soil, organic additive and environment, a number of reactions will determine the extent of movement and persistence in soils. The organic additive may be absorbed by soil, exchanged, absorbed by plants, decomposed into more or less mobile, toxic products, precipitated or leached into ground water, drainage water and streams.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0031, INORGANIC & ORGANIC IMPURITIES OF IRRIGATION WATERS AFFECTING SOIL PROPERTIES AND PLANT GROWTH
L.D. DONEEN, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D0-WSE-1529-H)

OBJECTIVE: Investigate effects of kinds and concentrations of salts on soil structure and penetration of irrigation waters into soil; effects on plants of materials dissolved in irrigation waters, degree of accumulation of harmful salines in soil as affected by kinds and concentrations of salts in water, soil conditions, climatic conditions, and practices of growers; study of suitability of sewage effluents and drainage waters as irrigation waters.

APPROACH: Two lysimeter studies are under way. One in the greenhouse includes 2 soils and 13 waters of varying quality. The other is a large outdoor installation employing 9 waters of varying quality from which yield can be obtained. These studies are concerned with infiltration rates, salt balance, leaching requirements for chloride and bicarbonate waters and their effect on soil properties. Miscible displacement in being investigated. This is fundamental to understanding simultaneous solute and fluid transfer processes. Both velocity and diffusional mixing are important, as well as the media itself, in determining distribution of solute.

PROGRESS: Laboratory, field, and computer techniques were employed to investigate the processes and conditions controlling the quality of irrigation water, soil solutions drainage and deeply percolating waters. Emphasis was placed on the salt--and nutrient--leaching patterns in newly developing and older irrigated lands. Computer simulation models were developed and tested to predict solubility, ion association, exchange, sorption, and movement of salts and pollutants under in situ laboratory and field conditions.

SUPPORTED BY U.S. Dept. of Agriculture

2.0032, PROGRESSIVE EUTROPHICATION OF LAKE TAHOE
C.R. GOLDMAN, Univ. of California, School of Letters, *Davis, California* 95616

Lake Tahoe is an oligotrophic, high montane lake whose deep blue color and remarkable clarity are due to extremely low mineral content and productivity. Accelerated eutrophication during the last decade threatens to destroy its natural beauty and much of its economic value. Extensive commercial, urban, and recreational development in the lake's basin has disrupted normal soil stabilzation processes and caused extensive erosion of the upland forest ecosystems. This release of suspended particulate matter and dissolved nutrients to the lake on a massive scale has reduced light penetration and promoted the growth of attached and planktonic algae. Photosynthesis in the lake has increased by 72% in the last decade.

The efficiency of natural ecosystems for protecting soil and conserving eutrophication nutrients has already been demonstrated in the eastern United States. This research will determine the quantitative effects of erosion products on Lake Tahoe, assess the relationship between forest and lake nutrient cycles and investigate the potential of both native and exotic plants for revegetation of eroded high altitude areas in the west. Particular attention will be given to evaluating long-term trends in the lake's heat budget as influenced by turbidity from sediment and algal growth.

SUPPORTED BY U.S. National Science Foundation

2.0033, PLANKTON COMMUNITY ECOLOGY IN NORTHERN CALIFORNIA LAKES
C.R. GOLDMAN, Univ. of California, Graduate School, *Davis, California* 95616

This research is concerned with the dynamics of plankton populations in lakes deriving their water and nutrients from coniferous forests in northern California. Important structural parameters will be calculated for both phytoplankton and zooplankton populations. A detailed study of the structure of the plankton communities in Castle Lake will be done using recurrent group analysis. A multiple regression analysis of the plankton population data and the limnological data important to such populations will be performed in order to uncover the functional relationships of the major species of the plankton. Estimates will be made of the amount of energy flowing through the different compartments of the plankton. After these four kinds of data reduction are completed a model of the plankton systems will be developed which takes into account energy accumulation and species interactions for each important plankton population. The project is to be expanded to include work on bacterial energetics, spatial distributions of phytoplankton, benthos and fish, and zooplankton respiration.

SUPPORTED BY U.S. National Science Foundation

2.0034, EUTROPHICATION OF SURFACE WATERS - LAKE TAHOE
P.H. MCGAUHEY, Lake Tahoe Area Council, *El Cerrito, California* 94530

The project is designed to demonstrate what compounds, nutrients, etc. occurring in the effluent from conventional or advanced waste treatment processes or storm water runoff contribute to the eutrophication of surface waters in general, and in Lake Tahoe in particular. Initial studies will be in laboratory-scale growth units with later studies in plant demonstration ponds.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0035, COLLISIONS IN WASHOUT
T.G. OWEBERG, T.G. Owe Berg Incorporated, *Garden Grove, California* (AT(04-3)-673)

Experiments are conducted to study the motion of a single particle in the vincinity of a falling single drop, simulating the conditions of washout of atmospheric particles by rain. The trajectory of the particle is determined by high-speed photography. The variables are size, charge, and fall velocity of drop and particle. They are measured for each pair of drop and particle. The particle is charged and suspended in a nonuniform ac field with a superimposed dc field. The drop is charged by induction. The falling drop intercepts a light beam and thereby triggers a relay that disconnects the fields, so that the particle falls freely, and opens the shutter of the camera. In order to make sure that particle and drop center are in a plane parallel to the film of the

high-speed camera, a picture is taken with a still camera at right angle to the optical axis. The collision efficiency can be calculated from particle trajectories that barely miss the drop.

RESULTS: Results have been published in J. Atm. Sci. 27 (1970) pp. 435-442 and Proc. Precipitation Scavenging Meeting, Richland Washington, June 1970. A third paper has been submitted for publication.

SUPPORTED BY U.S. Atomic Energy Commission

2.0036, RADIONUCLIDE METABOLISM IN AQUATIC ANIMALS

F.L. HARRISON, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

The uptake and lose of radionuclides by aquatic organisms are being followed in representative fresh-water and marine organisms consumed by man. Two types of studies are being conducted. The first of these are determinations of the biological turnover of minerals having radionuclides produced in nuclear events. Fresh-water clams, crayfish, and fish and marine clams, crabs and fish are maintained in aquarium systems where the radioactive and stable element concentrations are held constant. Whole body and tissue and organ uptake rates are assessed at different water temperatures and stable element concentrations, in animals of different size, and in fed and starved animals. Loss rates are determined under laboratory conditions and in natural habitats. The second of these studies are assessments of the comparative biological availability to aquatic organisms of radionuclides produced in contained and cratering nuclear explosions. Fresh-water and marine ecosystems are established in aquarium systems or large pools containing water which continuously leaches nuclear debris. The concentrations of fission and activation products are followed in the water, plankton, and animals. Bivalve molluscs, crustaceans and fish are dissected to determine tissue distribution and concentration of activity. Radionuclide analyses are performed on lithium-drifted germanium diode detectors.

Results: Rates of accumulation of radionuclides differed with the animal and radionuclide. They were affected by temperature and stable element concentration and changed with the size of the animal. The loss rates were more rapid in natural habitats than in the laboratory and the elimination of the radionuclides followed two or more component curves. Nuclear debris radionuclides differed in their availability to aquatic organisms. For some radionuclides, the availability was lower for contained than for cratering events. In general, the highest whole body doses to man were calculated for those fractions of the animals containing the visceral organs.

SUPPORTED BY U.S. Atomic Energy Commission

2.0037, MORPHOLOGY AND STABILITY OF STREAM CHANNELS IN SOUTHERN CALIFORNIA

J.B. MURPHEY, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Lompoc, California* 93436 (SWCW2-GLMP-1)

OBJECTIVE: Methods for predicting and control of gully and stream channel erosion, and sediment deposition damage.

APPROACH: Evaluate processes of channel aggradation, degradation, horizontal realignment, and changes in cross-sectional shape and net sediment yield in relation to types of bed and bank materials, upstream sediment sources, streamflow regimes and control measures.

PROGRESS: During the past five years the slope course and cross section surveys of Owl Rock Canyon, a 648 acre watershed near Moorpark, California, seem to indicate that an increase in rainfall over the previous year will cause aggradation in the channels instead of scouring them out further. Conversely, when the seasonal rainfall decreases a degrading of the channels is caused by the lighter runoff. This is probably due to the fact that smaller storms occurred during the last part of the water years which showed a seasonal decrease in total precipitation over the previous year. These late season storms were able to produce some runoff in the channels, thus scouring them out somewhat, but were of insufficient size to introduce very much new sediment into the channels upstream. The temporary wooden 16-inch Broadcrested V-notch Weirs met and withstood a rather supreme test in the form of the '100-year' January 1969 storms. All but one of the weirs were completely topped at least once during the peak stages of runoff, but not one of them shows the slightest structural damage. The only damage of any sort noticed was slight abrasion of the fiberglass surface above the stainless steel sheathing on the Owl Rock Canyon weir.

SUPPORTED BY U.S. Dept. of Agriculture

2.0038, VENTURA CALIFORNIA COOP

H.G. GREENE, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

States to which project pertains: California.

The Ventura project is concerned with the geophysical mapping of the nearshore portion of Ventura Basin near the seaward edge of the Oxnard Plain and the geophysical study of submarine canyons contained within the area. The geophysical survey consisted of marine seismic reflection profiling with a high resolution, 1 KJ sparker, an intermediate penetration, 33 KJ sparker, and magnetic profiling with a marine proton precession magnetometer. Wide angle seismic refraction (sonobuoy) profiles were obtained to give apparent velocities of the subsurface sediments. Continuous vertical temperature-salinity profiles will be made in the submarine canyons during times when the water table is at peak recharge in order to try to distinguish areas where fresh water aquifers may discharge.

The principle objectives of this project are (1) to seismically map geologic structures of a portion of the Ventura basin and the offshore area of Oxnard Plain: to establish geology, its structure and tectonic history; genesis, thickness, and depositional history of the sediments, (2) to determine the distribution and locations of fresh water aquifers, entrance areas of possible salt water encroachment, and to map the overall offshore ground water basin, and (3) to determine the origin of Hueneme, Magu, and other minor submarine canyons in the areas and determine their significance as it relates to the geology of the region.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0039, SOIL ENGINEERING RESEARCH

H.W. OLSEN, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

States to which project pertains: California.

The Soil Engineering Research Project: (1) Contributes to interdisciplinary topical investigations of engineering geologic problems and hazards with original research concerning, and applications of, soil engineering principles and methods. Current emphasis is on the potential hazards associated with the San Francisco Bay sediments; specifically, seismic ground amplification, liquefaction susceptibility of granular deposits, static and seismic stability of slopes and dikes, total and differential settlement from overburden fills, and subsidence from groundwater extraction. (2) Supports regional engineering and environmental geologic studies with (a) determinations of the engineering classification and in situ state properties of unconsolidated earth deposits, (b) correlations of these properties with geologic parameters, and (c) interpretations of their significance for land-use planning and engineering purposes. Current emphasis is on the unconsolidated deposits, hydrothermally altered rocks, and residual soils in the San Francisco Bay region.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0040, ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS

D.H. PETERSON, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

Purpose: To increase our limited knowledge of the factors which control the abundance, distribution, and composition of organic matter in coastal waters and sediment.

Methods: 1) Determine the relative abundance, distribution and clay mineralogy of suspended sediment in San Francisco Bay waters in relation to source and waters, such as the distribution of saline water. 2) Survey the abundance and distribution of organic carbon in San Francisco Bay waters and sediment in relation to

season, source and differences in depositional environment such as the distribution of NO3 and oxygen dissolved in the waters. 3) Study the distribution of specific trace elements in relation to the distribution of organic matter. 4) Survey the distribution of pesticides in sediment in relation to depositional environment and depth in sediment. 5) Study abundance and composition of organic matter thought to be of prime importance in the engineering properties of sediment. 6) Study the composition of selected geochemical constituents with depth in sediment in relation to source and subsequent alteration of organic matter.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0041, WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM
W.D. SILVEY, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of California. The total project is to provide the knowledge needed to avoid excess blooms of tidal plankton and undesirable concentrations of dissolved oxygen by determining the relationships between nutrients, tidal plankton, dissolved oxygen, and fish in this estuarian environment. The water quality aspects of the study includes source and concentration of both organic and inorganic constituents in waters in the delta system together with pertinent physical characteristics.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0042, DISPERSION OF HEAT IN STRATIFIED FLOW
J.G. WEIL, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

This study seeks means of predicting the spatial and temporal distribution of warm water flows discharged from power plant cooling systems into natural bodies of water. Previous studies of warm water jets have generally excluded some hydrodynamic factors found in natural situations, such as turbulence and shear in the receiving water. In order to predict thermal patterns in prototype siuations, knowledge must be gained of dispersion patterns in waters with turbulence and shear, and allowance must be made for lateral spread of the stratified warm water layer.

Theoretical and experimental work will be aimed at providing quantitative information for predicting the extent of thermal influence in a natural situation near a power plant. This may be accomplished by study of the dispersion characteristics of warm water discharges in stratified flow.

Laboratory experiments will be done to determine the longitudinal and lateral spread characteristics of a warm water discharge flowing over moving receiving water with turbulence and shear. The character of the plume will be described by the velocity of the warm water front, dilution due to entrainment of underlying water, and stability of the front away from the warm water source. Initial studies will be for uniform flow of receiving waters, but later studies might possible include the case of oscillating flow, which would be typical for estuary power plant sites. Atmospheric heat losses and dispersion after the plume has been vertically well mixed will not be of prime importance.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0043, ALGAE DEGRADATION IN WATERWAYS
P.L. MCCARTY, Stanford University, School of Engineering, *Palo Alto, California* 94305

The aim of this research investigation is to evaluate the rate and extent of decomposition under no-light conditions of heterogeneous algae cultures of various ages and grown in various chemical and physical environments. In addition, the incremental effect of small quantities of light on this degradation rate will be studied. This will be directed towards determining the rate and extent of algae degradation so that the possible translocation of pollution by algae can be better predicted and controlled. The study will be conducted in five phases to ascertain the effects of algae type, water characteristics, aerobic conditions, anaerobic conditions, and temperature on the rates of degradation and oxygen consumption observed.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0044, CHARACTERIZATION OF SOIL NONWETTABILITY AND THE DEVELOPMENT OF CRITERIA FOR THE MOST ECONOMIC TREATMENT OF THESE SOILS
J. LETEY, Univ. of California, School of Agriculture, *Riverside, California* 92502

Soils which repel water and are commonly referred to as nonwettable soils have been reported in many areas of the world. Large percentages of areas burned by forest fires exhibit nonwettable soils. Nonwettable soils can be treated with wetting agents to make them wettable and increase water infiltration.

The proposed research will involve developing criteria to predict the most effective and economic treatment of a nonwettable soil with wetting agent to increase water movement through the soil. The necessary parameters will be measured and predicted water infiltration will be compared with calculated values. The parameters to be measured are: critical surface tension of soil, wetting agent adsorption by soil, wetting agent concentration relationship with solution surface tension, and depth of soil affected.

The release of surfactants by soils as affected by various factors will be investigated to predict the longevity of a surfactant treatment and to provide estimates of possible long-range ground water contamination.

A field survey will be undertaken to gain a better evaluation of the extent of nonwettable soils.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0045, FORTY-YEAR FERTILIZER EFFECTS ON NO3 IN GROUND WATER
P.F. PRATT, Univ. of California, School of Biological Sciences, *Riverside, California* 92502

The project proposes to determine the nitrates and soluble salts in soil samples taken at depth of 0-220 ft. from a long-term fertility trial with citrus. The plots, which were not previously fertilized, were established in 1917 on the experimental farm of the Citrus Research Center and Agricultural Experiment Station, Riverside, California. Because complete records have been kept of all nitrogen added, the plots present a unique opportunity to study the contribution of fertilizers to the nitrate in ground water.

During the first year (Nov. 1, 1968 to Oct. 31, 1969) of the project, samples were taken to a depth of 100 ft. These samples were analyzed for field water content and saved for laboratory analysis. During the second year of the project (Nov. 1, 1969 to Oct. 31, 1970) these samples will be analyzed for nitrate and soluble salts. Samples, which will be used for the determination of nitrates and salts, will be taken from the 100 to 220 ft. depth. Also, we will collect undisturbed cores from various depths to determine their hydraulic conductivities at the water contents found in the field.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0046, INFLUENCE OF SUBSURFACE WASTE DISPOSAL SYSTEMS ON RECEIVING WATERS
K.D. KERRI, Sacramento State College, School of Engineering, *Sacramento, California* 95819

Recreational facilities and other rural locations frequently rely on subsurface waste disposal systems. The desirability to live near impoundments in remote regions without wastewater collection systems has attracted numerous developments to meet the leisure demands of society. The objective of this research project is to develop prediction models capable of indicating the influence of existing and proposed sub-surface waste disposal systems on receiving waters. Nutrients contributing to the eutrophication of impoundments will be of primary interest. Factors influencing the nutrient load on impoundments and possibly incorporated in the prediction model include chemical and physical properties of soils, depth to water table, rate of groundwater movement, stage of nutrient cycle, and contributing sources.

SUPPORTED BY Sacramento State College - Calif.

2.0047, WATERSHED INVESTIGATION, GRASS VALLEY CREEK
R. STREITZ, State Div. of Mines & Geology, *Sacramento, California*

Specific information upon request. To determine as accurately as possible the reason for sedimentation in the salmon spawning beds of Trinity River.

SUPPORTED BY California State Government - Sacramento

2.0048, INVESTIGATIONS OF MINERAL DEPOSITS THAT INFLUENCE WATER QUALITY
R. STREITZ, State Div. of Mines & Geology, *Sacramento, California*

Investigation of mines, mills, and mineral deposits to determine quantity and quality of runoff waters that debouches into water supplies. The products are brief reports that are transmitted to Water Quality Control Boards in the state.

SUPPORTED BY California State Government - Sacramento

2.0049, LEAD POLLUTANTS IN NEAR SHORE MARINE ENVIRONMENTS
T.J. CHOW, Univ. of California, Graduate School, *San Diego, California* 92038

The occurrence of lead in various near-shore marine organisms ranging from plankton to fish will be studied to ascertain whether there is a phylogenic relationship with lead content. Comparable specimens from pelagic regions will be analyzed to compare biological concentration in near-shore and open ocean environments. Studies will be concentrated in California coastal areas and correlated with simultaneous lead analyses from water samples and coastal sediments. Particular attention will be given to areas adjacent to sanitary outfalls. Wherever possible, isotopic ratios will be determined, and analyzed for system variation and possible causes.

SUPPORTED BY U.S. National Science Foundation

2.0050, STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN - SUBPROJECT 1 - DETAILED EXPLORATION OF CS-137 AND CS-133 IN THE OCEAN
T.R. FOLSOM, Univ. of California, Graduate School, *San Diego, California* 92038 (AT(04-3)34,Proj.071)

Objectives: Information as to moving, stable subsurface oceanic strata at moderate depths.

Background: Means for wide oceanic survey of Cs-137 have been developed.

Procedures: Relatively large samples of Cs-137 are collected on ferrocyanide granules and normalized by reference to Cs-133 also collected. Summing and two-dimensional gamma spectrometry are used for other fallout nuclides.

Continuation: Further development of two-dimensional gamma analytical procedures, especially for study of Co-60, Ag-110m and Ag- 108m to follow up a recent discovery of their usefulness in tracing Pacific water masses. Further improvement of Cs-133 procedures and survey methods in collaboration with other laboratories. Collections of Cs-137 and Cs-133 across the Pacific.

Results: Hundreds of Cs-137 samples have been analyzed showing characteristics of subsurface layers in the N. Pacific. Very recently, Ag-108m has been used to give absolute dates (within close limits) to a certain subsurface water mass frequented by N. Pacific albacore.

SUPPORTED BY U.S. Atomic Energy Commission

2.0051, STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN - FALLOUT DISTRIBUTIONS IN SELECTED MARINE ORGANISMS
T.R. FOLSOM, Univ. of California, Graduate School, *San Diego, California* 92038 (AT(11-1)34-PROJECT)

Objectives: Information as to the behavior of cesium, rubidium, and potassium in the ocean and in certain organisms.

Background: Literature values of cesium concentration by marine organisms are in conflict with our findings. Little is reported as to rubidium in marine organisms. Absolute assays of Cs133 by different institutions have been widely discrepant.

Procedure: Radiocesium is assayed by gamma spectrometry with little or no purification. Nonradioactive cesium traces are assayed by flame after concentration and purifications.

Proposed Continuation: Continued development of sources of very pure reagents for rare-alkali research, particularly AMP manufacture in pure form. Completion of the specialized equipment for further study of cesium and rubidium. A careful resurvey to 300 meters for details of the variation of Cs133. Review the cesium and rubidium concentration buildup factors in larger fish with newer techniques.

Results to date: Near completion of the cesium analyses in Salton Sea biological samples. The results to be reported by David Young in PhD dissertation.

Some data suggests higher concentration ability in vertebrates of higher trophic levels. Absolute assays of Cs133 developed and compared with activation reports.

Part 2 of 2.

SUPPORTED BY U.S. Atomic Energy Commission

2.0052, AIR TRANSPORT OF POLLUTANTS TO THE MARINE ENVIRONMENT
E.D. GOLDBERG, Univ. of California, Graduate School, *San Diego, California* 92038

A study of the sources, routes and fates of man-produced materials introduced to the marine environment through the atmosphere. The initial work involved the chlorinated hydrocarbon pesticides, their degradation products, and their carriers, such as talc, and emphasized (1) the long distances of transport, thousands of kilometers, in such wind system as the monsoons and (2) the winds transported such materials in amounts similar to those carried by major river systems. The areas studied included the Northern Indian Ocean with inputs from Africa, northern India and the Indo-China Peninsula through the monsoons, the Caribbean with inputs from Africa through the Northeast Trades, and the northern Pacific with inputs from the European-Asian arid regions through the jet stream.

Presently, we have identified two other materials that may be entering the marine environment in substantial amounts: mercury and flyash. Methods for the rapid and accurate analyses of chemical species of mercury and of the flyash by chemical and microscopic means respectively has been developed. Analyses of mercury in various components of the marine environment indicate mercury levels in animals of the sea 500 times higher than in comparable volumes of sea water on the average. Already man's impact upon the marine environment can be seen in the dispersion of mercury containing substances in high concentrations about sewer outfalls. Since, most of the dispersion of mercury about the environment appears to take place atmospherically, a program of analyses of various marine airs and surface waters is to be initiated in the spring of 1970.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0053, STUDY OF KEY WEST DESALTING PLANT EFFLUENT
J.W. JOY, Westinghouse Electric Corp., *San Diego, California* 92121

The project is concerned with the impact of the effluent from a large desalting plant located in Key West, Florida. The effluent is characterized by elevated temperatures, high salinity and low alkalinity. The following physical measurements have been made at stations distributed over the study area; temperature, salinity, dissolved oxygen and alkalinity. Biological measurements and observations have been made at these stations as well as additional ones. The major objectives of the study have been to trace the extent of the effluent by measuring the physical parameters above and to detect the effects of the effluent on the marine communities in the study area. There has also been some attempt to identify what physical parameters are influencing the biota in the immediate region of the discharge plume.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0054, TRACE ELEMENTS IN GRAND RIVER AND LAKE ERIE
R.F. PLATFORD, Canadian Cen. for Inland Water, *Burlington, Ontario, Canada*

A study of certain trace elements, including nutrient and toxic elements, their speciation and distribution in the Grand River and in eastern Lake Erie.

SUPPORTED BY Canadian Government - Ottawa

2.0055, AN ASSESSMENT OF RADIOACTIVE FALLOUT
M.T. SHIOMI, Canadian Cen. for Inland Water, *Burlington, Ontario, Canada*

An assessment of the usefulness of a study of radioactive fallout and its application to the study of sedimentation in lakes.

SUPPORTED BY Canadian Government - Ottawa

2.0056, GEOCHEMISTRY-MINERALOGY OF THE MACKENZIE RIVER
A.A. LEVINSON, Univ. of Calgary, *Calgary, Alberta, Canada*

The Mackenize River is the second largest in North America and is virtually unpolluted. Geochemical and related clay mineralogy studies, therefore, could be of fundamental importance in understanding the chemical characteristics of these water and the clay absorption characteristics (of which this is virually no information) but also could be applied to other river systems throughout the world. The major tasks of the project are: 1. determine amount of suspended sediment and type of clay minerals from the major tributaries and the Mackenzie. 2. determine trace and major dissolved elements. 3. determine the extent of the 'salt water wedge' from the Arctic Ocean. 4. clay mineralogy studies of deep-wells now being drilled in the Mackenzie delta. 5. study the geochemistry of boron for understanding of the 'paleosalinity- paleoenvironment problem'. 6. study the clay mineralogy boron and other trace elements in the fresh water deltas entering lake Athabasca.

SUPPORTED BY Amer. Chemical Society - Washington, D.C.

2.0057, THE ROLE OF SLUDGE WORMS IN PROMOTING EUTROPHICATION
R.O. BRINKHURST, Univ. of Toronto, *Toronto, Ontario, Canada*

The study attempts to discover the role of the abundant sludge worms of polluted sediments in promoting eutrophication.

The reclamation of lakes after sewage disposal may be accelerated by the mineralization of sediment and the removal of oxygen demand by the worms, or it may be hindered by the retrieval of otherwise trapped organic matter by them.

The study attempts to elucidate the rate of utilization of organic sludge by worms in a grossly polluted harbour at Toronto and possibly in a series of sites in the trophic gradient of the Bay of Quinte, Lake Ontario.

The study entails research on the types of bacteria present, the types of nutrients present (amino acids, sugars, for example), the relationship between these and the worms, the abundance of the worm species in the harbour, the respiration growth efficiency and feeding rate of worms under various conditions.

The work on most of these sub-programmes has been begun following build-up of staff, equipment and methods. The rate of progress indicates that initial modeling might be contemplated in late 1970, using the theoretical study recently completed.

The project will include consultant services for the identification of sludge worms from Alaska for FWPCA personnel. Similar facilities can be offered to other FWPCA projects and regional offices by arrangement.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0058, ECOLOGY OF A TROPICAL SHORE - PRE-ANALYSIS FOR POLLUTION STUDIES
P.W. GLYNN, Smithsonian Institution, *Balboa Heights, Canal Zone*

On December 13, 1968, the 35,000 barrell tanker 'Witwater' broke up on a track 2 to 3 miles from the STRI marine laboratory at Galeta Island, inundating the shore line with 20,000 barrels of bunker 'C' and diesel oil. With few exceptions too little quantitative data was available on the biota of the adjacent coral reefs and mangroves to adequately assess the 'biological costs' of oil pollution in this area (i.e., short and long term disturbances to biomass and to biological succession including displacement and/or replacement of particular species).

The STRI proposes through its own staff and assemblage of various outside experts to engage in a program which will lay the basework for evaluating the biological costs of future oil spills on tropical and related ecosystems. The roles of several natural agents of oil pollution abatement will be delineated.

SUPPORTED BY Smithsonian Institution

2.0059, EUTROPHICATION OF PONDS IN SOME NEW MEXICO LAVA BEDS
R.W. PENNAK, Univ. of Colorado, Graduate School, *Boulder, Colorado* 80302

Year-round study of productivity at primary and secondary levels as an interpretation of varying levels of eutrophication in a group of small ponds in a lava flow.

SUPPORTED BY University of Colorado

2.0060, EFFECT OF COPPER SULFATE ON AQUATIC WEEDS
T.R. BARTLEY, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Laboratory studies and experiments by other investigators have shown that copper has a pronounced effect on higher forms of aquatic vegetation. Copper has been used for many years as an effective algaecide. This study was undertaken to determine the effects of a semicontinuous feed of low concentrations of copper on the growth of aquatic weeds common to Western irrigation canals.

Small copper sulfate crystals are fed into the flowing water at a calculated rate based on water volume by means of an automatic feeding device equipped with a timer. The copper sulfate is fed into the water daily throughout most of the irrigation season. The aquatic weed growth will be observed frequently through the season to determine the effect of the treatment. Concentration of copper in the irrigation water will be monitored. Total alkalinity of water on copper concentrations is being investigated. Water temperature and other factors are investigated in this aquatic weed control study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0061, SEDIMENT PROCEDURES DEVELOPMENT AND RESERVOIR SEDIMENTATION
W.M. BORLAND, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Studies to develop or improve the techniques of computing sediment transport in channels; determining stable channels; computing degradation below dams and scour at siphon and bridge crossings; and determining the efficiency and effectiveness of settling basins and sediment control facilities at diversion dams. Existing reservoirs are periodically resurveyed to determine their current area and capacity amounts. Added research value of the surveys include collecting basic data related to watershed unit sediment yield rates; unit weight of deposited sediments; reservoir delta formation patterns; degradation below dams; sediment distribution; and trap efficiencies. Improvement is continually sought in instrumentation techniques and in developing better equipment to conduct the reservoir surveys. Computer programs are being written for specific sediment and hydraulic problems that require iterative processing of the collected field data.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0062, VELOCITIES OF RADIONUCLIDES AT ARMARGOSA SITE
D.B. GROVE, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

The investigations are designed to obtain information concerning: (a) the ground-water system in the carbonate rocks, rhyolites, and tuffs of the Nevada Test Site, (b) the hydraulic properties of earth material and aquifers that need to be considered in predicting the rate transport of radioactive products produced during a nuclear detonation, and (c) the chemical factors affecting the rate of transport of the same products.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0063, LARGE IMPOUNDMENTS - TEMPERATURE PREDICTION IN IMPOUNDMENTS
D.A. HOFFMAN, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The Bureau of Reclamation has constructed numerous large impoundments which are characterized by being deep and long, located in an arid climate, and relatively unknown from the standpoint of limnological data. The lack of information is perhaps the greatest void in water data on these reservoirs.

Temperature Prediction in Impoundments is a study underway to determine the usefulness of a mathematical model to predict the temperature in large impoundments. Presently, data are being collected on existing impoundments in order to verify and update a mathematical model.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0064, LARGE IMPOUNDMENTS - EUTROPHICATION OF LAS VEGAS BAY, LAKE MEAD
D.A. HOFFMAN, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The Bureau of Reclamation has constructed numerous large impoundments which are characterized by being deep and long, located in an arid climate, and relatively unknown from the standpoint of limnological data. The lack of information is perhaps the greatest void in water data on these reservoirs.

During the surveys of Lake Mead it was found that the Las Vegas Bay was an area of poor quality water due to the low dissolved oxygen and high dissolved salts. As a result, it became obvious that an extensive study of this reach of Lake Mead should be made. Field studies will be made to quantitatively and qualitatively define, analyze, and recommend solutions needed to improve the water quality in Las Vegas Bay.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0065, ENGINEERING GEOLOGY RECONNAISSANCE STUDIES OF COASTAL COMMUNITIES, ALASKA
R.W. LEMKE, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

State(s) to which the work listed herein pertains: Alaska.

Reconnaissance engineering geology studies, directed principally toward assessing potential earthquake and other geologic hazards, have been completed and open-file reports are being prepared for the following Alaska Coastal towns: Skagway, Haines, Sitka-Mount Edgecumbe, Ketchikan, Metlakatla, Petersburg, Wrangell, Yakutat, Hoonah, Nome, Bethel, Dillingham, Naknek-King Salmon, Unalakleet, Kotzebue, and Barrow. It is concluded that most parts of these towns are built on more stable geologic materials than those beneath towns heavily damaged by the 1964 Alaska earthquake. Nevertheless, in the event of a large earthquake, some communities are susceptible to damage because of amplified shaking in poorly consolidated deposits, slides of rock and snow, ground fissuring, flowing sediments caused by liquefaction, and subsidence due to soil compaction. In addition, harbor areas and other low-lying parts of some towns may be damaged by vertical changes in the land, by seismic sea waves, and by other abnormal waves produced locally by land tilting or by submarine landsliding.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0066, DENVER METROPOLITAN AREA, COLORADO
R.M. LINDVALL, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: Colorado.

The project objective is to prepare detailed general-purpose geologic maps of eight quadrangles covering the major part of the Denver metropolitan area. These maps, on a scale of 1:24,000, are designed to provide basic information on the geologic factors pertinent to maximum utilization of land in a rapidly expanding area of urban development. Information to be provided concerns the engineering properties of the surficial and bedrock units, location of potential hazards such as landslides, areas subject to flooding, areas subject to possible earthquake damage, areas of poor foundation conditions, and the location and extent of sand and gravel deposits necessary for construction aggregate materials.

The maps, including a brief descriptive text, are to be released first in open files and subsequently published in the Geologic Quadrangle Map Series. The geologic map of the Arvada quadrangle was released in open files in 1970. A comprehensive geologic report covering all eight quadrangles is planned for the Bulletin Series.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0067, PREDICTION OF MINERAL QUALITY OF RETURN FLOW WATER FROM IRRIGATED LAND
J.T. MALETIC, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The research is aimed at developing procedures for predicting the mineral quality of irrigation return flows. Such procedures are needed to provide a means for determining the potential impact of new irrigation developments on the water quality of western streams. Related research areas include computer models for simulating the more important chemical reactions in soils that influence mineral water quality, systems analyses studies of water quality in stream segments or basins, influence of surface water storage on water quality, and computer and analog model studies of ground-water patterns.

The research will be conducted on an existing irrigation project. The physical, chemical, hydrologic, and agronomic conditions in the area will be characterized to provide data inputs for: (1) determining the quality of the percolating water, (2) determining the effect of percolating water on drainage effluent, (3) comparing and verifying computer and analog models, and (4) evaluating influences of hydrologic or agronomic changes on the quality of outflow water.

The field work will be performed near Vernal, Utah, on the Vernal Unit, Central Utah Project.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0068, SURFICIAL GEOLOGY OF JUNEAU AND VICINITY URBAN AREA, ALASKA
R.D. MILLER, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: Alaska.

The Juneau project started as part of a coastal communities program of earthquake hazard studies following the March 1964 Alaska earthquake. The original primary objective was to investigate and evaluate potential hazards from earthquakes as a result of the geologic setting. The study has been broadened to include other natural geologic events and to try and relate man's use of the land to the existing geologic environmental conditions.

The project consists of differentiating and mapping surficial deposits and performing physical properties tests on selected samples. Development of raised marine and glaciomarine deposits, glaciofluvial, glacial, and lacustrine deposits is coupled to the geologic history, which in part influences the different physical properties inherent in the materials. The availability and utilization of this information can help the planning and execution of urban expansion and industrial development to hopefully avoid geologic pitfalls by taking into account the geologic influence on the environment such as relative stability of deposits in case of severe earthquakes, areas of known or potential rock falls and avalanches, and differing foundation conditions. Geologic mapping will also provide information regarding the available or potential sources of aggregate for construction uses.

A preliminary map with tabular text is being processed for release in open files, and after a final field season the final reports and map will be prepared.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0069, SAN FRANCISCO BAY SEDIMENTS ENGINEERING GEOLOGY STUDIES, CALIFORNIA
D.R. NICHOLS, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

State(s) to which work listed herein pertains: California

1) establish the geology of the fault-bounded bedrock basin; its structure and tectonic history (with Office of Marine Geology); 2) establish the genesis, areal distribution, thickness, composition, physical and chemical parameters, and geologic history of the unconsolidated sediments of the Bay and the bordering areas of present and former marshlands (with Office of Marine Geology); 3) determine the earthquake and other geologic hazards associated with the Bay including the engineering behavior of sediments under static and dynamic loads and the relations of the engineering behavior to geologic parameters (with Engineering Geology Branch) 4) contribute to the geologic history of a significant segment of the San Andreas fault system in support of the earthquake program, and 5) devise, interpret, and present geologic data of significance to regional planning.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0070, GEOLOGIC INVESTIGATIONS, NEVADA TEST SITE
P.P. ORKILD, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: Nevada.

The primary objective is to maintain a current synthesis of the geology, geophysics, and hydrology of the Yucca and Frenchman Flat and Pahute Mesa areas at the Nevada Test Site. The investigations consist of: 1. Appraisal of general areas for their test media potential and public safety. 2. Selection and evaluation of specific drill sites as to geologic contacts, geologic media, water table, faults and lineaments. 3. Limited geologic mapping at selected sites. 4. Monitoring and logging of the drill holes. 5. Field studies of both preshot and postshot geologic effects. 6. Synthesis of structural, stratigraphic, chemical and physical property data. 7. Reporting on the geology and test media potential of Nevada Test Site and adjacent areas.

All phases of the investigations are continuing and the results are reported immediately to the responsible agencies. Longer term results, the detailed geologic knowledge, both surface and subsurface, of a typical and most thoroughly probed alluvial valley and volcanic plateau in the Basin and Range Province, will be reported in professional papers in FY 71-72.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0071, GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS
N.E. OTTO, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Successful continued control or eradication of rooted submersed aquatic weeds requires information on methods to reduce or eliminate the regrowth potential of the aquatic plant to a point where they produce insignificant problems. Studies have been conducted to gain a better understanding of organism ability to reproduce itself in subsequent growing seasons. These studies include influence of treatment on stage of growth, number and type of herbicide applications necessary to reduce the amount of vegetative growth and propagule development, amount of propagative material produced by a clone of plants and food reserves in the propagule.

Laboratory investigations show that pondweeds treated with repeated aromatic solvent and acrolein applications in one growing season significantly reduced vegetative propagule production. A significant reduction in number and size of propagules was accomplished in successive treatments. Preliminary studies on the development of vegetative propagules of sago pondweed indicate that they commence development with the onset of plant flowering and fruiting. Continuing laboratory and field studies suggest that low rate, long contract period applications of a number of aquatic herbicides show promise on significantly suppressing the growth of rooted aquatic weeds, thus reducing potential residue hazards as well as controlling weed growth.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0072, FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT
N.E. OTTO, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Study of the ecological relationships of plants and animals in canal and reservoir environments are necessary to gain understanding of biological problems existing in these areas. Knowledge of environmental factors and interactions are essential to future improvement of aquatic weed and animal problems existing in irrigation distribution systems. Data have been collected from irrigation canals in three different geographical areas concerning the physical, chemical, and general biological aspects. Samples of soil, water, and biological materials are being collected for chemical and physical analyses in both weed-free and heavily infested canal sites. Observations are being made of all physical, chemical, and biological factors suspected as being important in the environment. Data obtained to date indicate that rooted submersed aquatic weeds are adapted to a wide range of environmental conditions, and no one specific set of factors nor interaction of factors has been demonstrated as being responsible for pondweed invasion and establishment in a canal system. Present emphasis on this phase of the aquatic pest investigations program is associated with more detailed study of the nutrient requirement of submersed aquatic weeds, including filamentous green algae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0073, SMALL IMPOUNDMENTS - FOSS RESERVOIR
P.R. TRAMUTT, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

In addition to the large reservoirs covered by other studies, the Bureau of Reclamation has many small impoundments which very in their shape, operational mode, and climate from deep canyon reservoirs in mountain locations with a comparative high flow-through rate to shallow reservoirs located in the plains and operated with periods of long holdover. A research program was initiated with Region 5 for a water quality survey in the plains-type Foss Reservoir. The water in Foss Reservoir has been held in storage since March 1961, and the quality has been deteriorating due to an accumulation of dissolved solids. The deterioration has been accentuated by the retention of good quality water in upstream watershed development ponds. This study was scheduled for completion in FY68, but was continued to provide data for the demineralization study conducted during FY69. The revised completion date is FY71. This study will be completed and the data collected in previous years will be published in a short report.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0074, BEHAVIOR OF POLLUTANTS IN WATER
R.L. WERSHAW, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

The objective is to study pesticide residence time, transport mechanisms, and projected residue levels in natural soil and in natural hydrologic environments. The mechanisms of infiltration and solution of certain pesticides are being studied in the laboratory and conjunctive field studies are being planned to obtain information on the parameters related to subsurface infiltration and to the migration, retention, and decomposition in ground and surface waters.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0075, HYDROLOGIC STUDIES LEADING TO SITE UTILIZATION
S. WEST, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

Study the hydrologic regimen around nuclear test areas and supply the knowledge gained to safety and engineering management practices. Provide data for utilization of water resources around nuclear test sites.

Specific major areas of study include: (a) natural hydrochemical and hydrogeologic conditions near sites of planned atomic detonations, (b) distribution of radionuclides in earth materials and associated groundwater, (c) field transport characteristics of radionuclides.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0076, IRRIGATION RETURN FLOW - NUTRIENT BALANCE
R.F. WILSON, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Flows from irrigation projects have been unduly criticized for the deterioration of the water quality in receiving waters. Much of the salt content of many river basins has been attributed to irrigation projects. Studies based upon the transmission and fate of agricultural chemicals including fertilizers and pesticides will be supported and coordinated with related studies being performed under other Reclamation activities and by other organizations. In order to differentiate the salt contribution from natural irrigation, municipal and industrial sources two catagories have been made under the main heading.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0077, VEGETATIVE STABILIZATION OF MINE TAILINGS, WASTES, AND SPOILS
W.A. BERG, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00020)

OBJECTIVE: To identify problems associated with establishing vegetation on mine tailings, wastes, and spoils. To determine treatments, techniques, and species required to establish and maintain vegetation on tailings, wastes, and spoils. To classify tailings, wastes and spoils by chemical and physical composition, climate, and topographic features in relation to requirements for and feasibility of vegetative stabilization.

APPROACH: Treatments, techniques, and species for revegetation will be determined by a combination of laboratory, greenhouse, and field work. Physical and chemical properties significant to plant growth on the tailings, wastes and spoils will be determined. Greenhouse studies will be used to investigate nutrient deficiencies and toxicities, and for exploratory work on species selection. Field experiments will be used for species selection, establishment techniques, nutrient and toxicity problems, and for determination of maintenance requirements, longevity, and feasibility.

PROGRESS: Studies were made on uranium, molybdenum, and gold tailing and on limestone and uranium spoils. In field studies on Mo tailings at an elevation of 11,000 feet, cereal rye seeded immediately after the snow-pack melted (May 28) made sufficient growth by Sept. to stabilize limed and fertilized tailings. Eight grass species seeded in May made little growth by Sept. Native willow cuttings planted on the Mo tailings had an excellent rate of sprouting and root initiation. However, by Sept. many had died. A possible explanation is that the cuttings were rooting below the zone of lime application (about 6'). Willow cuttings planted on nearby soils had a lower initial sprouting rate, but those that sprouted survived. P fertilization of the Ur tailings at one location increased grass growth several-fold. The P deficiency was unexpected as soil tests (NaHCO(3) extraction) indicated P was adequate. On 3 other Ur tailings plant growth was very poor even with leaching, liming, and adequate N, P and K fertility levels. This may indicate a plant toxicity from chemicals used in ore processing. The only extensive colonization of processed tailings by native vegetation was found on old gold tailings at Victor. Here Elmus triticoides, has partially stabilized 1/4 of 40 acres of tailings.

SUPPORTED BY Colorado State Government

2.0078, FLUXES OF HEAT, MOMENTUM AND TRACERS IN WIND AND WATER TUNNELS
J. GESSLER, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521 (AT(11-1))

This is a study of basic research on absorption rates of particulate pollutants as it is affected by the action of wind and, in turn the wind-generated waves. Beyond this the investigation will cover the behavior of the pollutant after it has been absorbed by the water, where the wind has a very definite effect on the rate of dispersion.

At present no quantitative knowledge on absorption rate is available, but such information is very essential if the effect of fallout on water purity is to be evaluated. But it is not only the water pollution which is of interest. Of similar importance is the fact that the air, after moving over lakes or the ocean, will have lost considerable amounts of the polluting matter. Finally, one should concern oneself with the question of what happens to the polluting matter after it has reached the water and how it is going to disperse.

SUPPORTED BY U.S. Atomic Energy Commission

2.0079, LAND USE AND WATER QUALITY ON FORESTED MOUNTAIN WATERSHED
J.R. MEIMAN, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00312)

OBJECTIVE: Assess water quality within a forested mountain watershed at varying natural flow, measure the effects of multiple land use management--including road construction, logging, recreational developments and grazing--on water quality.

APPROACH: Water quality determinations including total residue, filtrable and non-filtrable residue, pH turbidity, coliform group bacteria and temperature will be made before, during, and after land management practices.

PROGRESS: Five stream temperature stations were installed in the Little Beaver watershed and continuance records of rate temperature collected during the summer and fall of 1969. Data is currently being analysed.

SUPPORTED BY U.S. Dept. of Agriculture

2.0080, SEDIMENTATION AND CONTAMINATION CRITERIA FOR WATER RESOURCES PLAN AND MANAGEMENT
H.W. SHEN, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00112)

OBJECTIVE: Study the effect of vegetation on flow rates, sediment yield and dispersion of contaminant (attached to soil), during surface runoff in watershed.

APPROACH: Cylinders and other flexible elements will be inserted in laboratory flume to simulate vegetation. Radioactive and fluroescent tracers will be used to study the movement of contaminant material and sediment yield. Analysis will be made from a combination of stochastic and analytical approaches.

PROGRESS: A general stochastic model to describe sediment transport is formulated. This model may apply to meandering streams, etc. Experimentally, we have completed this analysis of resistance to flow due to simulated vegetation. A design criteria has been found. At the present time, we are writing a review of literature report on estimating the magnitude of soil erosion from upslope area. We shall attempt to use optimization method for an engineering guide to design erosion control structure.

SUPPORTED BY Colorado State Government

2.0081, MOVEMENT AND ACCUMULATION OF HARMFUL NUTRIENTS IN SOILS AND WATER
F.G. VIETS, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Fort Collins, Colorado* 87101 (SWCW8-DFC-6)

OBJECTIVE: Determine the contribution of various uses of agricultural land, including livestock feeding, industrial and municipal waste disposal, to nutrient enrichment of surface and subsurface waters, soil properties and productivity; and devise systems of fertilizer and waste management on soils to prevent soil and water pollution.

APPROACH: Laboratory and field studies are conducted to determine the amounts and forms of mineral nutrients, such as nitrogen, phosphorus and potassium; and organic substances that create biological oxygen demand or pollute waters that run off or

percolate through soils used for agricultural livestock feeding or industrial and municipal waste disposal. Effects on the chemical and biological quality of water and the physical and chemical properties of soils and their productivity are determined. Alternative and improved methods of land and waste management on soils to reduce pollution are investigated.

PROGRESS: Laboratory column studies designed to simulate two kinds of cattle feedlot management show marked contrast in the kinds of ground water and air pollution possible. In well-drained soil columns kept moist over a 16-week period, 65% of the total nitrogen in added urine was oxidized to nitrate and leached through or stored in the column, about 10% remained in the soil as ammonium, and 25% was lost as ammonia gas. No denitrification occurred. In soil columns started initially dry, to which urine was added each 4 days to simulate lower stocking rates, no nitrification or leaching occurred, 10% of the total N in the urine remained in the soil as ammonium, and 90% of the nitrogen was lost to the air as ammonia gas. These columns produced nitrate when wetted with water. In the vicinity of large feedlots (80,000), ammonia volatilization and catchment by lake surfaces is significant for eutrophication. Estimates of absorption of ammonia by lake surfaces indicate that from 13 to 65 pounds of nitrogen per acre per year may be contributed, whereas control water surfaces get only 3 to 7 pounds. Absorption is comparatively independent of the time of year. Nitrogen in rainfall is not increased by the proximity of feed yards. Physicochemical studies of the equilibrium between phosphate in solution, the soil, and fertilizer predict that more phosphate will be lost to percolating water the lower the clay.

SUPPORTED BY U.S. Dept. of Agriculture

2.0082, ASSESSMENT & PREVENTION OF EXCESSIVE NUTRIENT ENRICHMENT OF SURFACE & GROUND WATER BY FERTILIZERS

F.G. VIETS, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Fort Collins, Colorado* 87101 (SWC-027-DFC-8)

OBJECTIVE: Assess the extent of excessive nutrient enrichment of surface water by runoff and erosion and accumulation of nitrate in ground waters by deep percolation as affected by kind and amount of fertilizer currently applied for crop and range forage production, and determine if fertilizer recommendations for most efficient crop and range forage production are compatible with pollution control.

APPROACH: Laboratory, lysimeter, and field studies, concerned mainly with nitrogen and phosphate, will be conducted to determine the extent of movement in solution and on sediment in runoff water and leachate as affected by recommended and experimental rates of fertilizer application in relation to crop needs, the availability to aquatic plants of phosphorus and nitrogen adsorbed on or contained in sediment, the extent of denitrification in the deep profile, and absorption of nitrate by deep rooted alfalfa. Effects of burning of crop residues and leaching of nutrients from vegetation onto frozen soils will be investigated.

PROGRESS: Core drilling studies in northeastern Colorado had shown that alfalfa removes practically all of the NO(3)-N from the soil profile to a depth of at least 20 feet. A field study was conducted to determine if alfalfa removes nitrate by simple absorption. N O(3)- was placed at various depths and the forage analyzed periodically. The uptake of tagged nitrate from the 4-foot and 8-foot soil depth was negligible for the first three cuttings. Less than 0.01% of the nitrate placed at 4 feet was absorbed and translocated to the tops. Generally less than 0.2% of the nitrogen in the tops came from the tagged fertilizer. Acid traps located at varying distances from cattle feedlots confirm that ammonia volatilization from cattle feedlots is a significant factor in the nitrogen enrichment of soil and surface water. Acid traps near feedlots absorb as much as twenty times more ammonia than the control sites. Limited data show that snow absorbed 0.05 lb. of NH(3) - N(2) per acre per week in a control area as compared to a maximum of 0.43 lb./acre per week at a site near a large feedlot. Coarse-textured soils may lose more phosphate by runoff than fine- textured soils given the same amounts of phosphate fertilizers according to laboratory research on phosphate in soil solutions.

SUPPORTED BY U.S. Dept. of Agriculture

2.0083, OIL SPILL CONTROL FACILITY

W.A. BOYD, Essex Marine Laboratory Inc., *Essex, Connecticut* 06426

The accidental spillage of some of the petroleum products shipped on the Connecticut River is an ever-present danger. A survey of oil shippers showed that on the average at least two tankers or barges are on the river at any given time. It was found that the facilities presently available for the control of an oil spill are extremely limited.

The requirements for an effective oil spill control system for the Connecticut River were determined on the basis of reports of experience elsewhere. It was recommended that one or more depots be established along the river to house the equipment and that a plan of action for an emergency be developed.

SUPPORTED BY Connecticut State Government

2.0084, ORGANIC DEBRIS ON CONNECTICUT BEACHES AND SHORES

R. BENOIT, General Dynamics Corporation, *Groton, Connecticut* 06340

General field surveys of selected sites are made. The quantity and identity of beach debris present in significant amounts is determined. Water characteristics (temperature, dissolved oxygen, salinity, turbidity) are determined. The origin of the debris is determined if possible. The microbial flora of water, sand, mud, and debris are determined in relation to the mode of decomposition of the debris.

SUPPORTED BY Connecticut State Government

2.0085, NUTRIENT EXCHANGE IN RIVERS AND LAKES

C.R. FRINK, Conn. Agric. Expt. Station, *New Haven, Connecticut* 06504 (CONH00732)

OBJECTIVE: Determine the contribution of nutrient ions to waterways from woodlands, farms, homes, and cities, and its division water, sediments, plants and outflow from a lake.

APPROACH: Monitor water volume and concentration of nutrients entering and leaving impoundments on the Housatonic River.

PROGRESS:

SUPPORTED BY Connecticut State Government

2.0086, PHOSPHORUS IN LAKE SEDIMENTS

R.D. HARTER, Conn. Agric. Expt. Station, *New Haven, Connecticut* 06504 (CONH00411)

OBJECTIVE: Discover the nature of the phosphorus exchange between lake sediment and water by studying self diffusion of P through lake sediment, establishing the effect of temperature on phosphorus equilibrium between sediment and water, determining which fraction of mud phosphorus is exchanging with water, and evaluating the rate of movement of phosphorus from sediment into water across a mud-water interface.

APPROACH: Self diffusion through mud will be determined by constructing a core of bottom mud in small glass tubes. The base of the column, or to the water above the soil, P will be added. Rate of exchange of phosphorus from mud to overlying water will be evaluated by placing lake sediment in large cylinders and slowly renewing distilled water over the mud.

PROGRESS: The sediments of two recent man-made reservoirs, both considered highly eutrophic, were compared with those of a third moderately eutrophic lake created naturally about 10,000 years ago. The P content of the sediments was found to increase dramatically as P concentration increased in the incoming water, confirming predictions from previous laboratory studies of P sorption by sediments. Moreover, the distribution of P amongst the various inorganic fractions was strikingly similar to laboratory predictions: the adsorption maximum for NH(4)F-extractable P was estimated to be 350-450 mu g P/g. sediment, and values observed in the reservoirs were 350-500 mu g P/g. In laboratory stu-

dies, NaOH-extractable P increased sharply as P was added, presumably due to precipitation of iron phosphates. In man-made reservoirs, NaOH-extractable P was 10-fold greater than in the natural lake, although the incoming P concentration was only about twice as great. The implications of these observations of new lakes is not encouraging. The most recent impoundment, only 13 years old, was found to contain twice the sediment P concentration as the natural lake after 10,000 years. 'Galloping eutrophication is apparently more than a catchy phrase.

SUPPORTED BY U.S. Dept. of Agriculture

2.0087, HYDROLOGIC-MINERAL CYCLE INTERACTION IN SMALL UNDISTURBED AND MANIPULATED ECOSYSTEMS

F.H. BORMANN, Yale University, School of Forestry, *New Haven, Connecticut* 06520

Continued experiments with a set of small watersheds is capitalizing on the ecosystem approach and computer simulation studies to examine input-output functions of chemical and biological variables of these forested systems as a whole. Treatments imposed on a catchment may yield an economic return in the form of more water, but additional responses such as alterations of the nitrogen cycle are also under study.

The opportunity to examine an adjacent lake will provide a paleoecology or time framework to the manipulated watershed experiments. Specific studies of nutrient budgets, vegetation, stream-forest interactions, lake and stream limnology, system responses to cutting treatments, and weathering sequences, will contribute to the computer modeling and simulation study.

SUPPORTED BY U.S. National Science Foundation

2.0088, CONTROL OF AQUATIC WEEDS

J.F. AHRENS, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONH00607)

Progress: In the late fall of 1967 dichlobenil was applied to an irrigation pond to control aquatic weeds in 1968. Water samples were taken at 1, 2, 3 and 4 months after treatments, frozen and later assayed to determine residual phytotoxicity. Oat seeds were watered with 1/2 or 1 inch of the water samples and root growth was measured. Water samples taken at 1 or 2 months severely injured oats but later samples caused no injury. The pond was essentially weed free during 1968 and the water was used to irrigate container nursery stock. To determine the residual effects of 2,4-D in water, 2,4-D butoxyethanol ester in granular form was applied in 2 farm ponds at 1 and 5 ppm. Water samples were taken at weekly intervals up to 36 days after treatment and will be analyzed for 2,4-D by Amchen Products, Inc.

SUPPORTED BY Connecticut State Government

2.0089, THE QUANTITY & MOVEMENT OF NITRATES IN SOIL WATER IN TWO CONNECTICUT SOILS TREATED WITH HIGH & LOW LEVELS OF INORGANIC NITROGEN FERTILIZER

G.F. GRIFFIN, Univ. of Connecticut, School of Agriculture, *Storrs, Connecticut* 06268

The Connecticut soils, one with a fragipan, will be used to study the distribution of nitrates in soil water (with regard to potential ground water pollution) resulting from applications of inorganic nitrogen fertilizer for silage corn. Vertical and lateral movement of nitrates in soil water will be measured with suction lysimeters installed to depths of one, two (or fragipan depth) and four feet. Soil water samples will be taken from the suction lysimeters weekly except from those at the four-foot depth, where daily samples will be obtained. Soil moisture determinations will be made with a neutron moisture probe whenever samples are taken from the suction lysimeters.

On the upper half of each field a randomized complete block design with four replications will be used. Nitrogen treatments will be plus N (250 lbs. of N/acre) and minus N (no nitrogen). The plusN and minus N treatment plots will be separated from each other by buffer plots. Corn will be grown on all plots. On the lower half of each plot, ryegrass will be grown and suction lysimeters will be installed to permit measurement of the downslope movement of nitrates. Yields of corn and its nitrogen uptake will be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0090, RELATIVE POLLUTION STRENGTHS OF UNDILUTED WASTE MATERIALS DISCHARGED IN HOUSEHOLDS AND THE DILUTION WATER USED FOR EACH

R. LAAK, Univ. of Connecticut, School of Engineering, *Storrs, Connecticut* 06268

The proposed research plan involves measuring the weight of commercial products wasted through the plumbing fixtures in households, the dilution water used will also be measured. The individual ingredients wasted such as soap, tissue papers, urine, feces, etc... will be analysed in the laboratory.

The purpose is to gather basic data. The relative strengths, character and importance of each ingredient would be expected to show the potential improvements that could be made in redesign of fixtures and water conservation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0091, WORKSHOP ON EFFECTS OF ATOMIC RADIATION ON OCEANOGRAPHY

A. SEYMOUR, Natl. Academy of Sciences, *Washington, District of Columbia* 20037 (AT(49-7)3005)

In September, 1967 a Workshop on Effects of Atomic Radiation on Oceanograpy was held at Woods Hole, Mass. A report resulting from that Workshop and subsequent deliberations by the Panel on Radioactivity in the Marine Environment of the Committee on Oceanography is now in preliminary publication form. The report, to be entitled Radioactivity in the Marine Environment, will contain sections on: Sources of Radioactivity and their Characteristics; Oceanic Distributions of Radionuclides from Nuclear Explosions; Physical Processes of Water Movement and Mixing; Marine Chemistry; Marine Sediments and Radioactivity; Accumulation and Redistribution of Radionuclides by Marine Organisms; Ecological Interactions of Marine Radioactivity; Radiation Effects: and Evaluation of Human Radiation Exposure.

Results: Publication of the report is planned for this fall.

SUPPORTED BY U.S. Atomic Energy Commission

2.0092, CHEMISTRY OF ATMOSPHERIC PRECIPITATION

D.W. FISHER, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

The general objective is to obtain a better understanding of environmental factors that determine the chemical nature of precipitation and to assess the role of precipitation in determining the quality of streams and of ground water.

Sampling networks are in operation in New York - New England, St. Thomas, V. I., and in North Carolina in three distinctly different environments. A specific watershed is being studied in North Carolina to relate precipitation chemistry to terrestrial water quality.

Specific attention is being given to the correlation of the sulfate and nitrate content of precipitation with atmospheric concentrations of sulphur and nitrogen to resolve basic problems on the sources of some important precipitation constituents.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0093, DRAINAGE OF PENNSYLVANIA ANTHRACITE MINES

G.H. WOOD, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

States to which project pertains: Pennsylvania.

Project is to provide geologic data concerning the structure, stratigraphy, mining, and anthracite resources of specified areas in the Pennsylvania Anthracite region. These areas are chosen by the U.S. Bureau of Mines and the Pennsylvania Bureau of Mines

on the basis of surface and subsurface problems related to mine drainage. The geologic data is to be incorporated with hydrologic data provided by the Water Resources Division into reports recommending or not recommending the specified areas as sites for underground or surface engineering and construction projects whose purposes are to alleviate mine drainage problems. Geologic work directed towards the submittal of reports is undertaken only when project areas are chosen and a request is made.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0094, BEHAVIOUR OF RADIONUCLIDES IN MARINE BIOTA IN CONNECTION WITH THEIR ENVIRONMENT
J.K. MIETTINEN, Helsingin Yli. Helsing. Univ., *Helsinki, Finland*

Microbial methylation of mercury and uptake, location and excretion of methylmercury in marine animals, especially fish, are studied in the Mediterranean and the Gulf of Finland using the radioactive isotope Hg- 203. Biological half-times are determined by whole-body counting of individual live animals for several months after introducing the labelled compound as a single dose either orally (by plastic canula into stomach) or by muscular injection or by uptake from water through gills. Retention equation is two- exponential, the slow component usually representing 80-90 % of the dose of methylmercury administered.

Biological half-times of the slow component are mostly quite long, varying from a few hundred days to about 3 years in different species.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0095, HYDROSPHERIC ENRICHMENT OF MERCURY STUDIED BY 203-HG-LABELLED ORGANIC COMPLEXES
J.K. MIETTINEN, Helsingin Yli. Helsing. Univ., *Helsinki, Finland*

Using compounds labelled by the radioisotope (203Hg), intake and excretion of mercury 2 ion and methylmercury as the ionic form CH3Hg plus or as the insoluble protein bound form CH3Hg- protein are studied in fish and molluscs. Effect of dose, temperature and way of administration on the amount and rate of excretion are studied by 'whole body counting' individually marked live animals during several months. Experiments are carried out in collaboration between IAEA laboratory of Marine Radioactivity at Monaco and the field research team of this Department at the Tvarminne Marine biology station of the University of Helsinki.

Excretion rates of 203Hg labelled methyl ethyl and propyl mercury in rainbow trout (Salmo gairdneri) are compared. Methylation of mercury by microorganisms in bottom muds is studied in anaerobic and aerobic conditions.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0096, BRACKISH WATER IRRIGATION IN SOUTHERN FLORIDA FLATWOODS
E.H. STEWART, U.S. Dept. of Agriculture, Plantation Field Laboratory, *Fort Lauderdale, Florida* 33310 (SWC-021-BPL-2)

OBJECTIVE: Determine the effect of brackish water irrigation on salinity of the soil, quality of ground water, hydraulic conductivity and other soil-water properties; the relationship between mineralogical, chemical and physical properties of the soil, soil water movement and retention.

APPROACH: Chemical content of ground water and depth to water table will be related to salinity of soils that are only a few feet above sea level. Effects of salt content of percolating water on hydraulic conductivity and other soil properties related to water control and crop response will be measured on soil with a high water table. The salt content of the rootzone will be periodically measured and related to rainfall.

PROGRESS: Studies in South Dade County, Florida show the salinity level in Perrine marl is related to amount and direction of water movement in a marl soil that lies 2 to 4 feet above mean sea level elevation. The salinity was highest during the dry winter months when water evaporates from the soil surface, and was lowest in the rainy summer when rain water infiltrates into the soil. Water tables fluctuated from slightly above ground level to no more than 2 feet below ground level throughout the year. Rainfall pattern and amount, drainage ditch level and ocean tides all affected the ground water level in the field. Chlorine content of the surface soil was above 200 ppm during the rainy summer months and 800 to 2000 ppm during the drier winter period. There was little fluctuation in the chlorine level of 1400 ppm at 40 cm depth in the soil. The electrical conductivity (EC) of soil- water extract at 20 cm depth of soil varied from 9 mmho/cm after the dry season to 5 mmho/cm at the end of the wet season, while at 40 to 50 cm depth EC was nearly constant throughout the year at 6 mmho/cm. The EC of ground water was constant also at 4.5 mmho/cm. Large amounts of salt were removed readily from the surface soil by leaching laterally through beds with water applied in alternate furrows. This method of salt control could be used effectively during the dry season where crops are grown in ridged rows. Effective leaching of salt by rain water through the soil profile would require pumping large volumes of water to keep the water table at or near sea level elevation.

SUPPORTED BY U.S. Dept. of Agriculture

2.0097, MEASUREMENT OF ELEMENTS DEPOSITED FROM ATMOSPHERE
H.L. BRELAND, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-SL-01382)

OBJECTIVE: Determine the amount of chlorine, fluorine, iodine, and sulfur brought down from the atmosphere in rainfall.

APPROACH: Rainfall will be caught in stainless steel rain gauges and collected in acid-leached jugs. The jugs will be changed monthly and analyzed for the elements in question.

PROGRESS: Rain water samples were collected for analysis with raingauges. Lake and stream samples were also taken at approximately one month intervals. A total of 180 samples were collected and 1630 separate determinations were made. The determinations included Al, Ca, Cu, F, Fe, I, K, Mg, Mn, Na, P and F. Some elements, such as Al and Cu, were too low for detection by the methods used; they will probably not be determined in the future. Values obtained for the lake and stream samples were generally higher than those obtained for rainwater.

SUPPORTED BY Florida State Government - Tallahassee

2.0098, THE CONTRIBUTION OF ORGANIC SOILS AND AGRICULTURE TO EUTROPHICATION IN LAKE APOPKA
C.C. HORTENSTINE, Univ. of Florida, School of Agriculture, *Gainesville, Florida* 32601

It is apparent that Florida lakes are vulnerable to accelerated eutrophication through natural and artificial agents. The subtropical climate provides an ideal environment for 'algal blooms', if and when sufficient amounts of the limiting nutrients, phosphorus and nitrogen, are present. During recent years, the primary artificial agent, man, played a major role in eutrophication of Lake Apopka. However, only meager scientific data are available that delineate the contribution from each of man's numerous activities. In other words, no one can say unequivocally that farming contributes more P and N to the lake's waters than municipal sewage or industrial wastes.

Plots will be installed in old cultivated organic soil and newly drained organic soil on the northern shore of Lake Apopka. Management and cropping will be the same as with commercial vegetable production except that fertilizer applications will vary from none to twice normal amounts. Water samples will be collected periodically from soil moisture tubes, shallow wells, and mole drain outlets and analyzed for orthophosphate, total phosphorous, nitrates, nitrites, ammonia, and total nitrogen. Soil samples will be collected at 6-inch depths down to 2 feet and analyzed for phosphorous and nitrogen. Plant material will be removed and analyzed for phosphorous and nitrogen.

In addition to the plot research, water pumped into the lake from the organic soils will be monitored as to quantity and sampled continuously for chemical analyses. Also, we propose to determine the amount of water exchange between the lake and drainage canals through the dam that separates the organic soils from the lake proper.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0099, NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA

C.C. HORTENSTINE, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-SL-01468)

OBJECTIVE: Determine the contribution of fertilizers, pesticides, and soil management practices to eutrophication in Lake Apopka. Also, to study the hydrologic pathways in the Lake Apopka watershed as a basis for using the mineral soils as a disposal area for sewage and citrus processing plant effluent.

APPROACH: Field plots will be established on newly cleared and on older cultivated muckland, fertilized with varying rates of mineral fertilizers, and cropped to appropriate vegetable plants. Plant tissue, soil, and soil solution samples from several soil depths will be analyzed periodically for plant nutrients. The movement of plant nutrients through sandy soils into ground water under selected orange groves will be studied by weekly sampling and analyses of soil and soil solution. The ability of these soils to retain applied phosphorus will be determined. Flow patterns of water through the lake will be determined through the use of fluorescein dye.

PROGRESS: Plots were laid out, fertilized differentially, and planted to spinach on organic soil which has been under cultivation for several years; plots were also laid out on newly drained area and planted to carrots with no fertilization. Soil in the first category had pH 6.15 and contained 1440 ppm Ca, 1990 ppm Mg, 39 ppm P, and 530 ppm K. Soil from the newly drained area had pH 7.0 and contained 2195 ppm Ca, 3565 ppm Mg, 356 ppm P, and 755 ppm K. Nutrients were extracted with 1N NH(4) OAc at pH 4.8. The high pH and high fertility in the latter case indicate that this is probably burned over area. Soil samples, from another section in the same area where the clearing operation is not completed, were collected for comparison to verify this assumption. These samples have not been analyzed. Soil moisture tubes were installed in both experimental areas, but no analytical data are available. The main objective in the current research is to determine the movement of N and P through the organic soil into surface water from previously cultivated and newly cultivated areas. Much of the eutrophication in Lake Apopka is attributed to farming on organic soils along the lake's shore. There are no valid research data to verify this assumption. Data collected under this project will partially serve to prove or disprove the accusation.

SUPPORTED BY U.S. Dept. of Agriculture

2.0100, NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA

A.R. OVERMAN, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-AG-01468)

OBJECTIVE: Determine the nature and quantity of nutrient transfer between contingent agricultural areas and Lake Apopka.

APPROACH: Chemical analysis will be performed on the soil and lake waters to analyze the nutrient balance of the lake. Water flow patterns in and around the lake will be studied to evaluate relative inputs and outgo of nutrients. Meteorologic and hydrologic data will be used to estimate evaporation and stream outflow.

PROGRESS: Information is needed on the nutrient inputs to Lake Apopka from organic and from mineral soils. Agriculture has been indicated as a major source of pollution of the lake. Field plots are being established on newly cleared and on older cultivated muckland under different cropping and fertilization practices with drainage ditch arrangements to permit the imposition of several different subirrigation, drainage, and flooding water management systems. Flux of water and nutrients through the muck profile and to and from the canals during drainage and subirrigation periods will be determined from water samples obtained from shallow wells, tension lysimeters, and the canals and from pore pressure -- water content relations by porous cup tensiometer -- piezometer units and calibration data relating water content and unsaturated conductivity, hydraulic head, and saturated conductivity, water content, and tension. Water samples will be obtained at least weekly at 15,30, 60, and 90 centimeter soil depths and will be analyzed for total N, ammonical - N, Nitrate - N, total P, orthophosphate - P, K, Ca, Mg, pH and total soluble salts. Fertilizer treatments will be: no fertilizer, one-half commercial rate, commercial rate, and twice the commercial rate.

SUPPORTED BY U.S. Dept. of Agriculture

2.0101, DEPOSITION OF FINE SEDIMENTS IN TURBULENT FLOWS

E. PARTHENIADES, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

The primary general goal of the proposed project is the discovery of the flow parameters which control the initiation, degree and rates of deposition of fine cohesive sediments in turbulent flows, and the derivation of analytical relations between these variables. Recent investigations by the principal investigator and co-workers revealed important conclusive relationships on the effect of bed shear stress on the percentage and rates of deposition of fine sediments. Secondary currents have also been shown to be important.

The experimental investigations will be conducted in special equipment constructed at the Coastal Engineering Laboratory of the University of Florida. Its main components are an annular channel containing the water sediment mixture and an annular ring positioned within the channel and in contact with the water surface. The simultaneous rotation of these components in opposite directions generates a uniform turbulent flow field free of floc disrupting elements. Investigations related to the deposition rates and of the effect of secondary currents on the distribution of boundary shear stress and on the deposition rates, have been scheduled for the near future.

The objectives of the project are related to the control of shoaling in navigable channels and to the pollution in estuaries, caused by the transport and deposition of fine solid waste materials.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0102, PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARINE WATER

H.D. PUTNAM, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

The objective of the proposed research is to contribute to an understanding of the synthesis and decomposition of organic matter by primary producers in an estuarine environment. Studies will be conducted to estimate the productivity of certain red and brown algae which are part of the benthic community in the Waccasassa Estuary. Appropriate methods for measuring fixation of isotopic carbon by attached plants were worked out under grant No. WP-00678-03 which will be completed by this investigator August 31, 1967.

In addition an attempt will be made to define more clearly the limiting factors for primary production in the Waccasassa Estuary. Emphasis will be directed toward the interaction of chemical and biological factors.

Efforts also will be made to follow the decomposition of organic matter under anoxic conditions in esturaine sediments. These studies will be directed mainly toward the characterization of substrates which are involved in methanogenesis. The pool size of volatile fatty acids resulting from the breakdown of algae will be determined and efforts made to establish metabolic turnover rates of these components.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0103, EUTROPHICATION FACTORS IN NORTH CENTRAL FLORIDA LAKES

H.D. PUTNAM, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

The project objectives are: (1) to determine the validity of criteria now in use in other areas in measuring trophic levels in shallow, subtropical lakes, and if necessary develop other criteria;

(2) to demonstrate the validity of the mathematical model of eutrophication developed by the application of systems analysis techniques and procedures; (3) to determine the controlling factors in the eutrophication process; (4) to establish guide lines to be used by regulatory agencies in the prevention of surface water deterioration. A small lake in an unhibited drainage basin is to be used as a model for eutrophication and will be separated into control and experimental units by a dike. Nutrients will be fed into the experimental unit at a controlled rate. Changes in parameters will be determined and related to the change in nutrient flux to the unit. The ability of the lake to assimilate nutrients, the rates of recovery after nutrient enrichment ceases, and the possibility of controlling the factors inducing eutrophication will be studied.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0104, VIRAL CONTAMINATION

J.L. RUNNELS, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

It is proposed that the study of viral contamination of estuarine waters be extended as set forth in the Sea Grant Institutional program. In substance the objectives are to: (1) determine which viruses are stable enough in sea water to survive; (2) determine at what level stable viruses are concentrated in marine animals such as the oyster; (3) develop a technique for detection of stable viruses in the estuary; (4) test water and marine animals of Biscayne Bay for the presence of contaminating viruses. Most of the next year should be spent in extending the number of viruses tested, standardization of techniques, and detection of viruses in the Bay.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0105, NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA

R.B. FORBES, Central Fla. Agric. Expt. Sta., *Sanford, Florida* 32771 (FLA-CF-01468)

OBJECTIVE: Determine the effects of pesticides, fertilizers, crops, water management and climate on the inputs and outgo of nutrients and pesticides from the soils in the Lake Apopka area; the hydrologic pathways through Lake Apopka in relation to the nutrient status of the lake; the effects of using the mineral soils of the area for disposal of wastes for abating pollution of surface water.

APPROACH: Field experiments on the muckland adjacent to Lake Apopka for study of effects of cropping, fertilization and water management systems; water sampling sites in mineral soils around lake to determine flow patterns and chemical quality; tracer studies of flow patterns in Lake Apopka; field plot studies in use of sewage plant effluent for irrigation of sandy soils.

PROGRESS: Water quality work formerly reported as nonprojected has been expanded and written into a cooperative project with Soils and Agricultural Engineering Departments of the main station. Field experiments to determine the effects of fertilization and management programs on chemical properties of farm drainage water were begun in the latter part of 1969. Sampling of water in the canals and lake has continued. Little or no DDT has been found in drainage water since June 1968. Higher levels of soluble salts, solids and nutrients in the canals were found over the summer months than during the winter and spring.

SUPPORTED BY U.S. Dept. of Agriculture

2.0106, AN ANOMALOUS OCCURRENCE OF SALINE WATER IN THE FLORIDAN AQUIFER

C.R. SPROUL, State Bur. of Geology, *Tallahassee, Florida* 32302

A small area in which water from the Floridan Aquifer contains in excess of 3000 ppm of chloride and is recorded in Lee County, Florida. The area is about 1/2 mile in width and 2 miles long. Wells in the surrounding area commonly yield water containing less than 1000 ppm of chloride. Preliminary work indicates a positive temperature anomaly congruent with the chloride anomaly. It is planned to utilize electrical gamma ray, cliper, temperature, conductivity and flowmeter borehole logging techniques to locate and identify the source of the saline water in the aquifer in this area.

An evaluation of the application of geophysical logging to specific problems in geohydrology is also planned in conjunction with this study.

SUPPORTED BY Florida State Government - Tallahassee

2.0107, SALINE WATER POLLUTION OF POTABLE WATER SUPPLIES THROUGH DEEP ARTESIAN WELLS

C.R. SPROUL, State Bur. of Geology, *Tallahassee, Florida* 32302

The expansion of urban development into previously agricultural areas is resulting in the abandonment of large numbers of wells formerly used for irrigation. Most of the abandoned wells were drilled from 10 to 50 years ago and were constructed without regard to protection of potable water supplies. The water from these wells commonly contains from 500 to 1000 ppm chloride, and is under sufficient pressure to flow at land surface. Water from these wells intrudes lower head artesion aquifers and water table aquifers which normally contain potable water.

The first phase of this study is to outline the problem areas and to evaluate quantitatively the seriousness of the problem. It is planned to rely heavily upon geophysical well logging in this phase of the study.

Also to be considered are certain legal aspects of this problem, principally the advisability of statutory requirements for the adequate plugging of abandoned wells.

SUPPORTED BY Florida State Government - Tallahassee

2.0108, THE EFFECT OF URBAN LAND DEVELOPMENT ON WATER QUALITY

M.W. ANDERSON, Univ. of South Florida, School of Engineering, *Tampa, Florida* 33620

The efficient management of water resources in a rapidly developing urban area requires concise and quantitative measurements of effects of changing land use. As regions are changed from a natural state to other acceptable levels of population density, changes occur in water runoff both in quantity and quality. Decisions involving both projected land use and water quality management are always made more difficult by the lack of quantitative data upon which to make evaluations.

A parcel of land near the University of South Florida, consisting of approximately 160 acres (presently in a natural state but scheduled to be developed into a medium density populated area), has been selected for a study which will have the following objectives: 1. To establish quantitatively the original state of this land. This will include: (a) An inventory of existing flora and fauna and soil conditions. (b) The quatity of runoff. (c) A complete water balance and energy balance. (d) The magnitudes of each of the water quality parameters in the water runoff. 2. To evaluate at regular intervals the following: (a) Changes in the topography and flora and fauna (b) The quantity and quality of runoff (c) Changes in water balance and energy balance. (d) The magnitude of each of the water quality parameters. 3. To correlate the changes in evapotranspiration, percolation, and runoff as well as the changes in amounts and characteristics of the water quality parameters as the land development proceeds.

The parcel of land chosen for this study is ideally suited to this purpose. Topographically it is an almost complete drainage area. Runoff into the area is largely at one corner of the property where a simple wier will be used to measure the surface input. Rainfall gages placed around the area will help determine the rainfall distribution within the 160 acre tract. A small local lake has existed in equilibrium for many years, thus infiltration rates can be estimated with some degree of accuracy. The outflow for the area is by the way of two small streams which lend themselves to simple wier or outfall methods of obtaining flow measurements. Samples of water taken at the overfall and in the lake will be subjected to standard tests for water quality parameters. Local percolation and transmissibility tests will determine the soil characteristics. Evaporation tests will be conducted us (Text Truncated - Exceeds Capacity)

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0109, RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS
D.E. SMITH, Rollins College, Graduate School, *Winter Park, Florida* 32789

Objective: Field and laboratory studies will be aimed at determining the relative leaching rates of various nitrogen carriers from sandy soils surrounding the Winter Park, Florida chain of lakes in an effort to evaluate the role of lawn fertilization in the nitrogen enrichment of the lake water.

Approach: The project will have three aspects: (1) Analysis of storm drain effluent for total available nitrogen; (2) Laboratory determination of nitrogen losses from sterilized soil columns; (3) Tabulation of amounts, frequency of application, and types of fertilizers used by lakefront and proximate landowners. Results of the investigation are expected to increase our understanding of the causes of an acute aquatic weed problem in local lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0110, GAVE DE PAU RIVER
UNKNOWN, Sogreah, *Grenoble, France*

A study of the relation between stream flow and sheet flow over alluvium to aid the pollution problems created by the Gave de Pau.

SUPPORTED BY French Government

2.0111, RURAL RUNOFF CONTROL
D.W. HILL, U.S. Dept. of the Interior, Federal Water Quality Admin., *Athens, Georgia* 30601

This research is designed to evaluate the contribution of rural runoff to pesticide and primary nutrient concentrations found in natural watercourses. Many phenomena are being investigated in detail, such as: adsorption mechanisms, degrees of reversibility, thermodynamic parameters, and the nature of the ionic equilibria between the particulate phase and classes of pesticides. More general interrelationships will be studied in the field including such phenomena as types and amounts of agricultural chemicals carried in surface runoff, in solution or adsorbed on different materials in the particulate phase; those that are mobile in interflow, and an estimate of the total amount received in the watercourse from other than surface runoff. An overall computer program will be constructed to incorporate those relationships that appear amenable to calculation. In some cases the findings outlined above will be incorporated in detail whereas other relationships may be grossly simplified in an effort to emphasize those phenomena which are relatively important in contributing to water pollution by rural runoff and to de-emphasize those which are relativcly insignificant. Control recommendations and methodology will result from this research.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0112, THE ARTESIAN SYSTEM IN GEORGIA STRATIGRAPHY AND HYDROLOGY OF THE OCALA
R.E. CARVER, Univ. of Georgia, School of Arts, *Athens, Georgia* 30332

The Ocala limestone is a principal source of water for the south Georgia region whose continued development depends upon the intelligent use of water supplies from this aquifer. The hydrologic and recharge characteristics of the Ocala are not well understood; hence the long range productivity of the reservoir cannot be predicted.

The major objectives of the research are to determine: (1) the lithology and distribution of the Ocala and correlative units, (2) the hydrologic and recharge characteristics of the Ocala and correlative units, and (3) the effects of long term use (last 50 years) on the piezometric surface.

Procedure: All known data regarding the geology, water and well records of the Ocala limestone aquifer will be compiled. In addition, palynological, petrological, lithostratigraphical and biostratigraphical studies of the Ocala limestone from well samples and also from the entire outcrop area within the state of Georgia will yield new data on the three dimensional stratigraphy of this aquifer in both the surface and the subsurface. This knowledge will lay the groundwork for further studies on ascertaining where and how the Ocala derives its recharge and where and how the water moves through the Ocala. These additional data will ultimately enable the pinpointing of sources of pollutants.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0113, VARIABLE SOURCE AREA RUNOFF
J.D. HEWLETT, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO-03-0328)

OBJECTIVE: Determine the source and path of travel of storm and base flows from a forested basin.

APPROACH: A 60-acre forested catchment at Whitehall, Georgia will be gauged and operated as an observation watershed to describe behavior of water on and in soil. Primary measurements will be streamflow, rainfall, soil moisture, ground water and soil physical properties. Flow will be calculated and expressed in various ways in order to relate volumes of water to source areas and also to rate response of this catchment to others in Piedmont province. Organic and inorganic solutes and sediments will be measured and an attempt will be made to relate these to source of water flows. Results will be used to support and clarify some new concepts of streamflow as generated by variable source areas and unsaturated flow, rather than by surface runoff and groundwater only.

PROGRESS: One PhD student, one Technician and two staff members continued collection and analysis of hydrologic data on the only fully forested study watershed in the southeastern Piedmont province from Virginia to Mississippi. Dr. Wilhelm Tischendorf received his PhD degree on the basis of the thesis listed below. The findings of the study were incorporated into a final report to the Office of Water Resources Research and some portions of the findings were written into a new 'Outline of Forest Hydrology'. The gaging network continues for another 3 years under revised objectives as a cooperative effort between the School of Forest Resources, the Zoology Department, the Georgia Forest Research Council and the State Agricultural Experiment Station. The work to the end of 1969 has shown among other things that drastic revision of traditional surface and subsurface hydrology is necessary to meet the need for new understanding and control of the source, timing and pathway of water delivery from upland areas. In addition some new values for the organic and inorganic detritus production from the first order, forested, Piedmont stream have been secured.

SUPPORTED BY Georgia State Government

2.0114, INVESTIGATION OF THE INFLUENCE OF VALENCE STATES OF IRON AND MANGANESE UPON THE BIOTA OF THE HYPOLIMNION
J.J. HEISE, Georgia Inst. of Technology, School of Biological Sciences, *Atlanta, Georgia* 30332

The proposed research will investigate the role of valence changes in manganese and iron cations and the resulting effectiveness of their utilization by micro-organisms of the hypolimnion. The study will investigate both the absorption of these cations in sediments and the factors which make them soluble for use by biota. Model systems will be formulated from the data obtained to predict the dynamic changes in reservoirs brought about by changes in valence states of cations that affect the biota. Additionally, optimal conditions for high quality water sources may be determined from the data.

Field work will involve the sampling of biota, water, and sediments of selected reservoirs. In the laboratory, the samples will be analyzed, quantitatively and qualitatively simultaneously, for certain valence states of manganese and iron by electron spin resonance spectrometry; a secondary colorimetric technique will be used to determine the total quantities of cations for comparison with valence states found; data will be evaluated to determine changes in the cations as they exist in solution, in micro-organisms, and in sediment.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0115, A STUDY OF THE EFFECTS OF ISLAND DEVELOPMENT ON LAKE WATER QUALITY
M.A. MCCLANAHAN, Georgia Inst. of Technology, Environmental Resources Center, *Atlanta, Georgia* 30332

Studies of Lake Lanier, a man-made lake on the Chattahoochee River about 35 miles north of Atlanta, Georgia, are being conducted to define water quality and trophic state of the lake in the vicinity of islands undergoing development, largely for recreational purposes. It is intended to establish present conditions in the lake, particularly in the vicinity of the islands. Analyses will include NH3,NO3,PO4, Fe, Mn, and other trace elements as they seem desirable, suspended solids, and light transmittance. Evaluation of the trophic state of the lake in the vicinity of the islands will be based upon routine determinations of temperature, pH and oxygen profiles, secchi disk readings, light transmission and chlorophyll a. Analyses of plankton populations and productivity will be undertaken on occasion during the study period. Studies will be undertaken periodically during and after development in order to define the effects of development on water quality.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0116, TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY
R.J. REIMOLD, Univ. of Georgia, Marine Institute, *Sapelo Island, Georgia* 31327

Recent pilot studies conducted by the University of Georgia Marine Institute revealed a potential pollution problem related to the release of toxaphene into estuarine waters and sediments. The data revealed toxaphene concentrations of approximately 1.07 ppm in the estuarine water and 4,700 ppm in sediments about one-quarter mile from the effluent outfall. The research work is designed to consider the extent (quantity and quality) of this work contaminant in the sediments, water and biota. Attention also is focused on the concentration process in the sediments and its potential relationship to biological and geochemical processes. Concern is also directed to the toxaphene concentration in the estuarine sediments related to biological or chemical degradation. Studies are also being conducted to look at the transportation of the contaminant through the estuaries, and methods of rendering the existing effluent and sediments nontoxic.

Field studies focus on the randomly selected collection sites in the potentially contaminated area compared with samples collected from an undisturbed and thoroughly studied salt marsh watershed adjacent to Sapelo Island, Georgia. This newly discovered site of pesticide concentration within the estuarine ecosystem will become a problem of great public concern with time. The research considered herein will attempt to identify the significance of toxaphene contamination in the total estuarine ecosystem and its potential roles of limitation of seafood production as well as changes induced on the estuary due to its potential toxic effects.

SUPPORTED BY Hercules Incorporated - Wilmington, Del.

2.0117, PROTECTION OF HIGHWAY AND MOTORWAY HEDGES FROM DEICING SALTS AND THE PLANTING OF SALT RESISTANT SPECIES OF PLANTS
G. SAEUR, Fed. Inst. Road Research, *Cologne, Germany* (005795)

Experiments have been carried out on the usual plants with protective coats. Also, field experiments have enlarged the group of plants known to be resistant in their parts above ground, by selection. Thawing agents now offered by the chemical industry are being tested to determine their harmlessness for plants.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY West German Government

2.0118, POLLUTION IN HAWAIIAN WATERSHEDS
R.H. YOUNG, Univ. of Hawaii, Water Resources Research Ctr., *Honolulu, Hawaii* 96822

Insufficient data is available on the pollution load contributions introduced into drainage channels and streams from agricultural, domestic, and industrial sources. However, some recent studies have identified these as a principal source of contamination of Hawaiian coastal waters. A three-phase study to investigate pollution effects on the water quality of watershed drainage on channels and streams of the island of Oahu and to determine the influence of these waters on the quality of Hawaiian coastal waters has been proposed.

The initial phase would concentrate on a single watershed receiving industrial pollutants as well as surface drainage. The sources of pollution will be identified and their individual contributions to the pollutant load wil be determined. Parameters of biological and chemical quality will be monitored including bacterial indicators, gross organic load, nutrients, planktonic mass, and benthic organisms. These quality characteristics will be evaluated in relation to land use, stream flow, and impact on the coastal receiving water environment.

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SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0119, BIOLOGICAL PRODUCTIVITY OF THE COEUR D'ALENE RIVER AS RELATED TO WATER QUALITY
F.W. RABE, Univ. of Idaho, Water Resources Research Inst., *Moscow, Idaho* 83843

The objectives of this study are (1) to collect and analyze certain physical and chemical data from the South Fork and North Fork of the Coeur d'Alene River, Idaho; (2) to measure primary production in various zones of the river and to estimate standing crop of herbivore and carnivore levels over a yearly period; and (3) to determine the median tolerance limits (tlm) of rainbow trout, Salmo gairdneri, to various concentrations and combinations of heavy metals from the river. Field collections will consist of collecting data from various locations in the river which typify clean water and water treated with mine wastes and domestic sewage. Periphyton will be collected to assess production. Laboratory studies will involve bioassays of fish under both static and running water conditions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0120, CHEMICAL AND BIOLOGICAL CONSTITUENTS IN NORTHWEST WATERS AND SOILS AS RELATED TO IRRIGATION
D.L. CARTER, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Twin Falls, Idaho* 83341 (SWCW8-FTF-18)

OBJECTIVE: Evaluate interrelationship of fertilization and irrigation on chemical and biological constituents in water and soil. Determine the relative chemical and biological constituent concentrations in inflow and outflow waters for irrigated lands. Determine the effects of chemical constituents in water on biological activity and dissolved oxygen.

APPROACH: Measure the quantity and the chemical and biological constituents of inflow and surface and subsurface outflow waters for selected irrigation districts and determine concentration or dilution of these constituents as water passes through soil and underground aquifers. The contribution of agricultural land fertilization to the nitrogen and phosphorus concentrations in outflow water and subsequent effects of downstream water use is evaluated. The effects of varying chemical constituent concentrations and temperature of water on biological activity are determined.

PROGRESS: Two-week sampling of diverted and drainage waters associated with 202,000 acres of land irrigated by the Twin Falls Canal Company indicates that irrigation decreases PO(4)-P pollution. The PO(4)-P in water used by evapotranspiration remains in the soil, accounting for about one-fourth of the PO(4)-P in the diverted water. As water passes through the soil and becomes drainage water, 70 to 90 percent of the PO(4)-P it contained is lost in the soil. Drainage water contains several times more NO(3)-N than does the diverted water but maximum concentrations reached only 4 ppm. This concentration difference results from greater concentrations of Cl , HCO(3), SO(4) S, NA , Ca , and Mg in the drainage waters. In this system waters from the subsurface drains and tunnels are constant temperature at

about 13.5 C and this water enters surface drains carrying surface runoff, thus cooling the total flow to well below maximum quality standard temperatures.

SUPPORTED BY U.S. Dept. of Agriculture

2.0121, CHEMICAL AND BIOLOGICAL CONSTITUENTS IN NORTHWEST WATERS AS AFFECTED BY IRRIGATION
D.L. CARTER, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Twin Falls, Idaho* 83341 (SWC-027-FTF-8)

OBJECTIVE: Evaluate interrelationship of fertilization and irrigation on chemical and biological constituents in water and soil and determine amounts of chemical constituents in return flows from irrigation.

APPROACH: Measure water quantity, temperature, and chemical and biologic constituents of inflow and surface and subsurface outflow waters for irrigation districts and determine concentration or dilution of these constituents as water passes through soil and underground aquifers. Measure nitrogen and phosphorus concentrations in outflow water and relate to fertilizer practices. Measure and evaluate seasonal fluctuations in nitrogen, phosphorus, and total salt concentrations and temperature of surface and subsurface drainage water. Measure effects of water quality on biological activity.

PROGRESS: Irrigation water passing through the soil of a 202,700- acre irrigation tract lost 65% of its initial PO(4)-P and 24 lbs of K per acre per year. There was a net output of 1 ton of soluble salt and 30 lbs of NO(3)-N per acre per year from the same system. These outputs of soluble salt and nitrate contribute to downstream pollution. The salt was assumed to be solubilized from soil minerals, but the source of the nitrate-nitrogen is not known. The diverted irrigation water was heavily polluted from upstream sources, but bacterial counts were very low in subsurface drainage water coming from the irrigation tract. Although surface drainage water contained more organisms than the subsurface drainage water, there was an estimated 56% fewer organisms in the combined drainage waters than in the diverted irrigation water. The water temperature was lowered 3 to 5 C as the water flowed across the surface of the irrigated field.

SUPPORTED BY U.S. Dept. of Agriculture

2.0122, ATMOSPHERIC CHEMISTRY
D.F. GATZ, Argonne National Laboratory, *Argonne, Illinois* 60439 (2-31-109-ENG-38)

The purpose of this study is to improve our ability to estimate wet deposition through a better understanding of (1) rain scavenging processes and (2) the precipitation processes and storm structure that form the basic framework in which the scavenging occurs. The approach is to relate contaminant element concentrations in rain and snow to concentrations in air for various precipitation parameters and aerosol sizes. Measurements of 20-40 elements are made by neutron activation analysis and other techniques on aerosol samples (collected on filters and size-specific impactor stages) and rain samples (both time- distributed and integrated over entire storms).

The measurements will be made at Argonne and also in two cooperative field research programs with other research groups. In Project ITREX (Illinois Tracer Experiment) sequential rain samples will be collected at three locations 1-2 miles apart near Clinton, Illinois. One filter sampler will collect aerosols on a daily basis. A second field study is now being planned to study urban effects on precipitation at St. Louis, Missouri. Aerosol and rainwater sampling is planned at 3- 5 ground-level stations and by aircraft near cloud base.

Results: Three sequential rain samplers have been built and are now operational. A few rain samples have been collected and analysed as part of a program to develop standard sampling and sample handling procedures.

SUPPORTED BY U.S. Atomic Energy Commission

2.0123, STUDY OF CAUSES AND CONTROL OF GROUND WATER INFILTRATION INTO SEWERS
A.T. BROKAW, Amer. Public Works Assn., *Chicago, Illinois* 60637

The purpose of the study is to investigate and determine the current situation relating to the technical, economic and social aspects of infiltration of extraneous waters into sanitary, storm or combined sewers. The investigation will consider all types of extraneous inflow of ground water and surface water into various sewerage systems. This study will be performed by means of a coordinated program of interviews and questionnaires with officials of local government agencies, consulting engineers, construction firms and manufacturers. A detailed investigation of about 24 selected communities or regions throughout the United States and Canada will be conducted. A major result of the study will be the preparation of a manual of recommended practice based on existing technology relating to control or prevention of infiltration. This manual will cover the design and construction practices, maintenance procedures, and regulatory practices. The study was started in June 1969 and should be completed by October of 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0124, SCAVENGING STUDY OF SNOW AND ICE CRYSTALS
M.R. JACKSON, I I T Research Institute, *Chicago, Illinois* 60616 (AT(11-1)-578,)

Objective - To study the efficiency with which snow and ice crystals scavenge suspended atmospheric debris in below-cloud sedimentation. Scientific Background for Study - The capture of airborne particulate matter by natural precipitation is very important in the removal of industrial pollutants, biological organisms and radioactive fallout. Recognition that precipitation removes trace materials from the atmosphere is widespread, but little is known about specific collection mechanisms and scavenging efficiency of precipitating rain or snow.

Most of the studies dealing with atmospheric washout have been concerned with the scavenging action of rain. Limited studies have been performed by Engelmann and Perkins, Reiter and Carnuth, Itagaki et al, Vittori et al. Experimental study of simulated crystals has been performed by Starr and Starr and Mason.

Proposed Procedure - A test chamber 1m x 1m x 2.6m high has been constructed. In operation the test aerosol is generated within the chamber, crystals are allowed to fall into the chamber through a trap door and are collected at the bottom of the chamber. The scavenged material is studied for number and location of particles.

Test Objects and Agents - 3.4mu florescent dye particles, 1mu B. Subtilis spores, 0.56 and 0.28mu latex particles and 0.1mu sodium chloride particles have been scavenged by snow and ice crystals.

Results: Experimental investigation of scavenging of particles ranging in size from 3.4mu to 0.1mu has shown that snow and ice crystals have a higher efficiency than raindrops of the same size. It has further been shown that the scavenging efficiency shows a minimum value for scavenged particles having sizes between 0.3 and 0.4mu. It has also been shown that the scavenging efficiency of a snow flake increase as its diameter decreases.

SUPPORTED BY U.S. Atomic Energy Commission

2.0125, ACCUMULATION OF METALS IN THE AQUATIC FOOD CHAIN IN THE ILLINOIS RIVER
B.J. MATHIS, Bradley University, Graduate School, *Peoria, Illinois* 61606

The purpose of this study is to determine the effect of selected metals in reducing the biotic diversity of the Illinois River.

Atomic absorption spectrophotometry will be used to determine the concentrations of selected metals in the water mud, and biota of the Illinois River. Concentrations of metals in water, mud, and biota in non-polluted streams near Peoria, Illinois will also be determined and compared with those found in the Illinois River. Selected species of fishes and benthic macroinvertebrates from unpolluted streams will be utilized as bioassay organisms.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0126, PREPARATION AND EVALUATION OF STARCH DERIVATIVES FOR DETERGENT BUILDERS
C.L. MEHLTRETTER U.S. Dept. of Agriculture, Northern Utilization Res. Div., *Peoria, Illinois* 61604 (N1-1-323)

OBJECTIVE: Prepare starch and dextrose derivatives containing a variety of functional groups, and evaluate the products as chelating agents for calcium ions for possible use as detergent builders.

APPROACH: Starch and dextrose will be reacted with such reagents as oxidants, ammonia, amines, thiols, and nitriles to produce a variety of derivatives containing amino, thio, carboxyl and related functional groups. Also, copolymers of starch with vinyl monomers will be chemically modified with such reagents as unsaturated acids copolymerized with maleic anhydride. The products will be tested for chelation of calcium, magnesium, and iron ions as an indication of utility for use as detergent builders. Promising products will be further evaluated for builder performance in household detergents under various conditions of pH, temperature, and concentration. Ability to support algae growth will be studied from the standpoint of stream pollution.

PROGRESS: Procedures were investigated for more economical preparation of carboxymethyl starch and dicarboxyl starch derivatives. A chemical synthesis of dialdehyde starch was developed, and both sodium chlorite and bromine oxidations of dialdehyde starch to dicarboxyl starch were carried out. Dicarboxyl starches of different carboxyl contents and molecular sizes were synthesized. Carboxymethyl starches of various degrees of substitution and molecular weights were also prepared by relatively simple methods for builder study. Evaluation of the products for builder action was delayed, however, by the unavailability of more Foster D. Snell standard soiled cotton. Another standard was purchased (ACH Fiber Service) which required repetition of the detergency tests with the more effective starch derivatives. Five- day BOD evaluations of the carboxylated starches showed that such derivatization greatly reduced the biological degradation of the starch molecule.

SUPPORTED BY U.S. Dept. of Agriculture

2.0127, FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT
R.C. HILTIBRAN, State Natural History Survey, *Urbana, Illinois* 61801

The proposed research will investigate the fate of the aquatic herbicides, diquat and endothall, after their introduction in the aquatic environment for the control of specific plant pests.

The toxicity of aquatic herbicides to aquatic plants and fishes has been documented. It has been recognized that aquatic herbicides may adversely affect other aquatic biota, but this has not been as well documented.

Data concerning the persistence of aquatic herbicides in water and their removal from water is accumulating. The research proposed is directed to the point: can aquatic herbicides be used in potable water, where their use may be necessary, and not constitute a potential hazard to people using the water? If so, what herbicides can be used and under what conditions?

The length of time the herbicides can be detected in water will be estimated. How are the herbicides removed from the water? Are the herbicides taken up by the fishes and aquatic biota, and to what extent? What are the interactions of the herbicides with the aquatic environment? Can the aquatic herbicides gain access to food utilized by humans? Data from the proposed research will permit a greater understanding of the questions raised.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0128, ALGAL GROWTH POTENTIAL OF ILLINOIS WATERS
R.L. EVANS, State Water Survey, *Urbana, Illinois* 61801

The objective of the study is to develop the methodology that will permit the use of algal growth potential (AGP) as a meaningful index of water quality. Methods for expressing productivity will also be investigated. Sensitivity, reproducibility, and minimum detectability are the major factors to be examined. After methodology and optimum environmental conditions have been established, a general survey of Illinois water will commence. Preliminary results should permit tentative classification of the waters based upon their potential for algal growth. The final phase of the study will relate to the applicability of bench observation to field experience. Currently the most practical expression for productivity would appear to be rate of growth in terms of weight.

SUPPORTED BY Illinois State Government - Springfield

2.0129, DISPERSION AND HEAT DECAY OF THERMAL DISCHARGES
V. KOTHANDARAMAN, State Water Survey, *Urbana, Illinois* 61801

A study has been undertaken to investigate the patterns of dispersion and heat decay of rejected heat discharged into the Illinois River by a power generating plant. A model will be developed to establish the relationship between river water temperature and dry bulb air temperature. This will provide the information for predicting natural river water temperature changes as reference for better delineating the temperature effects of waste heat additions. The patterns of dispersion and heat decay will be monitored in-stream, with corresponding measurements of pertinent atmospheric and flow conditions.

SUPPORTED BY Illinois State Government - Springfield

2.0130, NITRATE IN SURFACE WATERS IN ILLINOIS
T.E. LARSON, State Water Survey, *Urbana, Illinois* 61801

Periodic analyses are being made for NO3 on samples from streams in Illinois. These have clearly shown that this ingredient is increasing in concentration over the past 20 years. Intensive sampling of farm drain tiles is being conducted at several small watersheds to correlate with the fertilizer application over the past 5 or more years, and with the soil types, NO3 in streams, and factors influencing its presence in tile drainage.

SUPPORTED BY Illinois State Government - Springfield

2.0131, FATE OF TRACE METALS DERIVED FROM POLLUTION SOURCES IN LAKE MICHIGAN
H.V. LELAND, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

In the proposed investigation the accumulation of lead from pollution sources will be examined in water, sediments and biota of Lake Michigan and several of its major tributaries. In addition, a search will be made for other trace elements that have accumulated in the sediments. Particular attention will be focused on the geographical distribution and amounts of trace metals in the sediments of southern Lake Michigan, the factors affecting sedimentation and distribution of trace metals in the basin, and the concentrating capacity of aquatic animals for lead. The extent of dispersal of trace metals from atmospheric and surface water sources will be determined. Analysis of lead transport from pollution source to adsorption by lake sediments will be conducted.

SUPPORTED BY University of Illinois

2.0132, DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM
R.L. METCALF, Univ. of Illinois, School of Arts, *Urbana, Illinois* 61801

Little is known about the environmental fate, biodegradability, and ecological magnification of the thousands of organic micropollutants entering the environment as industrial wastes, pesticides, detergents, etc. A simple model ecosystem with a seven element food chain is used to evaluate these properties for micropollutants of any type by introducing a radiotracer preparation of the compound into the ecosystem, allowing it to cycle into the food chains, and assaying the magnitude and nature of the radiolabeled products by thin layer chromotography, radioautog-

raphy, scintillation counting, etc. As a result of the total appraisal each micropollutant can be rated for the degree of hazard that it poses as an aquatic environmental pollutant. It is proposed that the method may be of value as a standard system for judging the suitability of proposed new pesticides and industrial chemicals for uses that may affect water quality and lead to the establishment of criteria and standards for permissible chemical contamination of raw water supplies. In addition, the method will provide data leading to the preparation of a catalogue of ecosystem biodegradability in which specific types of organic compounds, including ring systems and substituent groups, can be characterized for their relative biodegradability and capacity for ecological magnification.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0133, RAINOUT OF RADIOACTIVITY IN ILLINOIS
R.G. SEMONIN, Univ. of Illinois, State Water Survey Division, *Urbana, Illinois* 61802 (AT(11-1)-1199)

Field measurements of tracer chemicals introduced into storm systems, the meteorological evaluation of their motion in the storms, and laboratory experiments on raindrop collection efficiencies of sub- micron aerosol are proposed.

A field experiment in cooperation with the Argonne National Laboratory, the University of Chicago, and the University of Wyoming is proposed whereby tracer materials will be released into clouds to study the precipitation scavenging processes. The clouds will be monitored by aircraft, radar, and ground observations. The rainwater from nearly 75 collectors within a 30 by 30 mile area and from time-resolved samplers in the vicinity of St. Louis, Mo. will be collected to determine the distribution of the tracer and other elements related to the urban environment. The results from this experiment will be used to infer the internal motions of the storm and the effects of urbanization upon the precipitation formation.

Current laboratory experiments will be continued on the measurement of raindrop sub-micron aerosol collection efficiencies with emphasis on the role of the electrical characteristics in the scavenging process. These results will eventually be used as part of a cloud model depicting the removal of aerosols by the precipitation process.

Results: Six storm situations were treated with chemicals during 15 May to 30 June, 1970. The chemical analysis of the rainwater for sodium, magnesium, potassium, and lithium (tracer) has been completed and maps of the deposition over a 400-square mile area have been prepared. The detailed analysis of the storm structure is in progress. The scavenging efficiency of raindrops in the size interval from 0.2- to 5.0-mm diameter for B. subtilus spores as a function of drop charge has been completed.

SUPPORTED BY U.S. Atomic Energy Commission

2.0134, ROLE OF FERTILIZERS IN WATER POLLUTION
L.F. WELCH, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-15-0351)

OBJECTIVE: Determine inorganic ions, principally nitrate and phosphorus, in sub-surface drainage water from agricultural fields and relate the findings to past and present fertilizer and cropping practices.

APPROACH: This study is to be limited initially to concern with drainage water that becomes surface water near the place where leaching occurs and will be related only to commercial fertilizers. It is recognized, however, that this study may be broadened to include the deeper leaching which becomes part of the water table and may later include other pollutant sources such as feed lots, herbicides, insecticides, etc. Primary concern will be for nitrate and phosphorus in drainage water but some attention will be given to cations that accompany them. Five to ten sites (2 to 160 acres) will be selected so that cropping and fertilization can be defined for each. Tile drainage water will be sampled at least twice each week when water is being discharged. Samples will be analyzed for nitrate and phosphorus, and other elements such as potassium, calcium, and magnesium. Volume of flow will be determined at time samples are collected. Results will be related to cropping and fertilization practices.

PROGRESS: Nitrate concentration in water of four drainage ditches was much less in July than in April. The decrease is probably due to removal of nitrate from the water due to absorption by plants growing in the ditches in July. Also, water in the ditch in July had drained from a lower depth in the soil profile than in April. There was a large variation in nitrate content of tile water from farmers' fields. One tile averaged 3.6 ppm NO(3)-N while another averaged 13.5 ppm. The field drained by the low tile has received a low rate of N fertilizer. Concentration of nitrate was essentially independent of flow rate for a given tile. For example, after a rainy period the flow rate may have increased eight fold, but the nitrate concentration often changed very little if any.

SUPPORTED BY U.S. Dept. of Agriculture

2.0135, ROLE OF NITROGEN FERTILIZERS IN WATER POLLUTION, AS AFFECTED BY RATE AND TIME OF APPLICATION
L.F. WELCH, Univ. of Illinois, School of Agriculture, *Urbana, Illinois* 61801

Movement of fertilizer nitrogen in soils will be studied utilizing field tile drains in Illinois.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.0136, RADIOACTIVITY IN THE AQUATIC ENVIRONMENT (PART OF A COORDINATED PROGRAMME OF RESEARCH IN MARINE RADIOACTIVITY STUDIES)
A.K. GANGULY, Bhabha Atomic Research Centre, *Bombay, Mahrashtra, India*

The project is research cum monitoring orientated especially to study the cycling and distribution of radioactivity in marine matrices - benthic communities, sediment and sea water - off the west coast of India, with particular reference to Bombay Harbour Bay (18 degrees 55'N and 72 degrees 50'E) which receives radioactivity through the nuclear operations and Tarapur waters (19 degrees 54'N and 72 degrees 41'E) which receives rad waste from a 400 MWe BWR. To understand these problems, emphasis is placed on radioecology and biogeochemistry of indicator species in relation to environment and radiobiology to evaluate the effects of ionizing radiations on the blood of selected marine species.

The regular monitoring is followed to assess the capacity of local marine environments to receive rad wastes and to derive maximum permissible radioactive contamination limits in the hydrospace. The hydrographic studies - current patterns, salinity, temperature - are carried out to study the dispersion of radioactivity and movement of water masses, silt transport and deposition.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0137, THERMAL AND BIOLOGICAL CHARACTERISTICS OF LAKES
R.G. LIPSCOMB, U.S. Dept. of the Interior, Geological Survey, *Fort Wayne, Indiana* 46803

The project is to evaluate methods of evaporation computation, study thermal-stratification processes, investigate biological influences on water quality, and study the process of lake aging. Where practical, new investigative techniques will be developed. Time and spatial distribution data from detailed counts of algal species in Pretty Lake, LaGrange County, Indiana, are being related to the distribution of water temperature and of chemicals known to be important in growth processes. Wind, temperature, and radiation data are being used in the study of water temperatures and evaporation. Analyses of plant and animal remains in the lake sediments, along with other sediment analyses, will provide data for the study of the aging process in Pretty Lake.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0138, SALINE WATER RESOURCES OF INDIANA
T.M. ROBISON, U.S. Dept. of the Interior, Geological Survey, *Indianapolis, Indiana* 46204

2. WATER QUALITY

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Indiana.

Purpose: To defined the area of pollution of ground water aquifers by saline waters from oil field operations, pinpoint the source, and monitor the pollution.

Methods: Sites are selected in coordination with the State Oil and Gas Division and the State Geological Survey. The following sites are under study: 1) An area of new oil wells with no reported pollution of ground water 2) An area of both old and new oil wells with only a rumor of pollution of ground water 3) An area where known pollution ground water has occurred.

Field and laboratory analyses are made to determine the extent of pollution. Periodic sampling and analyses of water from selected wells monitor the movement of pollution.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0139, PATTERNS OF PESTICIDE CONTAMINATION OF WATER

L. CHANDLER, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01480)

OBJECTIVE: Determine interrelationships of pesticides and soils with respect to water transport and/or deposition. Analyze the biotic significances of earthworms and stoneflies in multidimensional quantitative systems.

APPROACH: Class-representative insecticides will be applied at several concentrations to columns of soils. Water will be percolated through each and analyzed by gas liquid chromatography. Columns will be analyzed to determine depositions. Large-scale simulation will be conducted to establish significance of lateral movements. Baseline data will be obtained by studies of stoneflies and earthworms at stream and floodplain sites and in the laboratory. Methods of quantitative ecological analyses will be developed.

PROGRESS: Species of winter stoneflies (Allocapnia spp.) were studied to determine: the factors related to coexistence, the basic life histories of our common species, the value of species as ecological indicators of stream conditions, and the major mortality factors. Preliminary results were obtained for all objectives as follows: competition among species is reduced by differences in seasonal development of the immatures and/or substrate preferences; development from eclosion to emergence is extremely rapid, the greatest period of time being spent in the egg stage (8-11 months); species are good indicators of certain specific factors but should not be used in the generalized sense of indicators; and silting and catastrophic flooding are the two most important mortality factors. Population predistions can be made on the basis of current speed as related to gravel-sand substrate.

SUPPORTED BY U.S. Dept. of Agriculture

2.0140, THE FACTOR CONTROLLING THE DYNAMICS OF NON-IONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS

J.L. HAMELINK, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907

Project objectives include: 1) Evaluation of the adsorption of non-ionic organic chemicals (NISOC) to intact and suspended lake sediments in water; 2) Evaluation of the desorption of NISOC's from intact and suspended lake sediments into water; 3) Evaluation of the influence of increasing organic matter content in the sediments has on persistence and recycling of NISOc's; 4) Evaluation of the influence of increasing organic matter content in the water has on persistence, biological magnification and recycling of NISOC's in lentic environments; 5) Initiate development of an evaluation procedure to be used for defining water quality standards governing NISOC's; 6) Development of economically feasible practices or treatments to reduce NISOC residue levels in contaminated lentic environments, and 7) Evaluation and comparison of the persistence of brominated and chlorinated NISOC's in lentic environments.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0141, FATE OF SURFACE-APPLIED NITROGEN FERTILIZERS

P.G. MOE, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01471)

OBJECTIVE: Determine amount of fertilizer nitrogen lost in surface runoff water and through leaching; determine the extent of ammonia volatilization and denitrification losses; determine the amount of fertilizer nitrogen immobilized by soil microorganisms and/or fixed in unavailable forms in the soil; determine ways of improving crop utilization of nitrogen fertilizers.

APPROACH: The fate of nitrogen fertilizers applied to well characterized field plots will be followed over an annual cycle. A rainfall simulator will be used to provide controlled amounts of precipitation for measuring nitrogen losses due to surface runoff and leaching. Laboratory incubation experiments will be used to measure volatilization losses and N-15 labeled fertilizers will be used to measure immobilization.

PROGRESS. Simulated rainfall field plot experiments were used to study the loss of nitrogen fertilizers in surface runoff water. Total nitrogen losses from ammonium nitrate treated plots were about double the losses observed on the urea treated plots. This was due to a deeper penetration of the urea into the soil. Delaying the rainfall application to 5 days after fertilizer application increased nitrogen losses from all plots due to an increase in nitrate nitrogen loss. Maximum nitrogen loss under the most severe conditions amounted to only about 15% of the applied fertilizer nitrogen.

SUPPORTED BY Indiana State Government

2.0142, NUTRIENT CYCLING AND PRODUCTIVITY OF DYSTROPHIC LAKE-BOG SYSTEMS

T.C. GRIFFING, Univ. of Notre Dame, School of Science, *Notre Dame, Indiana* 46556 (AT(11-1)-1770)

A bog lake system will be chemically manipulated with lime to substantially increase the alkalinity in order to test the effects of alkalization on the major systems components which regulate productivity and nutrient cycling. One primary factor which will receive particular attention is the soluble brown staining organic that restricts light penetration, binds nutrients and contributes to the acidity of the system.

Results to date: A model has been developed that describes the pathways of nutrient cycling and hydrographic flow in perched bog systems. Comprehensive decriptions of the absorption coefficients of high molecular weight dissolved organics have been determined which demonstrate the regulatory effects on light in the trophogenic zone. Primary productivity has been markedly stimulated by the addition of alkaline earth cations.

SUPPORTED BY U.S. Atomic Energy Commission

2.0143, EUTROPHICATION OF IOWA LAKES AND STREAMS

R.W. BACHMANN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01779)

OBJECTIVE: Determine the critical nutrients responsible for eutrophication in Iowa waters.

APPROACH: Carbon-14 algal bioassays will be run on selected natural waters to determine which nutrients are critical to algal production. Quantitative chemical studies will be made of these critical elements to determine their sources and cycles within the water body in question. A search will be made for means to disrupt the cycles of critical elements.

PROGRESS. Major efforts have been expended in setting up the laboratory facilities to carry out the carbon-14 nutrient bioassays. A constant temperature, illuminated incubator has been constructed with provision for magnetic stirring of the experimental cultures. Bioassays of water samples from the Des Moines River will begin during the coming year. A sampling program was initiated on 17 streams and 7 lakes in the central Iowa region. Analyses are being made of plant nutrients and algal populations for the purpose of providing baseline information of the state of eutrophication of these waters.

SUPPORTED BY Iowa State Government - Des Moines

2.0144, EUTROPHICATION OF IOWA LAKES AND STREAMS
R.W. BACHMANN, Iowa State University, School of Agriculture, *Ames, Iowa* 50010

Many Iowa lakes and reservoirs are highly eutrophic as evidenced by chemical composition, algal blooms and winter oxygen depletions. It is important to determine the fundamental reasons for this excess productivity in order to evaluate the potential benefits of programs designed to reduce nutrient inputs through more elaborate municipal and industrial waste treatment plants, restrictions of feedlot waste disposal or restrictions on other agricultural practices that contribute nutrients to Iowa lakes and streams.

Objectives: 1. To examine the plant nutrient status of selected Iowa lakes and streams in order to determine where possible the sources of nutrients, their cycles within the water body and their ultimate points of loss to the biological system. 2. To determine by bioassy procedures which nutrients are in critical supply. 3. To examine the feasibility of controlling the supply of critical nutrients.

SUPPORTED BY Iowa State Government - Des Moines

2.0145, STUDY OF SEDIMENT POLLUTION AND MOVEMENT BY ACTIVATION ANALYSIS PRINCIPLES
C.E. BEER, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01766)

OBJECTIVE: Determine the sources of sediment contributing to the pollution of streams and rivers. Determine the pattern of sediment movement in a field to check theoretical mechanics of erosion equations. Determine the change in total sediment load per unit of area as watershed size increases. Relate sediment production to storm characteristics.

APPROACH: In activation analysis certain elements are irradiated with nuclear particles to produce radioisotopes. By counting the rate of disintegration of these radioisotopes, a quantitative evaluation of the amount of the original element present is possible. The field procedure will involve mixing Lanthanum in soil on a large scale to produce a 'seeding' batch. The treated soil may then be placed in the field at predetermined points chosen to fulfill a given objective. Sampling would be done immediately after seeding and at any other points along the flow path where information is desired.

PROGRESS: The major accomplishments during the 6-month period since the project was funded are as follows: A data acquisition system has been developed whereby data from a pulse height analyzer can be transmitted directly through teletype to a main computer. Output is then secured as a remote job entry. Limited seeding of soil-lanthanum mixtures was done on a small watershed on the Western Iowa Experiment Farm. Samples have not been completely analyzed. Agreements with the U.S. Geological for cooperative operation of 3 sediment-flow gaging stations in Four Mile Creek have been completed. These watersheds will be instrumented in 1970. In a related project entitled 'Relationship of Hydrology and Soils to Gully Development', a review of literature has been made.

SUPPORTED BY Iowa State Government - Des Moines

2.0146, STUDY OF SEDIMENT POLLUTION AND MOVEMENT BY ACTIVATION ANALYSIS PRINCIPLE
C.E. BEER, Iowa State University, School of Agriculture, *Ames, Iowa* 50010

In activation analysis certain elements are irradiated with nuclear particles to produce radioisotopes. By counting the rate of disintegration of these radioisotopes, a quantitative evaluation of the amount of the original element is possible. The field procedure will involve mixing lanthanum in soil on a large scale to produce a 'seeding' batch. The treated soil may then be placed in the field at predetermined points chosen to fulfill a given objective. Sampling would be done immediately after seeding and along flow path where information is desired.

A 14 mi square watershed will be used in the study. The sediment and nutrient loads (N, P) will be obtained from 3 gaging stations, each controlling sucessively larger areas.

SUPPORTED BY Iowa State Government - Des Moines

2.0147, WATER EROSION MECHANICS AND CONTROL--DEEP LOESS HILLS AND TILL PRAIRIES
W.C. MOLDENHAUER, Iowa State University, U.S.D.A. Soil & Wa. Cons. Div., *Ames, Iowa* 50010 (SWC-016-CAMES-1)

OBJECTIVE: Develop fundamental concepts explaining influences of soil physical and chemical properties on soil detachment and transport by rainfall and runoff, develop methods to bring subsoils exposed by topographic modification to optimum production level; characterize runoff and erosion problems in this resource area.

APPROACH: Continue investigations to define role of soil and its management in erosion processes. Develop techniques for analysis of and identify factors that influence soil aggregation and surface seal and find their relation to infiltration and erosion. Study physical and fertility relationships on exposed subsoils to find limits of economic feasibility of topography modification.

PROGRESS: Increased production of row crops, especially soybeans, coupled with reduced dairying have resulted in critical soil conservation problems in the Corn Belt. In Iowa, for instance, more than 17 million acres are in corn and soybeans. To obtain this acreage, more and more rolling to steep land has been cropped. Uncontrolled erosion causes land deterioration, soil and water losses, and contributes to pollution by sediment, pesticides and nutrients. The only apparent solutions at this time are soil- and water-conserving tillage methods on lower slopes in conjunction with large-scale topography modification, such as grassed back-slope terraces, on slopes too steep for erosion control by tillage methods alone. Fields cropped to a 2-year system of corn and soybeans are likely to lose significantly more soil by erosion than fields cropped to corn each year. But the increased erosion occurs in the year after the soybeans rather than while they occupy the land. Average annual soil loss from the soybeans following corn just equaled that from corn following corn, but soil loss from the corn following soybeans was 40 percent greater. Average annual soil loss from corn following soybeans was 8.5 tons per acre in contrast to 6.1 tons from each of the other two cropping sequences (losses adjusted to 300 foot slope length). Soil loss from corn following soybeans was not only greater than that from continuous corn in each year of the test but also within the season whenever erosive rains occurred.

SUPPORTED BY U.S. Dept. of Agriculture

2.0148, EFFECT OF MINERAL ELEMENTS ON YIELD AND COMPOSITION OF CROPS AND ON SOIL CONDITIONS
J.R. WEBB, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01761)

OBJECTIVE: Acquire basic information concerning crop response to fertilizer rates and practices, devise means of predicting these responses under different cultural and environmental conditions, and study soil chemical conditions as influenced by fertilization practices.

APPROACH: Continue operation of established long-term experiments involving fertilizer and lime variables, with crop yield response, crop chemical composition and soil nutrient level evaluation being emphasized. Study the movement and fate of high rates of fertilizer in the soil and relate the results to crop response and potential pollution of ground water. Investigate levels of secondary and micronutrients in various soils and crops, characterize any observed deficiencies, and study corrective practices. Incorporate the research results into efficient fertilizer recommendations for crops grown under various conditions.

PROGRESS: Results for the period covered are largely from previously established long-term experiments involving soil fertility variables. These results indicate that (1) Well fertilized crops of corn and soybeans continue to show little or no response to lime. Liming to produce a soil pH in the 7.5 to 7.7 range has had no apparent adverse effect on the growth or yield of these crops. (2) Continuously grown corn which has received up to 1200 pounds N, 450 pounds P, and 900 pounds K per acre for five consecutive years continues to yield well (over 150 bushels) and show few harmful effects. Rates of 600 pounds or more of N have depressed germination and early season growth when applied

shortly before planting or when not well mixed through the plow layer. All N rates (200 to 1200 pounds) have reduced the pH of the 0-6 and 6-12 inch layers of soil and after the fifth application of 1000 and 1200 poundsrates measurable decreases in the pH of the 12-18 inch layers were evident. (3) N fertilizer effectiveness on corn has been influenced some by time of application at some sites. Fall, spring, and early summer was the order of increasing efficiency where differences were observed, (4) Zinc fertilization gave small corn yield increase on two sites which had not previously responded.

SUPPORTED BY Iowa State Government - Des Moines

2.0149, PROPERTIES OF TILE DRAINAGE WATER
T.L. WILLRICH, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01655)

Progress: Grab samples were collected only twice from the outlets of ten tile drainage systems during the spring and summer months because precipitation amounts and frequency of occurrences were not sufficient to cause tile flow except for short time intervals. The samples were analyzed for total nitrogen, phosphorus, potassium, total hardness, total alkalinity, sulfate and chlorinated hydrocarbon residual concentrations in addition to temperature, pH and specific conductance. Because of the limited number of samplings, quantitative values obtained during this year will be reported in the terminal report along with values obtained during the previous three years of investigation

SUPPORTED BY Iowa State Government - Des Moines

2.0150, LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS
D.B. MCDONALD, Univ. of Iowa, School of Engineering, *Iowa City, Iowa* 52240

Studies will be conducted to determine the relationship between runoff, plankton blooms and other chemical and biological factors on the concentration of various chlorinated hydrocarbon pesticides in the Coralville Reservoir and Iowa River, Iowa.

Additional studies will be conducted to determine the role of various aquatic organisms in the uptake and concentration of these pesticides.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0151, FERTILIZATION EXPERIMENTS IN THE EASTERN MEDITERRANEAN COASTAL WATERS
O.H. OREN, Israel Sea Fisheries Res. Sta., *Haifa, Israel*

The objectives of this project are: 1. Determination of leaching rate of phosphates from the ore wastes of Oron, under various conditions, in sea water. 2. Evaluation of nutrient value of these ores on planktonic organisms, under laboratory conditions, using the C14 method. 3. Evaluation of nutrient value of liquid and solid urban wastes. 4. Evaluation of plankton population, taxonomic studies of the phyto- and zooplankton, chemical analyses of water within semi enclosed bays along the shore. 5. Observations on fish population in the vicinity of sewage pipes in the sea. 6. Analysis of the changes in productivity of Isralie coastal waters following impoundment of the Nile River.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0152, RADIOACTIVE CONTAMINATION IN MARINE ENVIRONMENT AND BIOTA IN THE BASIN OF THE MEDITERRANEAN SEA
E. GILAT, Technion Res. & Develop. Fdn., *Haifa, Israel*

Radioactive contamination in marine environment and biota in the basin of the Mediterranean Sea (Part of a coordinated programme of research in marine radioactivity studies).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0153, BEHAVIOUR OF RADIONUCLIDES IN MARINE BIOTA IN CONNECTION WITH THEIR ENVIRONMENT
M. BERNHARD, Comitato Nazl. Lenergia Nucl., *Fiascherino, Italy*

Behaviour of radionuclides in marine biota in connection with their environment (part of a coordinated programme of research in marine radioactivity studies).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0154, DISTRIBUTION AND CYCLE OF RADIONUCLEOTIDES AND RELATED TRACE ELEMENTS IN MARINE ENVIRONMENT
B. SCHREIBER, Univ. Degli Studi, *Parma, Italy*

Our programme comprehends the radioactivity study of plankton, necton, benthos, sea water and sediments in the Taranto Gulf in view of the fact that in the near future radioactive effluents will be released into the Jonian Sea from a reprocessing plant.

As in the past, we are particularly interested in the study of plankton, mainly for the eventual presence of Acantharia that we consider good accumulators of radioactive strontium.

In our laboratory the study of Acantharia is highly important also for the collaboration, established many years ago, with Dr. W.T.Bowen, of the Woods Hole Oceanographic Institution, who entrusted Prof. E. Massera Bottazzi with the systematic-ecological study of Acantharia in the Atlantic Ocean.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0155, EFFECT OF URBANIZATION ON WATER QUALITY
E.E. ANGINO, Univ. of Kansas, Graduate School, *Lawrence, Kansas* 66044

The problem of water quality and contamination by the environment is one of the most challenging areas for research in our society. However, the more specific problem of the effect of urbanization on water quality has been essentially ignored. A search of literature reveals few good papers dealing with this problem.

We propose to examine this problem by investigating the quality of runoff water draining the south part of the University of Kansas campus and exiting down the Naismith channel. The study will include an investigation of seasonal, sudden storm, and dry period effects as reflected in the 10 water quality parameters: Biological oxygen demand, chemical oxygen demand, coliform count (total and fecal), solids content (total, dissolved, and volatile), nitrate phosphate, pH, temperature, and chloride.

Our objectives are: (1) to determine time-distribution of water quality both on a seasonal basis and in response to runoff following a heavy rainstorm. Little information of this type is available in the literature. 2) to determine the feasibility of using urban runoff as a supplemental municipal water source from a water quality standpoint. 3) to compare runoff quality between an open residential area (Lawrence) and a mixed-industrial-city urban area (1 paper in literature). 4) to ascertain whether climatic differences are evident in quality of runoff water.

SUPPORTED BY Kansas State Government - Topeka

2.0156, EFFECT OF NITRATE AND NITRITE IN THE DRINKING WATER ON PERFORMANCE OF MARKET TURKEYS
A.W. ADAMS, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN-05-692)

OBJECTIVE: Define the lethal toxic levels of nitrate and the accompanying external and internal changes of poults grown to various ages.

APPROACH: The study with market turkeys will be repeated.

PROGRESS: Using sodium salts, levels up to 7980 ppm nitrate were added to well water of Broad Breasted Bronze poults from day-old to various ages. The three highest levels (5320, 6650 and 7980 ppm) proved lethal by the fifth day post treatment. Results suggest that adverse effects of high levels of sodium nitrate were due to excess nitrate rather than sodium ions. Up to 1485 ppm nitrate had very little effect on body weight, feed and water consumption, mortality and blood hematocrit values of 24-week old turkeys. Necropsies indicated sodium nitrate and/or acetate caused an enlargement of kidneys. No consistent relation-

ship was observed between these materials and incidences of atypical conditions in tissues from the brain, intestines, liver and spleen. Data suggest 660 ppm nitrate gave a delayed growth response, particularly in males, when administered to 4-weeks of age. No significant change in meat color was observed when nitrates were added to the drinking water at levels up to 1485 ppm. Nitrates in chill water at 600 ppm significantly increased intensity of pink color. Uncooked meat showed more pink color than cooked meat. Ground cooked meat revealed less intensity of red color than unground cooked meat.

SUPPORTED BY Kansas State Government - Topeka

2.0157, MODELING AND OPTIMIZATION OF THERMAL POLLUTION CONTROL SYSTEMS
C.L. HWANG, Kansas State University, School of Engineering, *Manhattan, Kansas* 66502

There is an urgent need for gaining a better understanding of the physics of heat input, and transport and dissipation of water resources. There is also a need for designing improved discharge outfalls and finding optimal discharging policy for cooling water. This proposed research is to develop mathematical models for prediction of temperature and dissolved oxygen (DO) concentration distribution of a stream receiving cooling water discharges from power plants or other industrial processes, to carry out computer simulation of thermal pollution and various thermal pollution control policies based on the mathematical models, to determine the optimal design and operating policies of thermal pollution control systems for power plants or industrial plants which produce a large amount of waste heat effluent, and to develop additional optimization techniques and computational algorithms which can be applied to the optimization of the thermal pollution control systems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0158, LIMNOLOGICAL SURVEY OF SURFACE WATERS OF THE COTTONWOOD-NEOSHO DRAINAGE IN CHASE, LYON, AND COFFEY COUNTIES, KANSAS
C.W. PROPHET, State Forest. Fish & Game Com., *Pratt, Kansas* 67124

P.S Objective: To assess the relative contribution of nitrate, phosphate, and coliform bacterial levels to the Cottonwood-Neosho River Basin from natural and agricultural sources and to determine coliform bacterial utilization by fish and selected fish-food organisms.

Procedures: 1. Quantify the seasonal nutrient and coliform bacterial levels in selected lakes and ponds along the Cottonwood-Neosho Basin and determine whether there are significant changes in nutrients and coliform densities within 24-28 hours of precipitation in excess of 0.5 inch. 2. Quantify the nutrient and coliform bacterial levels in streams and water courses of a restricted watershed in which there are no known sources of contamination during non-runoff and within 24-48 hours of precipitation in excess of 0.5 inch. 3. Record complimentary physicochemical data from each selected lake or stream which can assist in characterizing their relative environmental quality (temperature, pH, BOD, suspended solids dissolved solids, and dissolved oxygen). 4. Estimate standing crops of major planktonic and benthic fish food organisms in the study systems. 5. Determine coliform bacterial utilization by fish and selected fishfood organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0159, REDUCTION IN DAMAGES TO FORESTS BY IMPROVING MINING AND REHABILITATION PROCEDURES
G. DAVID, Berea College, U.S.D.A. Northeast. For. Sta., *Berea, Kentucky* 40403 (NE1605)

OBJECTIVE: Develop practical methods to reduce watershed damage and water pollution during mining and to restore the wildlife, recreation, water, range, and timber resources after mining in the rugged forested watersheds of the Appalachian coal fields.

APPROACH: Basic study of mechanics of rock-soil mixtures, spoil- bank chemistry, and hydrologic processes and plant-soil-water relationships on strip mines; cooperative research and development with other organizations and operators to improve methods of excavating, placing and storing overburden, construction and maintenance of coal- haul roads, and mined-area stabilization by structures and vegetation.

PROGRESS: From our hydrologic studies of strip-mined watersheds in Eastern Kentucky it appears that sedimentation is the most serious overall water pollution problem. Acid pollution is also serious on many small severely disturbed watersheds, but generally it is not important in the larger watersheds or major rivers. A knowledge of spoil acidity and fertility is necessary for planning revegetation programs. For determining pH of mine spoils the LaMotte-Morgan method agreed more closely with a pH meter than did other 'field-kit' methods. The Bray 01 soil test for phosphorus gave meaningful results on spoils derived from soft Pennsylvanian shales, whereas stronger acid solutions for extracting P gave results that were misleading. Ameliorative treatments are sometimes needed to establish vegetation on spoils with certain adverse physical and chemical characteristics. Surface density of spoil was initially lessened by scarification but this influence was of short duration. One year after extremely acid spoil was mulched with hardwood chips the pH of the surface foot of spoil was raised while total salts and water soluble aluminum were reduced. Liming increased growth of four species of pine on extremely acid bituminous spoil; it was essential for the survival of trees planted on anthracite breaker refuse.

SUPPORTED BY U.S. Dept. of Agriculture

2.0160, WATER POLLUTION AND ITS CONTROL BY MICROBIAL METABOLIC ACTIVITIES
M.I. ALEEM, Univ. of Kentucky, School of Biological Sciences, *Lexington, Kentucky* 40506

It is well recognized that biological as well as non-biological transformations of organic and inorganic materials are the main cause of water pollution. The activities of sulfur oxidizing and sulfate reducing bacteria are known to be responsible for many of the characteristics of the acid mine wastes. In the proposed program emphasis has been given to the biochemistry of the oxido-reduction reactions of sulfur and nitrogen compounds, and the factors involved in the control of such microbial metabolic activities in order to seek a solution to the problems involved in the water pollution. Experiments are also described concerning the employment of biological systems capable of removing toxic sulfur compounds such as sulfides and sulfates from polluted waters most economically.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0161, THE RELATIONSHIP BETWEEN ALGAL GROWTH AND THE AVAILABILITY OF CARBON
R.A. LAUDERDALE, Univ. of Kentucky, School of Engineering, *Lexington, Kentucky* 40506

The objective of this project is to demonstrate that it should be possible to prevent the growth of algae in excessive amounts by controlling the amount of available carbon in the water.

This objective will be accomplished by determining the interrelationships between the amounts of inorganic and organic carbon present in a water and the amount of algal growth which can be sustained. More specifically the project will determine: (1) The level of growth which can be maintained if the sole source of carbon is the carbon dioxide available from the atmosphere. (2) The level of growth which can be maintained if the source of the carbon available is governed by the carbonate -bicarbonate equilibrium in water. (3) The level of growth resulting from a combination of (1) and (2). (4) The level of growth which can be maintained in a bacteria free medium containing various concentrations of organic carbon. (5) The level of growth which can be maintained in an organic medium in which bacteria also are present. (6) The level of growth resulting from combinations of the above.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0162, DEGRADATION OF RIPARIAN LEAVES AND THE RECYCLING OF RELEASED NUTRIENTS IN A STREAM ECOSYSTEM

L.A. KRUMHOLZ, Univ. of Louisville, Graduate School, *Louisville, Kentucky* 40208

The recycling of naturally occurring organic and inorganic nutrients is important in the study of aquatic systems. Leaf fall from riparian streams has a profound effect on the chemical composition of the water in the adjoining watercourse and an oversupply of such allochthonous material can cause drastic changes in the biota. The decomposition of such leaves after they enter the water releases nutrients from the leaves themselves but also utilizes large amounts of oxygen. The roles of such nutrients as proteins, carbohydrates, and lipids in the overall budget of the stream are not well known. However, some workers have pointed out that as much as half or two-thirds of the total energy budget may come from such sources.

Changes in the amounts of proteins, carbohydrates, and lipids will be measured as they are released into the stream over a period of about 4 months. In addition, calorific equivalent values for leaves from different species of trees will be measured and those values correlated with values for released nutrients.

This project is part of an overall study of a stream ecosystem and the results will be correlated with changes in the biota and the physical characteristics of the stream.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0163, THRESHOLD ODOR DETERMINATIONS OF WATER SAMPLES FROM THE LOWER MISSISSIPPI RIVER

M.R. RAD, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01504)

OBJECTIVE: Determination of the threshold odor values of the Lower Mississippi River water samples by a panel of judges. The values will be compared to the data obtained by chemical, microbiological and instrumental analysis. This study helps to make recommendations to eliminate the off and obnoxious odors associated with the Mississippi River and drinking water.

APPROACH: The threshold odor values of the water samples will be determined by a panel of judges consisting of at least 10 members who have had experience in organoleptic evaluation. The test will be run by the consistent series method as outlined in 'Standard Methods for the Examination of Water and Waste water', Twelth Ed., 1965, with modifications wherever it is found appropriate.

PROGRESS: An investigation was performed to determine if the odor of water can be used as an index of pollution, and to study the effects of the environment on the odor content of water in the lower Mississippi River area. Results obtained indicate that the odor level in the raw river water may be used as an index to pollution if the effects of river temperature and stage are taken into consideration. There was a low degree of correlation between the threshold odor values of the raw river and finished drinking waters. After analysis, the effects of temperature and river level were found to be very significant. The results of the analysis showed that the variation due to source and station were not significant. The actual effects on each station due to temperature and river stage varied. Equations showing the degree of variation in the effects of river temperature and stage on the odor content of the raw river water were derived for each sampling station. Other factors are probably involved which influence odor content in the raw river water, and should be considered before odor intensity is used as an index of pollution.

SUPPORTED BY Louisiana State Government

2.0164, THE COLIFORM BACTERIA, PLANKTON, & RELATED PHYSICO-CHEMICAL FACTORS IN LAKE PONTCHARTRAIN AT NEW ORLEANS, LA

D.H. STERN, Louisiana State University, Graduate School, *New Orleans, Louisiana* 70122

A summer study of the coliform bacteria, the plankton, and related physicochemical factors in Lake Pontchartrain at New Orleans will be carried out in 1969. The area of concentration in the lake will be that adjacent to the sewerage outfall canals and public recreation areas (Fig. 1). Cruises will be run each week, beginning in late May or early June. The cruise stations will be selected so as to sample inshore lake waters adjacent to unchlorinated outfall canals, canals being experimentally chlorinated by the New Orleans Sewerage and Water Board, public beaches, and areas used for general aquatic recreation.

During each cruise the following shipboard analyses will be made: residual chlorine, pH, methyl-orange and phenolphthalein alkalinities (surface waters); water temperature, dissolved oxygen concentration, specific conductivity, salinity (profiles - 1 M intervals); and Secchi disc transparency. In addition water will be collected for coliform bacteria counts, plankton tows will be made, and additional water samples will be collected for laboratory analyses. In the laboratory differential plankton counts will be made, and water samples will be analyzed for turbidity, solids, chloride ion, nitrogen states, phosphates, and Biochemical Oxygen Demand. Total and fecal coliform counts will be carried out using the membrane-filter technique.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0165, WATER QUALITY DEGRADATION BY SEPTIC TANK DRAINAGE

M.W. HALL, Univ. of Maine, School of Engineering, *Orono, Maine* 04473

This research is aimed at determining the quantities of nitrogenous and phosphatic materials that enter Maine lakes from septic tank drainage. Laboratory studies were focused on determining phosphorus (a) upstate, (b) retention, (c) movement, and (d) changes induced by freezing-thawing in three soils series: the Paxton, Adams, and Plaisted. All soils exhibited a large retention capacity, the rating being Paxton, Plaisted, and Adams in decreasing order of capacity. Although important, differences in phosphorus fixation were found to be not attributable solely to iron and alumina content. Fixation was also related to parameter of standard particle size analyses. Acidity may be an important parameter.

Results to date show that soil capacity to fix phosphorus is readily exhausted by natural conditions regardless of the presence of favorable soil characteristics. Freezing and thawing is seen to lessen the retention capacity of soils for phosphorus. Septic tanks are considered to be effective phosphorus 'traps' only when large leaching areas are available and when the groundwater table exerts no influence.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res Rch.

2.0166, AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES

M.W. HALL, Univ. of Maine, School of Technology, *Orono, Maine* 04473

This study provides field and laboratory data relative to several parameters thought to be important in the control of lake aging, soils, nitrogen and phosphorus concentration, alkalinity, temperature, pH, water clarity, lake morphology, etc.

The field data obtained is being used to determine: (1) The nutrient levels responsible for nuisance algal conditions in selected Maine lakes. (2) The effect of other selected parameters on critical nutrient levels. (3) The rate of change in nutrient levels in several Maine lakes, and the causes of this change. (4) The effects of the removal of major sources of nutrients on algal conditions in the lakes' waters. (5) The effect on the progress of algal development caused by biological treatment of wastewaters which eventually enter lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0167, PHOSPHATE RETENTION BY LAKE SEDIMENTS AS A FACTOR IN THE EUTROPHICATION OF LAKES

E.G. LOTSE, Univ. of Maine, School of Agriculture, *Orono, Maine* 04473

The purpose of the proposed research is to elucidate the influence of various factors governing the equilibria between phosphorus in lake waters and phosphorus in the lake sediments and to evaluate the long- range effect of phosphate retention by lake sediments on the eutrophication of lakes. To accomplish this, the effect of mineralogical and chemical composition of the sediments, equilibrium phosphorus concentration, pH, reaction time, solid to solution ratio, and phosphate to sediment ratio on phosphate retention will be studied, and different forms of phosphorus in the sediments will be determined. The rate and extent of phosphate retention by sediments and model substances such as pure clay minerals, hydroxides of iron and aluminum, and clay minerals with hydroxy-iron and hydroxy-aluminum interlayers will be determined by equilibration with 32 PO4-31 PO4 solutions of known concentration. It is expected that the proposed research will lead to new knowledge of the basic principles of phosphate retention and contribute substantially to the understanding of phosphorus accumulation in lakes. The findings would also be of great significance in evaluating methods for removal of soluble phosphate from waste effluents and in evaluating the effects of future land use practices.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0168, AREAL DISTRIBUTION AND PROVENANCE OF SEDIMENTS IN ST. GEORGE RIVER, KNOX COUNTY, MAINE

L.K. FINK, Univ. of Maine, Ira C. Darling Ctr. for Res., *Walpole, Maine* 04573

Sediment cores are being collected from the St. George Estuary. Grain size analyses and heavy mineral suites will be determined. This information will be used to determine areal distribution of the various heavy mineral suites and the provenance of the sediments in the St. George River. The possible contamination by pollutants of the estuary's sediments will be considered. The parameters which will define a signature of a specific estuary will be determined and will form the basis for further studies in other estuaries of the Maine coast.

SUPPORTED BY Maine State Government

2.0169, EVALUATION OF THE MAGOTHY AQUIFER - ANNAPOLIS AREA, MARYLAND

F.K. MACK, U.S. Dept. of the Interior, Geological Survey, *Baltimore, Maryland* 21204

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Maryland.

Purpose: To evaluate the quantities of water available in the Magothy aquifer and the possible hazard of salt-water contamination. To provide the knowledge necessary for proper development and management of the ground-water resources.

Methods: About 15 sites will be selected for test drilling, pumping tests, measurement of water levels, and collection and analysis of water samples. Geologic data and hydraulic coefficients, both for the Magothy aquifer and the overlying sands of the Monmouth and Aquia Formations will be obtained at the test sites. The permeability of the aquicludes separating the aquifers will be determined. An electric analog model will be constructed and used to predict effects of hypothetical pumping and for planning development and management of the Magothy aquifer.

Project started in 1968 and will be completed in 1971.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0170, CONTROL OR PREVENTION OF SOIL AND WATER POLLUTION FROM FERTILIZERS

A.W. TAYLOR, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Beltsville, Maryland* 20705 (SWC-027-AB-5)

OBJECTIVE: Determine the nature of the transformations of nitrogen fertilizers in soils that lead to the formation of nitrate or nitrite ions, and examine the factors that control the amounts of these ions and other nutrient elements moving into lakes, streams, and subsoil waters.

APPROACH: Experiments are conducted to study the transformations of soil and fertilizer nitrogen that lead to the formation of nitrate ions in soils, using chemical extractions, N -labelled tracer techniques, and incubation procedures to evaluate microbiological effects. Data obtained are evaluated in terms of rates of field applications of nitrogen and hydrologic data on water movement. Phosphate movement is measured by analyses of water samples from watershed where hydrologic measurements are made, and evaluated in terms of phosphate adsorption by associated soils and sediments. Adsorption isotherms are measured in laboratory studies using both unlabelled and phosphorus-32 labelled solutions.

PROGRESS: Losses of P through leaching or erosion from an agricultural watershed heavily fertilized with P is very small. Equilibrium studies demonstrate that sediment will continue to adsorb the P from stream water as a function of time. Losses of N and K from farmland were about twice those from woodland. Losses of these nutrients were sporadic, occurring almost entirely during the small portion of the year when water flows are highest. Stability of soil microaggregates in affecting accessibility of microorganisms to organic N may be one of the major factors in determining relative mineralization rates of recently incorporated N fertilizer, and of indigenous forms of soil N. Physical disruption of microaggregates by ultrasonic dispersion resulted in increased N mineralization. Need for controlling N fertilizer use within reasonable bounds has prompted continued effort in developing a reliable method in assessing the available N status of soils. A number of soils representing a wide array of chemical and physical properties were used to evaluate chemical methods for determining the available N status of soils. Results show that chemically extracted N clearly reflects relative biological availability as determined by plant uptake and N mineralization during aerobic and anaerobic incubation.

SUPPORTED BY U.S. Dept. of Agriculture

2.0171, KINETIC STUDIES OF THE OXIDATIVE DEGRADATION OF DETERGENT, AND RELATED CHEMICAL SPECIES IN AQUEOUS SOLUTION

R.B. BECKMANN, Univ. of Maryland, School of Engineering, *College Park, Maryland*

This is a joint research effort of the Department of Microbiology and Chemical Engineering to study the fundamental biological, and physical-chemical and engineering aspects of the biodegradation process for LAS detergents and to explore the similar fundamental aspects of alternative oxidation routes. Phase I is to be investigated by utilizing a pure (insofar as is possible) LAS derivative, such as A- Dodecene Benzene Sulfonate (or other alkyl derivative in the C12-C15 linear alkyl range) and investigate the rate of degradation in 'synthesized' systems; the systems being 'synthesized' in that the LAS, bacterial, and dissolved oxygen contents will be controlled and the intermediate products and end products will be continually monitored. Once the specific intermediate products have been identified, rate studies will also be carried out using these intermediates as starting materials. By utilizing the 'synthesized' reaction systems in this initial stage, a 'control' or 'ground state' can be established for extension of the kinetics into the realm of industrial or multicomponent mixtures, and it will also serve as a comparative base for the second (II) and concurrent phase of the project. The LAS concentration range covered will be that anticipated in normal effluents 10-1000 parts per million with ultimate extension to the more concentrated regions that might be encountered in sludges.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0172, HIGHWAY DRAINAGE STUDY

R.M. RAGAN, Univ. of Maryland, School of Engineering, *College Park, Maryland* (2R23080378)

The project reviews current surface & sub-surface drainage practices in various parts of Maryland. Hele-Shaw and electrical analog experiments have been used to test numerical models developed to synthesize the conditions around a longitudinal drain as a result of localized infiltration. Work on a design-storm model for the computation of surface runoff is being pursued.

Document provided to SIE by the Highway Research Information Service.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Transportation - F.H.A.

2.0173, THE TRANSIENT BEHAVIOR OF RECHARGE-DISCHARGE AREAS IN REGIONAL GROUND WATER SYSTEMS
R.M. RAGAN, Univ. of Maryland, School of Engineering, *College Park, Maryland*

The circulation of ground water under large areas of the Atlantic Coastal Plain is such that local and intermediate subsystems develop within the overall ground water reservoir. Often these sub-systems have little or no flow moving from one system to the other. The result is that recharge, discharge, and the extent of aquifer pollution caused by the introduction of contaminants could be controlled by local areas of the land surface. The study is directed toward a better means of predicting the lateral and vertical movement of contaminants that might enter such a ground water system as a result of the land disposal of municipal or industrial wastes. The initial efforts will be devoted to numerical studies using the differential form of the continuity and momentum equations in which the inertial terms are not neglected.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0174, POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS
W.F. SCHWIESOW, Univ. of Maryland, School of Agriculture, *College Park, Maryland* 20742

A gaging station and automatic sampler are to be installed at the discharge point of a small agricultural watershed. The watershed to be selected should be between two and twenty acres in size. A larger area may be used if other factors make it impossible to locate a suitable watershed having less than twenty acres. Flow rate and volume will be determined by use of a weir type gaging station. Samples will be drawn at three different elevations by use of a float regulated sampling pipe. Samples will be pumped into containers that are stored within a refrigerator located at the gaging station. Analyses will be made to determine the quantity of major plant nutrients and selected pesticides and herbicides in the runoff water.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0175, DEEP WATER DUMPS
E.A. CHRISTIAN, U.S. Navy, Ordnance Laboratory, *Silver Spring, Maryland* 20910

Technical Objective: Conduct study and exploration on the oceanic pollution impact of munitions disposed of by deep water dump (DWD) operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0176, MICROBIAL DEGRADATION OF ORGANIC POLLUTANTS OF INDUSTRIAL ORIGIN
H.B. GUNNER, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01002

Laboratory and ultimately pilot studies are proposed to establish the basis on which industrial installations may be developed for the removal, by microbiological agents, of toxic organic chemicals prior to effluent discharge into local water courses.

The methods of procedure are as follows: 1. Selection and adaptation of bacteria to specific chemicals in soil profusion columns by primary enrichment of flasks in shake culture and by continuous feed in simulated activated sludge systems. 2. Measurement of chemical degradation, manometrically by means of radioisotope labelling, gas and thin layer chromatography and by autoradiography.

Laboratory data will be employed to provide pilot plant scale units for the controlled degradation of selected organic pollutants.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0177, MICROBIAL INTERVENTION IN THE EUTROPHICATION PROCESS
W. LITSKY, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01002

The objectives of this project are: (1) to relate the microbial decomposition of lake sediments to the release of materials required as nutrient by phytoplankton and (2) to tie-up these nutrient materials in bacterial cells by manipulating the bacterial flora or the aquatic ecosystem.

Further, the purpose of this study is to investigate the processes by which the nutrients that are recycled from the bottom muds are liberated by microbial activity and to find ways whereby these soluble nutrients may be utilized before they become available to algae. In other words competition for the soluble nutrients by a microbial flora other than that involved in the eutrophication process, may be a means of limiting the growth of the undesirable algae species.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0178, THE ROLE OF AQUATIC VASCULAR PLANTS IN THE EUTROPHICATION OF SELECTED LAKES IN WESTERN MASSACHUSETTS
R.B. LIVINGSTON, Univ. of Massachusetts, Graduate School, *Amherst, Massachusetts* 01002

The proposed study will utilize SCUBA gear to obtain quantitative measurements on the productivity (standing crop) of the aquatic vascular plants in oligotrophic and eutrophic lakes in western Massachusetts. The field collections will also add to the record of the aquatic flora of western Massachusetts.

The distribution and abundance of these plants will be correlated with the geological and limnological conditions (pH, temperature, dissolved oxygen, total alkalinity, conductivity and light intensity). The sampling will be carried out in four lakes at monthly (hopefully bi- weekly) intervals.

The seasonal growth of the plants and the nutrient content of their tissues (total nitrogen and phosphorus) will be correlated with the limnological data and particularly the nutrient supplies avail- able in the water and the substrate. This should reveal the presence of any accumulators or indicators of trophic conditions.

Laboratory studies are being carried out on the significance of nutrient absorption by the roots in the metabolism of the aquatic vascular plant.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0179, EUTROPHICATION STUDIES IN BOSTON HARBOR
J.J. COCHRANE, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

Laboratory studies have been conducted at the Marine Science Institute in Nahant on the growth characteristics of the marine algae, Ulva latissima. In Boston Harbor, specific sites of high Ulva growth have been located, and in the field, changes in water quality and other environmental conditions are being followed to establish a correlation with laboratory results. The information will be used to develop a predictive model for marine algal blooms and their control.

SUPPORTED BY No Formal Support Reported

2.0180, WATER RESOURCES POTENTIAL OF AN URBAN ESTUARY
J.J. COCHRANE, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

This is an investigation of the physical, chemical and biological parameters pertinent to the development of an urban estuary for recreation and flood control. The specific objectives of the program include: the determination of the effects of nitrogen and phosphorous on the development of estuarine algae, the discovery of the influence of bottom deposits, including nutrients and toxic materials, on the balance of the ecosystem; and finally, the development of improved methodology for the characteriza-

tion of an estuarine environment; this methodology would include mathematical modeling, data collection frequency and analytical techniques.

SUPPORTED BY Massachusetts State Government

2.0181, WATER POLLUTION FROM SANITARY LANDFILLS
W.R. DOMEY, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

A study of the ground and surface water pollution beneath and near a sanitary landfill has been under investigation in Salem, New Hampshire and Holliston, Mass. This program seeks to correlate the problems involving water pollution which are caused by the solution of problems in solid waste disposal.

SUPPORTED BY Northeastern University

2.0182, BENTHAL DEPOSITS: EFFECTS ON THE QUALITY OF NATURAL WATERS
J. FILLOS, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

This investigation will study the release mechanism of materials from benthal deposits and determine the release of organics and nutrients that may be expected under natural conditions. An objective of this study will also be to demonstrate the feasibility of controlling the release rate of organics and nutrients through the control of DO levels in the overlying water. The ability to limit releases from benthal deposits by controlling the DO in the bottom waters would indicate a method through which eutrophication can be retarded in natural waterways.

SUPPORTED BY U.S. National Science Foundation

2.0183, GROUND-WATER CONTAMINATION FROM HIGHWAY SALTING IN MASSACHUSETTS
S.J. POLLOCK, U.S. Dept. of the Interior, Geological Survey, *Boston, Massachusetts* 02203

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Massachusetts.

Purpose: To define the hydrologic principles relating to the movement of highway salt into and through the ground.

Methods: Ground-water sampling stations will be set up in a variety of geologic and hydrologic environments along several major highways. If possible, sites for sampling stations will be selected where previous studies have described a portion of the hydrology and geology of the area. Also, soil samples will be taken from selected depths above the water table at these sites in order to trace the path and rate of movement of the salt both vertically and horizontally.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0184, GROUND-WATER CONTAMINATION FROM HIGHWAY SALTING IN NEW HAMPSHIRE
H.A. WHITCOMB, U.S. Dept. of the Interior, Geological Survey, *Boston, Massachusetts* 02203

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of New Hampshire.

Purpose: To define the hydrologic principles relating to the movement of highway salt into and through the ground.

Methods: Water samples from wells constructed along three major highways and two springs adjacent to two intermediate highways are collected periodically and analyzed. Particle-size analysis of soil samples from the ground-water sampling sites has permitted a comparative evaluation of the permeability of the materials.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0185, STATE-OF-THE-ART STUDY ON CHEMICAL POLLUTION OF FRESH WATER AS A POTENTIAL HUMAN HEALTH HAZARD
T.R. DAVIS, Arthur D. Little Incorporated, *Cambridge, Massachusetts* 02140

Conduct a state-of-the-art study on chemical pollution of fresh water as a potential human health hazard. Examine existing information which has identified chemicals or chemical classes in water and evaluate available data on their individual acute and biological effects which can be used to indicate potential hazards to health. Where the biological effects of identified chemicals are unknown, examine their relationship with chemicals the biological effects of which have been studied and for which a structure-activity relationship has been identified. By this means their potential effects on health can be tentatively predicted. In the course of the work, factors which can be used to arrive at quality criteria for chemicals in water will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0186, NAVY ENVIRONMENT - TRACE ELEMENT DISTRIBUTION IN THE OCEANS & SEA FLOOR SEDIMENTS, THE CONTROLLING BIOCHEMICAL AND PHYSICAL PROCESSES
J.M. EDMOND, Mass. Inst. of Technology, School of Science, *Cambridge, Massachusetts* 02139 (N00014-67 A-0204-0048)

Technical Objective: The potential use of chemical monitoring surveillance systems for the detection and source identification of man- made chemical pollutants will require information on the natural distribution of trace elements in the oceans. This research, which is directed toward determining the biological, chemical, and physical oceanographic processes controlling these distributions, will help provide basic data on natural trace element concentrations in selected oceanic water masses and the understanding necessary for predicting the geographic and time variability of these concentrations.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0187, RADIOELEMENT STUDIES IN THE OCEANS
V.T. BOWEN, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543 (AT(30-1)-2174)

Objective: Clarification of major pathways of geochemical circulation of Sr, Cs, the lanthanides, Sb, Pu in the oceans; estimation of rate of transport; relevant clarification of pathways of atmospheric circulation and of fallout delivery; collection of tracer information on Atlantic Ocean circulation, vertical and horizontal.

Reason: All these sorts of information are needed for prediction of fate of radioactive or other toxic wastes disposed to the atmosphere or seas. Much of this is also pertinent to estimation of how marine productivity may be increased.

Procedure: Radiochemical analyses of fallout or natural nuclides in sea water, over ocean aerosols, marine organisms, sediments and rocks; stable element analyses of such samples by emission spectrometry, activation analysis or wet-chemical methods.

SUPPORTED BY U.S. Atomic Energy Commission

2.0188, MICROBIAL SULFATE REDUCTION AND SULFIDE OXIDATION IN MARINE ENVIRONMENTS
H.W. JANNASCH, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

This grant will continue NSF support of investigations on the sulfur cycle in the marine environment, with emphasis on the role of bacteria on the biological transformation of sulfur compounds. This is a subject of importance to problems of corrosion, anaerobiosis, pollution, and general productivitiy in the sea.

Organisms that have been under study include the sulfate-reducing bacteria, and photosynthetic, purple, sulfide-oxidizing bacteria (Thiorhodaceae). Investigations will now be extended to include the colorless sulfide-oxidizing bacteria. Specific aspects

to be studied include determining (1) morphological and physiological characteristics of the various species of bacteria, (2) the rate of sulfate reduction and sulfide oxidation, and the effect of environmental factors on these processes, (3) enzyme activitiy in different cultures, (4) competition between species, and (5) growth characteristics under controlled environmental conditions.

SUPPORTED BY U.S. National Science Foundation

2.0189, ECOLOGY OF GREAT LAKES ESTUARIES
J.F. CARR, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Ann Arbor, Michigan* 48107

The various bays are among the most productive environments of the Great Lakes and they are also the most vulnerable to human activities. Industrial and domestic wastes impair the fertility of the water as well as the edibility of the fish. The immediate objectives of this project are to determine to what extent oceanographic methods can be applied to studies of these bays. Subsequent work will be concerned with the movements and influence on the biota of waters flowing into these areas. Thermal, light transmission, chemical, surface current, sediment, plankton, and benthos data have been collected from Saginaw Bay, Lake Huron. Flushing-rate estimates, using oceanographic methods, have been made for Saginaw Bay. Drogue studies have been made in northern Green Bay, Lake Michigan.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0190, FISH-MERCURY STUDIES IN THE GREAT LAKES
J. CARR, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Ann Arbor, Michigan* 48107

Intensive studies will be undertaken in selected localities of the Great Lakes to determine the distribution and dispersion of mercury in water, aquatic vegetation, fish and waterfowl. Water, sediment, flora and fauna samples will be analyzed for mercury residue. Basic chemical and physical measurements of water, aside from mercury itself, will be routinely made in connection with all samples at the collection site. Research will include the effects of mercury on the food chain organisms and fish and the conversion of inorganic mercury to organic mercury will be traced through the food chain. The acute and chronic toxicity of mercury to several species of fish will be determined.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0191, A COHERENT-AREA STUDY OF SOUTHERN LAKE MICHIGAN
J.C. AYERS, Univ. of Michigan, Inst. of Science & Technology, *Ann Arbor, Michigan* 48104

The work proposed involves a team-approach to the sedimentary, biological and chemical indications of the eutrophication process in the southern portion of Lake Michigan. This Great Lakes water body is a water resource of present value, and future greater value, within which the effects of man's wastes are becoming evident. The studies would assemble and assess the indications of eutrophic change with the aim of determining the onset of and the present rate of deterioration of water quality.

Related basic studies of the present sedimentary process and present sedimenting materials, along with needed basic studies of the weather-modifying effect of Lake Michigan would also be carried out.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0192, AN IN SITU EVALUATION OF NUTRIENT EFFECTS IN LAKES
M.E. BENDER, Univ. of Michigan, School of Public Health, *Ann Arbor, Michigan* 48104

Species Composition Replicates - Three experiments at Third Sister Lake to correlate or reproduce species changes observed in 1969, which were due to the main effects of chelation, nitrogen and phosphate. These experiments were conducted in April, September, and August; also a fourth experiment in November may be necessary to check on the N x P interaction.

Nutrient Forms - Three 2 x 2 factorial experiments will be conducted in May and June to elucidate the effect of various forms of nitrogen on species response.

An experiment in Crystal Lake during September to replicate the one conducted in 1969, as well as to test other variables (e.g., sewage ligands and trace metals).

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0193, CHEMICAL TRANSFORMATION, GRAND TRAVERSE BAY, LAKE MICHIGAN
D.C. CHANDLER, Univ. of Michigan, School of Arts, *Ann Arbor, Michigan* 48104

To measure the quality and quantity of chemical inputs to Grand Traverse Bay, to determine the fate of those inputs through the Bay and where they eventually go; and to determine the relative contribution from urban and rural areas.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0194, RAIN SCAVENGING STUDIES
A.N. DINGLE, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106 (AT(11-1))

Tracer studies of scavenging processes and convective storm circulations will be pursued in field experiments. Advances in techniques of measuring cosmogenic radioactive species will be investigated with the objective of applying these techniques to the measurement of contaminants in rain samples collected in the field program. Improved definition of the processes of scavenging and the time-scale of cloud processes will be sought. Distributed samples of rain will also be analyzed for their content of air pollution components, particularly lead (Pb) from automotive exhaust fumes, which appears to have peculiarly unfavorable properties for normal air cleaning processes.

SUPPORTED BY U.S. Atomic Energy Commission

2.0195, NUTRIENT CYCLING AND PRODUCTIVITY OF DYSTROPHIC LAKE-BOG SYSTEMS
F.F. HOOPER, Univ. of Michigan, School of Natural Resources, *Ann Arbor, Michigan* 48104 (AT(11-1))

During 1971 we plan to label the mat water of North Gate bog with a P32- rhohamine WT mixture during early spring. We will then follow 1) exchanges of phosporus and iron compounds between the mat and lake water, 2) incorporation of the label into the biota of the epilimnion, and 3) movement of the phosphorus into the hypolimnion via sedimentation and through biological transport by Chaoborus. We propose further studies on the biological conversion of organic phosphorus fractions isolated from the bog mat and from the upper layers of the thermocline using our in situ flow-through system.

We propose more detailed studies on the identification of the complex inorganic phosphorus compounds and the RNA phosphorus fractions from three series of samples at three locations within the basin. We propose to continue studies of the iron cycle by suspending a series of plastic cylinders within the lake that will enclose a core of water from the surface to a depth of 6M. These cylinders will be labeled with Fe59 and the water will then be sampled to measure the dispersion of the lable into various fractions and its movement throughout the water column.

SUPPORTED BY U.S. Atomic Energy Commission

2.0196, NUCLEAR PHYSICS PROGRAM
H.G. BLOSSER, Michigan State University, School of Natural Sciences, *East Lansing, Michigan* 48823

This is a continuation of research sponsored under NSF grant GP- 6760. The accelerator is used in a number of nuclear physics research areas as well as in areas of interdisciplinary research. The nuclear physics program includes transfer reactions where a particle entering a nucleus picks up one or more nucleons. Such reactions are (p,d), (p,t), (p,He3) and (p alpha). These studies give information on the level structure of a nucleus, and permit comparisons with calculations using various theories. Inelastic proton-scattering experiments also contribute information for these studies. Other experiments are performed to gain informa-

tion on the mass of various isospin multiplets and on the nature of this reaction. These involve measurements on various isospin multiplets and analogue states formed by (p,n) reactions. Other charge exchange reactions such as (He3,t) are also studied. Supplementing this information is data obtained through studies of radioactive decay.

In addition to the purely nuclear structure research program, there are studies in progress relating to the nuclear physics aspects of astrophysics, and the application of nuclear technology and results to problems in biology. A recently initiated program applies nuclear technology to the study of environment contamination, for example, the accumulation of mercury in fish.

SUPPORTED BY U.S. National Science Foundation

2.0197, WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN
M.E. STEPHENSON, Michigan State University, School of Engineering, *East Lansing, Michigan* 48823

The objectives of the project are to (1) establish a storage and retrieval system of data on water quality and quantity within the surface system of lakes and streams of a major watershed of Lake Michigan, the Grand River, and (2) collect and collate existing data pertaining to the physical, chemical, biological, and socio-economic aspects of the water resources of the basin, (3) incorporate a current evaluation of material transport (phosphorus, nitrogen, total carbon, pesticides, etc.) within the river system, (4) determine the qualitative and quantitative relationships between waste discharge and receiving stream water quality on the Grand River system and Lake Michigan, and (5) carry out a compilation and analysis of land use practices and socio-economic developments as related to each of the water resource parameters considered above.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0198, DISSOLVED ORGANIC MATTER AND LAKE METABOLISM
R.G. WETZEL, Michigan State University, W.K. Kellogg G. Lk. Biol. Sta., *Hickory Corners, Michigan* 49060 (AT(11-1))

Studies are continuing on the qualitative and quantitative analyses of production and utilization of dissolved organic compounds and their role in the nutrition and metabolism of planktonic and sessile producers. Discrimination between bacterial, algal, and macrophytic utilization of organic compounds directly in chemo-organotrophy or indirectly by the complexing of inorganic ions affecting metabolism is being approached experimentally. Both axenic and natural populations are used in distinguishing the significance of the individual mechanisms by which dissolved organic compounds influence photosynthesis at naturally occurring concentrations. Quantitative excretion of dissolved organic matter by sumerged macrophytes, planktonic and epiphytic algae is being studied, both in axenic culture and 'in situ,' with particular emphasis on the relation of such compounds to inorganic nutrition and metabolism. Experimental and 'in situ' analyses of nutritional biotic interactions and cycling on an annual basis are being integrated to develop a quantitative model of predictive capability to permit evaluation of stress parameters leading to eutrophication. Emphasis is being placed on thermal and dissolved organic enrichment.

SUPPORTED BY U.S. Atomic Energy Commission

2.0199, MERCURY IN THE ENVIRONMENT
D.H. KLEIN, Hope College, Undergraduate School, *Holland, Michigan* 49423

The first objective of this project is to define the pathways of mercury from its entry into the environment, through ecosystems, to its final reservoirs. It is not anticipated that sufficient data will be collected during the project period to permit establishment of an accurate environmental mercury budget. The second objective is to investigate the utility of the mercury content of human hair as an index of overall environmental exposure to mercury.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0200, STUDIES OF COPPER TAILINGS
T.D. WRIGHT, Michigan Technological Univ., School of Science, *Houghton, Michigan* 49931

This project involves basic research on the nature of copper tailings, with the intent of developing information which may be used for vegetative reclamation of the failings. Dr. Erbisch is growing plants experimentally to determine toxicity of the copper tailings. Dr. Kahan is experimenting with growth of blue-green algae to stabilize tailings before the growth of other plants. Dr. Wright is studying the effect of drainage from the tailings on the waters of the lake into which the drainage flows.

SUPPORTED BY Michigan State Government

2.0201, ENVIRONMENTAL FACTORS MODIFYING RADIONUCLIDE CONCENTRATION IN TUBIFICIDAE
C.J. GOODNIGHT, Western Michigan University, School of Liberal Arts, *Kalamazoo, Michigan* 49001 (AT(11-1))

The purpose of the study is to investigate the effect of environmental factors on the physiology of sludge worms (family Tubificidae), particularly as this worm regulates the concentration and retention of radionuclides. Since tubificids are one of the more common bottom dwelling invertebrates in our streams, this will aid in our understanding of the role these worms play in the transmission and concentration of nuclides in food chains which extend from bacteria to man. It will also give us information on environmental effects on concentration and retention of the nuclides among tubificids in a polluted stream.

The isotopes 32P, 45Ca, 89Sr, 43K, 134Cs, 64Cu, 59Fe, and 65Zn will be used in this investigation. All these elements are found normally in the environment and are of biological significance. The regulation and storage of these nuclides in the worms will be measured, using varied concentration of the nuclides in the worm's environment as well as other environmental variables which may influence uptake of the isotopes by this organism. The retention and uptake will be studied under different environmental conditions. The environmental variables to be tested include temperature, pH, concentration of non-radioactive ions in the environment, and type of bottom substrate the organisms live upon. The project was started in 1968 and is expected to be completed in 1973.

Results: Preliminary analysis indicates considerable differences among the several isotopes studied and demonstrates the need for additional data. Observation indicates that temperature affects the metabolism of this organism and results in alteration of the rate of uptake of the isotopes. Also, results indicate that some isotopes such as 32P may be more readily incorporated by tubificids when they are in an organic molecule. Therefore we have been studying the incorporation of these radionuclides in food chains.

SUPPORTED BY U.S. Atomic Energy Commission

2.0202, MEASUREMENT OF PRESENT SEDIMENT LOAD, AND EXPERIMENTAL ADDITION OF SEDIMENT IN TEST SECTION OF HUNT CREEK
D.S. SHETTER, State Res. & Dev. Division, *Lansing, Michigan* 48926

Objectives: To measure present sediment load in Hunt Creek, and to make provision for the addition of more sediment (sand) in a test section of Hunt Creek where its effects will be measured.

Procedures: Collect sediment samples once a week with sampling equipment furnished by Mr. Edward Hansen of the North Central Forest Experiment Station at Cadillac. Mr. Hansen has also agreed to perform the laboratory analyses on these samples. Samples will be collected over the period October 1970 to September 1971, at four or five sites through and below the control and experimental areas. This will entail the placement of three sill logs at sediment sampling sites to accommodate the sediment samples in measurement of bed loads. (2) Install a service road to

the Section A-B line of Hunt Creek by November 1970; excavate a sediment trap at the Z bulkhead for removal of sediment passing through Sections Z and A of Hunt Creek. (3) Introduce measured amounts of sediment into Hunt Creek at the Section A-B line according to instructions to be furnished by Ed Hansen as to amount and periodicity.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0203, EUTROPHICATION - REMOVAL OF NUTRIENTS - SHAGAWA LAKE

L.P. SEYB, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ely, Minnesota* 55731

The objective is to evaluate the removal of algal nutrients from municipal sewage in an advanced waste treatment pilot plant as a means to impede blue-green algal blooms. Nutrient removal will be accomplished by combinations of coagulation, filtration, ion exchange and carbon adsorption operations. Pilot plant effluent will be mixed with lake water in one 125,000 gallon pond immersed in the lake to determine the effect of nutrient removal on algal populations. A similar pond will receive trickling filter effluent mixed with lake water. A third pond will serve as a control. Similar tests will be made in 200 gallon and 5 gallon containers to determine scale effect. Water quality of Shagawa Lake, its inflow, and outflow streams will be determined regularly to establish base-line information.

If nutrient removal by the pilot plant is effective, a full scale tertiary sewage treatment plant for the removal of algal nutrients from Ely's sewage will be considered as a demonstration. Because bottom sediment might be a reservoir for algal nutrients, studies to determine the effect of sediment on the quality of lake water will be undertaken when experimental work in the pond ceases because of weather conditions.

Ultimately, enough facts about algal and aquatic plant growths in Shagawa Lake will be available to provide for a plan to reverse the lake from its eutrophic condition to one that is less or non-eutrophic.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0204, IMPROVEMENT AND MAINTENANCE OF WATER TIMING, QUANTITY, AND QUALITY BY MANAGEMENT OF NORTHERN FORESTS

R.R. BAY, U.S. Dept. of Agriculture, North Cen. Forest Expt. Sta., *Grand Rapids, Minnesota* (NC1602)

OBJECTIVE: Develop management practices, through basic hydrologic studies, which will maintain and improve water yield--streamflow timing, water quality, low-flow augmentation, and ground water recharge--on northern forested peatlands.

APPROACH: Gather information on: (1) the hydrology of forested bog watersheds while calibrating experimental watersheds; (2) physical properties and water transmissivity of organic soils; and (3) evapotranspiration rates of bog vegetation. Study effect of timber management and water control practices on: (1) water yield and ground- water recharge; (2) evapotranspiration, water storage, and changes in the properties of organic soils. Determine energy balance regimes in peatlands and other bog-vegetation complexes.

PROGRESS: Measurements of energy relationships on drained and undrained open peatland indicate no difference in net radiation but considerably higher daytime surface temperatures in the drained plot, suggesting decreased evaporation from the sphagnum moss surface when the water table is lowered 12 inches. Land treatments which lower water tables in peat bogs could thus alter the evaporation and runoff regime. Analysis of runoff water from several undisturbed bog watersheds show that the highly acid sphagnum moss surface has a major influence on water chemistry. Total ionic load is low compared to streams draining mineral soil areas. Iron and phosphate levels, however, are relatively high. The data provide a baseline for measuring future changes in water chemistry on the watersheds.

SUPPORTED BY U.S. Dept. of Agriculture

2.0205, HISTORY, EVOLUTION AND EUTROPHICATION OF MINNESOTA LAKES

E. GORHAM, Univ. of Minnesota, School of Biological Sciences, *Minneapolis, Minnesota* 55455

This research will continue the comparative regional studies of aquatic sediments, semi-aquatic peats, and terrestrial soils supported by NSF grants G-23309, GB-2448, and GB-6018, with particular reference to analysis of sediment cores from lakes of several types. Attention will focus upon chemical indices to determine (1) aquatic productivity, past and present, (2) onset of summer anaerobiosis in the hypolimnion, (3) development of eutrophy as marked by abundance of blue-green algae, (4) changes in erosional intensity in the watershed, and (5) changes in water level of shallow lakes. The indices employed may include (1) diversity and concentration of chlorophyll derivatives and carotenoids in sedimentary organic matter, (2) sedimentation rates for organic and carbonate carbon, (3) changes in ratios of iron to manganese, and of organic carbon to sulfur, nitrogen, and phosphorus, and (4) ratios of sodium and potassium to elastic material. These studies will be correlated with regional studies by several members of the Limnological Research Center at this university and by staff of the State Conservation Department.

SUPPORTED BY U.S. National Science Foundation

2.0206, THE ROLE OF MIXING IN MAINTAINING STRATIFIED FLOW

E. SILBERMAN, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414

In controlling pollution of lakes, streams, and beaches, it is desirable to be able to predict the relative importance of stratification and mixing between an effluent and ambient water when there is a difference in density between the two. Density differences may arise, for example, when warm water is discharged into cooler water, when aerated sewage is discharged into normal river water, when fresh water wastes are discharged into salt water, and when sediment-laden water is discharged into clear water. Two somewhat different physical situations are involved; these are the outfall area where effluent and ambient fluid first meet and the area distant from the outfall where persistence of stratification requires study. A broad analytical and experimental study of the problems involved is proposed. The objectives are to improve the ability of the engineer to: (1) determine the degree of stratification that may be expected under given outfall conditions, (2) control stratification and mixing at an outfall, (3) determine the persistence of stratification at a distance from an outfall, (4) determine the effect of wind waves on stratification and mixing, and (5) make model studies of stratification and mixing problems.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0207, ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES

E.J. STABA, Univ. of Minnesota, School of Pharmacy, *Minneapolis, Minnesota* 55455

The objective of the research is to find a nutritional, medicinal or industrial use for the unwanted aquatic plants in lake shoreline areas. It is possible that some aquatic plants may contain industrially useful gums-mucilages or new useful antimicrobial, anticoagulant, or antineoplastic therapeutic principles. Aquatic plants will be collected from various lakes in Minnesota and identified, processed and phytochemically screened for useful compounds. Microbial and animal studies will be conducted. If a good industrial, medicinal or nutrional use for aquatic plants can be discovered, the results of the research could provide an economic incentive for aquatic plant collection and control. The successful completion of the project might significantly assist the state and Nation in partially solving their lake pollution problems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0208, DEVELOPMENT OF A MATHEMATICAL MODEL TO PREDICT THE ROLE OF SURFACE RUNOFF AND GROUND WATER FLOW IN OVERFERTILIZATION OF SURFACE WATERS

C.P. STRAUB, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

Better control of agricultural and natural pollution is required to protect Minnesota intrastate and interstate surface waters. Since nutrient enrichment information is inadequate, studies are planned to develop a mathematical model to predict the role of surface runoff and groundwater flow in the overfertilization of surface waters. Following development of the model, which will include theoretical expressions required for a complete hydrologic budget and general expressions relating to nutrient balance, criteria will be developed for controlling sources contributing to the overfertilization or eutrophication of Minnesota waters. The research effort will identify the primary factors introducing nitrogen and phosphorous to the aquatic environment, will delineate areas where additional data are needed and will evaluate the resultant model under field conditions. The model will assist state and federal agencies in initiating surface water fertilization control programs.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0209, RELATION OF AGRICULTURAL PRACTICES AND NATURAL VEGETATION TO NUTRIENT CONTENT OF WATERS

D.R. TIMMONS, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Morris, Minnesota* 56267 (SWC-027-CMOR-4)

OBJECTIVE: Evaluate the nutrient status of surface runoff from different crops and natural vegetation; determine the influence of different management practices on the nutrient content of runoff water; develop management practices which will minimize the amount of nutrients entering the surface water supply from overland runoff.

APPROACH: Natural rainfall plots will be utilized to study the influence of conventional farming practices on the nutrient content of runoff water. Similar plots will be used to evaluate the nutrient content of runoff water coming from forrested land before and after it passes through a sphagnum peat bog. An artificial rainfall simulator will be used to study the effect of different fertilizer and crop residue management practices on nutrient content of runoff water in an effort to develop practices which will minimize the contribution of runoff from agricultural land to the nutrient enrichment of surface waters.

PROGRESS: Rural land runoff generally contains low concentrations of soluble phosphorus, which is either attached to eroded soil material or in solution in the water. Eroded soil material contains appreciable amounts of phosphorus which is rather rigidly affixed to the eroded soil materials. Thus the quantity reaching surface water supplies and its availability to the biota is not well understood. Phosphatic fertilizer application increases the phosphorus content of the surface soil, which is most vulnerable to erosion. Therefore, practices that incorporate fertilizer phosphorus to greater depths in the surface soil offer promise for minimizing the contribution from fertilizer. Dissolved phosphorus in runoff waters is usually very low; however, under some conditions (leaching of frozen vegetation) appreciable amounts of dissolved phosphorus can enter surface waters. The use of sound soil and water conservation practices, which hold more soil and water on the land, reduce the contribution that rural land runoff makes to the nutrient levels of our lakes and streams. Nutrient enrichment of surface waters is a natural process which cannot be eliminated, but it can be decelerated by judicious application of known soil and water conservation practicies.

SUPPORTED BY U.S. Dept. of Agriculture

2.0210, COOPERATIVE GULF OF MEXICO INVENTORY AND STUDY - III - SEDIMENTOLOGY OF MISSISSIPPI'S ESTUARIES

J.Y. CHRISTMAS, State Marine Conserv. Comm., *Biloxi, Mississippi* 35930

Objectives: (1) To determine the sediment forms of Mississippi estuaries as an index of their respective conditions. (2) To establish a base line for the evaluation of expected changes in sediment distribution and its effect on the biota. (3) To develop an atlas of the sediments of Mississippi estuaries. (4) To make the state atlas available, in cooperation with the other Gulf States and the Bureau of Commercial Fisheries, for inclusion in an atlas of Gulf of Mexico estuaries.

Procedures: (1) Locate and complete existing data for textural analysis (sand, silt and clay) and carbonate, carbon, and nitrogen content in the study area. (2) As time permits, collect and analyze additional samples in a pattern arranged to complete a description of the sediment distribution pattern in the study area. (3) Collect, analyze and prepare data in a state atlas in a form which will be available for incorporation as a section in an atlas of the estuaries of the Gulf States in cooperation with members of the Gulf States Marine Fisheries Commission and the Bureau of Commercial Fisheries. (4) Prepare and publish additional notes and papers as necessary.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0211, IDENTIFICATION AND ORIGIN OF SEASONAL FOAM IN THE PEARL RIVER RESERVOIR

J.P. MCKEOWN, Millsaps College, Undergraduate School, *Jackson, Mississippi* 39210

Analytical procedures are used to identify the components and source of large quantities of foam which appear periodically on the surface waters of the Pearl River Reservoir. One of the major goals of this investigation is to train undergraduates in procedures used in water analysis and fresh water ecology.

SUPPORTED BY Millsaps College

2.0212, STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS

W. ABBOTT, Gulf Coast Research Laboratory, *Ocean Springs, Mississippi* 39564

The captioned research grant has provided funds for construction of 18 estuarine ponds. These ponds are being utilized for field scale testing of hypotheses developed during a series of microcosm studies (Abbott, J. Water Poll. Control Fed., 38:258-270 (1966); 39: 113-122 (1967).

Studies are oriented toward evaluation of phosphorus and nitrogen turnover rates, kinetics of uptake of these elements, and validity of their roles as limiting nutrients in hyperfertilized estuarine situations.

SUPPORTED BY Rockefeller Foundation - New York, N.Y.

2.0213, RESERVOIR SEDIMENTATION

F.E. DENDY, U.S. Dept. of Agriculture, Sedimentation Laboratory, *Oxford, Mississippi* 38655 (SWC-015-BE-2)

OBJECTIVE: Expand knowledge of sedimentation volumes and rates in various type reservoirs. Evaluate reservoir, watershed, and hydrologic factors affecting the deposition rate, density, and areal distribution of sediment and the trap efficiency of reservoirs. Study the physio- chemical aspects of reservoir sediments. Develop instrumentation and techniques to measure significant variables.

APPROACH: Compile and analyze existing reservoir sedimentation data. Isolate and evaluate effects of significant parameters such as capacity-watershed ratio, capacity-inflow ratio, reservoir size and shape, spillway design and operating practices, and watershed and climatic characteristics on reservoir sedimentation and its Properties. Use field and laboratory models. Study sediment bypass and discharge methods.

PROGRESS: A supplement to USDA Miscellaneous Publication 1143, 'Summary of Reservoir Sediment Deposition Surveys Made in the United States Through 1965' was prepared and distributed to various government agencies and individuals. Data recently acquired from reservoirs under cooperative study with the Soil Conservation Service showed a continuation of relatively low sediment deposition rates. Accumulation rates for 13 reservoirs ranged from 0.02 to 3.4 acre feet per square mile of sediment contributing area for periods of from 4 to 14 years. Trap ef-

ficiency ranged from 70 to 93 percent. Soil and reservoir sediment samples were colleted for gamma-ray spectrometric analysis for fallout cesium-137. The concentration of fallout cesium-137 in soils was found to vary with depth in the profile, cover type, and erosion. Cesium-137 was found to a depth of as much as 24 inches in sediments with surface sediments generally less than at a lower depth. The improved dual gamma probe, using the attenuation of transmitted cesium- 137 gamma rays, was shown to operate satisfactorily in estuaries and in small reservoirs for measurement of sediment densities.

SUPPORTED BY U.S. Dept. of Agriculture

2.0214, SEDIMENTATION ON FLOOD PLAINS AND IN ESTUARIES AND HARBORS

S.C. HAPP, U.S. Dept. of Agriculture, Sedimentation Laboratory, *Oxford, Mississippi* 38655 (SWCW1-BE-5)

OBJECTIVE: Extend knowledge of: the amounts, rates and quality of valley sedimentation; the amounts, rates, and causes of channel deposition; the rates, amounts, causes, and location of deposits in valleys, harbors, and estuaries in relation to the flow regimen, basin geometrics, sediment characteristics and other things.

APPROACH: Determine the net effects over a period of 25-30 years of stream and valley sedimentation in selected valleys from a compilation of existing data, resurveys of established cross-sections, and supplemental measurements of selected alluvial fan deposits, streambank and gully erosion, and surveys of selected small reservoirs. Use C-14 dating techniques where appropriate.

PROGRESS: In parts of the Brown Loam hills of north central Mississippi, valley sediment 'plugs', formed at stream channel occlusions, have persisted for more than 30 years of record. Such persistence is due, at least in part, to underlying tough silts which resist headward incision of new or deepened channels below the 'plugs.' These circumstances are largely responsible for deposition of most sediment in headwater parts of creek valleys, 50 that concentrations of suspended sediment carried farther downstream are measured only in hundreds of parts per million, in contrast to thousands of parts per million suggested by generalizations such as Geological Survey Hydrologic Atlas HA-61. Additional data of various kinds, secured during 1967 and 1968, strengthens previous findings that sediment deposits tend to be concentrated in the upper parts of valleys, and that rates of valley sedimentation have declined during the past 30 years both in northern Mississippi and in southeastern Minnesota. The work of dating the loess in the Vicksburg, Mississippi area and the peats in the Florid Everglades and in the Wild Flower Sanctuary Bog of Vermont by the Carbon-14 technique has progressed to the manuscript stage.

SUPPORTED BY U.S. Dept. of Agriculture

2.0215, SEDIMENT SOURCES, YIELD, TRANSPORT, DEPOSITION AND PROPERTIES

L.L. MCDOWELL, U.S. Dept. of Agriculture, Sedimentation Laboratory, *Oxford, Mississippi* 38655 (SWC-014-BE-1)

OBJECTIVE: Determine and predict the magnitude of sediment production, sediment yields from watersheds, the amounts, rates and causes of valley and channel deposition, study all aspects of sediment transport, extend knowledge of physical and chemical attributes of sediment.

APPROACH: Determine by laboratory and field experiments the effect of flow, material and physical conditions on sediment transport; obtain information of physical and chemical properties of sediments by treatments, sampling and analysis. utilize new and existing instrumentation to study sediment yields on watersheds and from models; use modern techniques like remote sensing to relate land use, cover, topography, soils, practices, runoff and other variables to watershed sediment yields; obtain information on rates, amounts, causes, and location of deposits in valleys, harbors and streams in relation to flow regimes, sediment properties and other things.

PROGRESS: During the 1969 water year, sediment and flow data were obtained from 10 complex subwatersheds located in the Pigeon Roost Creek Watershed and one partially urban watershed, Laboratory Creek. Computed gross erosion from watersheds in the Pigeon Roost Creek area is being compared to measured sediment yield. Resurveys show that sediment accumulations have continued in the upper part of the Coldwater River Valley but at a reduced rate since 1940. Overbank sediment accumulation has practically ceased throughout most of the four other Yazoo tributary valleys where channels have been ditched. A similitude analysis of the pertinent variables expressed in the same terms. The sediment concentration profile data have continued to describe log-Gaussian distributions with relative flow depth. Recent tests in an open channel have shown that the variation of the sediment transfer coefficient over the flow depth is not affected by the total amount of material present, as measured by the mean concentration. Concentrations of agrichemicals in solution are frequently higher in the initial runoff from farm lands, but the major portion of the dissolved chemical load is transported at or near the peak water discharge. Significant quantities of plant nutrients such as K, Ca, and Mg were found to be transported in association with sediment.

SUPPORTED BY U.S. Dept. of Agriculture

2.0216, REDISTRIBUTION OF RADIOACTIVE FALLOUT IN WATERSHEDS DUE TO CULTURAL AND EROSIONAL PROCESSES

J.R. MCHENRY, U.S. Dept. of Agriculture, Sedimentation Laboratory, *Oxford, Mississippi* 38655 (AT(49-7))

Radioactive fallout on the earth surface is very likely to be redistributed due to erosion and transport in runoff waters. This study was designed: (1) to review and where necessary improve sampling methodology for accurate determination of radioactivity in soil and in sediment; (2) to measure the levels of radioactivity of sediments in water bodies and compare them with the levels in soils considered the source; and (3) to relate the radioactivity distribution in a containment basin to the fallout frequency and amount in the contributing watershed, its erosional activity and its soil, plant, and hydrologic characteristics. Watersheds in the vicinity of Oxford, Mississippi and throughout the U.S. will be used to provide soil and sediment samples for analysis of cesium-137 concentration as well as bulk density, particle-size distribution C, N, S, and P content, pH, and cation exchange capacity.

Results: Samples for analysis have been collected from 9 States and 24 watersheds for a total of 609 samples. About half of these samples have been analyzed for gamma-ray emissions and spectral data is ready for processing. A preliminary survey of the data from soil samples shows most of fallout cesium-137 is found in the upper one inch where it could be easily removed by erosion. The vertical distribution of cesium-137 in soils under pine forest and oak forest was similar, but under grass cover cesium-137 was found to greater depths. In sediments, concerntration of cesium-137 distribution was variable with lower concentrations in the surface.

SUPPORTED BY U.S. Atomic Energy Commission

2.0217, RATES AND PROCESSES OF RESERVOIR SEDIMENTATION IN THE CORN BELT

H.G. HEINEMANN, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Columbia, Missouri* 65201 (SWC-015-CMO-3)

OBJECTIVE: Relate the rate of sediment accumulation in reservoirs, reservoir trap efficiency, sediment distribution, and volume-weight of reservoir sediment deposits to the influencing watershed, reservoir, and spillway parameters.

APPROACH: Survey selected existing reservoirs in the Corn Belt for accumulation, volume-weight, distribution, and physical and chemical properties of the deposited sediment. Sample and determine the amount of suspended sediment flowing into and out of additional selected reservoirs for trap efficiency determinations on a storm basis. Monitor storage and thermal stratification of these trap efficiency reservoirs. Collect and evaluate the watershed and reservoir parameters which affect the sediment accumulation, volume-weight, distribution, and reservoir trap efficiency. These analyses of field conditions and resultant sedimentation activities provide design criteria for future similar reservoirs.

PROGRESS: At present, we lack useful knowledge on the sedimentation and eutrophication of small reservoirs. Some information exists on sediment yield, but little exists on the processes involved in reservoir sedimentation and eutrophication. Information is sorely needed to optimize reservoir designs for extended usefulness. The object of this research program is to study all the facets of reservoir sedimentation concurrently, in an effort to determine the relationships between its various components. Inflow is evaluated for the following items: runoff rate, sediment concentration and composition, nutrient concentration and composition, and temperature. In the reservoir itself, the movement of the inflow is followed by means of current meters, which give the direction and velocity of the flow and also by water temperature measurements. The nutrient content of reservoir water is analyzed periodically and detailed reservoir sedimentation surveys are made to determine the distribution, volume, and volume-weight of the deposited sediment, as well as its nutrient content, particle-size distribution specific gravity, and other physical dimensions.

SUPPORTED BY U.S. Dept. of Agriculture

2.0218, THE MOVEMENT AND YIELD OF NUTRIENTS FROM AGRICULTURAL WATERSHEDS

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OBJECTIVE: Determine the rates and forms of nitrogen and phosphorus compounds moving through agricultural watersheds as solutes in runoff and as adsorbed on sediment. Determine how these compounds are affected by storage in the soil matrix and in ground and surface waters.

APPROACH: The nitrogen and phosphorus content in samples of surface and ground waters will be analyzed and compared with fertilizer application rates, numbers of livestock, and other management practices in the study watershed. Behavioral differences in nutrient movement between terraced and unterraced watersheds will be measured. The concentration of nutrients in each sample, along with concurrent stream discharge rates at each gaging station, will be used to compute the rate and amount of nutrients transported from the watershed.

PROGRESS: Dissipation of commercial nitrogen and phosphorus by overland movement and deep percolation for Missouri Valley deep loess soil was initiated in 1969 on four watersheds near Treynor, Iowa. Measurements were made to determine nitrogen and phosphorus content of surface runoff, base flow, tile flow, and ground water. Core samples were obtained to the water table depth to determine soil profile physical and chemical characteristics. Sediment samples were obtained during storm runoff to determine nitrogen and phosphorus content of eroded soil material. Corn production measurements were made to determine yield and mature-plant nutrient uptake. Preliminary results indicate that, although precipitation was slightly above normal, runoff and erosion were low, resulting in negligible discharges of nitrogen and phosphorus from these sources. Base flow discharges of these nutrients were also low. In general, ground water concentrations of nitrogen and phosphorus were low and not affected by fertilizer application in 1969. This study is continuing.

SUPPORTED BY U.S. Dept. of Agriculture

2.0219, CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD

J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Initially, a suitable method for collecting uncontaminated fish blood will be selected. The various types of esterase(s) present in different fractions of blood will be characterized. This characterization will probably include such parameters as optimum substrate, optimum substrate level, optimum enzyme level, specific activity, effect of divalent cations, etc. Ideally, at least two species will be studied at the same time so that comparisons can be made. When the basic parameters are known the effect of various anticholinesterase agents will be studied. Initial studies will be in vitro, however, in vivo studies will be incorporated at a later date. In vivo studies will be designed to take advantage of the fact that the effect of a pesticide on individual specimens can be followed in the blood without sacrificing the animal.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0220, ISOTOPES IN THE BIOSPHERE

E.R. GRAHAM, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00418)

OBJECTIVE: Study the movement of rain-out Sr-90 from surface soil to impounded water systems.

APPROACH: Runoff and erosion experiments of plots contaminated with fission product radioactive nuclides will be continued. It is planned to use I and Ce in addition to Sr on the plots. The plots under study will be continuous bluegrass, corn stover, and wheat stubble. The collected runoff water and soil removed by erosion will be assayed as previously. Some preliminary studies on the effect of nitrogen fertilizers on growth rate of forages and the accompanying effect on the uptake of fission product radionuclides will be undertaken. These will be greenhouse experiments with small grains and legumes.

PROGRESS: Lambs maintained on natural ration with different levels of added cobalt ($CoCl_2$) showed differences in retention of Co cyanocobalomin after intravenous injection of the isotope. Differences in percentage retention of Cobalt by these animals were apparent within day 3 after administration.

SUPPORTED BY U.S. Dept. of Agriculture

2.0221, HEAVY METAL ION INTERACTION AND TRANSPORT WITH SYNTHETIC COMPLEXING AGENTS AND DETERGENT PHOSPHATE SUBSTITUTES IN AQUATIC SYSTEMS

S.E. MANAHAN, Univ. of Missouri, School of Arts, *Columbia, Missouri* 65202

The overall objective is to study transport, reactions and biodegradation of chelates formed from heavy metal ions and synthetic complexing agents, such as proposed detergent phosphate substitutes, in aquatic ecosystems. Initially emphasis will be placed upon citrate ion and ethylenediaminetetraacetate ion.

Specific aspects to be studied are solubilization of metals from metal surfaces by low levels of complexing agents in solution, biodegradation of heavy metal chelates, the influence of synthetic complexing agents upon the leaching of heavy metal ions from sediment deposits, the role of synthetic complexing agents in keeping essential trace metals in solution, thus contributing to algal growth and eutrophication, competition between calcium ions and heavy metal ions for complexing agents and possible methods of heavy metal ion removal from heavy metal chelates.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0222, NITRATES IN WATER SUPPLIES

G.E. SMITH, Univ. of Missouri, School of Engineering, *Columbia, Missouri* 65202

Soils in feed lots of different ages and in various geologic areas are being sampled to depths of 15-25 feet to determine the penetration of nitrate. Included in the sampling are abandoned feeding areas where no livestock have been present for some years. Samples are also collected on transects at different distances from the area of contamination (both feed lots and sewage disposal systems) to determine lateral movement. Movement is being correlated with soil physical properties.

Detailed soil samples are being collected and topographic maps are being prepared of areas where new feed lots are being built. This information will serve as a basis for measuring changes that occur in the surrounding soil areas in the future.

Accumulation of residual nitrate from chemical fertilizers is being measured at locations where detailed soil fertility studies are being conducted with varying rates of nitrogen fertilization. Samples of soil, to depths of 10-20 feet, are also being made on individual farms where accurate records of heavy fertilization with nitrogen are available for 10 to 15 years. These results are compared with adjacent areas that have no nitrogen.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0223, NITRATES IN PLANTS AND WATER SUPPLIES FROM NITROGEN FERTILIZATION
G.E. SMITH, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00485)

OBJECTIVE: Study the effect of N, P, K and trace element fertilization on the accumulation of nitrates in forages and vegetables. Investigate the effect of species and plant age on nitrate reduction in plants and the accumulation of other nitrogen fractions. Survey the nitrate content of domestic and livestock water supplies in the state and determine the influence of watershed fertilization on nitrate content of runoff.

APPROACH: Forages and vegetables will be grown in the greenhouse under different nitrogen fertilizer treatments and samples collected at different stages of growth for analysis. Surveys will be made of surface water supplies and shallow wells in the different areas of the state where high nitrates have been found. Effort will be made to find the source of contamination.

PROGRESS: Where 120 lbs. of N in chemical fertilizer per acre have been applied annually for 20 years to corn on Mexico silt loam, nitrate has been found to a depth of 9 feet. Total nitrate accumulation during this 20 year period was 180 lbs. per acre-9 lbs. per acre- per year, (corn yields averaged 85 bu/A.) This amount is insignificant as a pollutant of groundwater for animals, but this quantity entering surface water could stimulate eutrophication. Nitrate accumulation on far soils of different texture after 7 years with different rates of fertilization show that annual nitrogen addition should be no greater than crop removal. Generally, where annual nitrogen application was 100 lbs. per acre or less there has been little nitrate accumulation. With heavier amounts there was sufficient carry-over to be of concern in water pollution. On sandy soils nitrogen not absorbed by crops entered groundwater supplies. Further studies of nitrates under feed lost showed penetration was associated with soil type and length of operation. In most cases nitrate concentration dropped to low levels from 300-500 feet from fences.

SUPPORTED BY U.S. Dept. of Agriculture

2.0224, GEOLOGICAL FACTORS RELATING TO SURFACE AND GROUNDWATER POLLUTION
J.H. WILLIAMS, State Geol. Survey & Wa. Reso., *Rolla, Missouri* 65401

Agency carries out, as a part of its routine work, continuing investigation of the geological factors that allow the contamination of groundwater, streams, and impoundments. Much of this work is done in cooperation with the State Divison of Health and the State Water Pollution Board. Problems of site selections for sewage lagoons, pollution of groundwater by contaminants introduced through sinkholes and caves, and well construction problems in karst terrains are physical ones. Publication of results of studies is made as time and circumstances permit.

SUPPORTED BY Missouri State Government

2.0225, SALT POLLUTION OF GROUNDWATER
N. AHMED, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

The proposed research plan involves a laboratory study of the movement of a salt water body under the influence of suction gradients. Salt water with different concentrations will be used in the lower part of a parallel plate model. Fresh water will be used in the upper part of the model. Fresh water will be drawn out under the suction head and movement of salt water will be observed. It is anticipated that results of this study will be useful to understand the phenomena of flow of salt water in groundwater reservoirs.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rcn.

2.0226, THE IMPACT OF LEAD-ZINC MINING ON THE QUALITY AND ECOLOGY OF SURFACE WATERS IN SOUTHEAST MISSOURI
E.A. BOLTER, Univ. of Missouri, Water Resources Research Ctr., *Rolla, Missouri* 65401

A study is proposed to investigate the impact of Lead-Zinc mining activity on the quality and ecology of surface waters in the 'New Lead Belt' of SE Missouri. The study area now has little population and industry, but intensive mining activity will develop during the next few years.

During the investigation, the background values for lead, zinc, copper, iron, silver and cadmium in unpolluted surface waters, sediments and aquatic life samples will be determined. After pollution has started, the self-cleaning capacity of the streams by precipitation or adsorption of the metals and the uptake of the metals by aquatic life will be determined. The analyses will be done with an atomic absorption spectrophotometer.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0227, INVESTIGATION OF PRESENT THERMAL REGIME OF MISSOURI RIVER IN MISSOURI
J.C. MAXWELL, Univ. of Missouri, Water Resources Research Ctr., *Rolla, Missouri* 65401

The proposed research is to characterize the present thermal regime of the Missouri River between Kansas City and St. Louis, Missouri for the seasons of the year. This will include temperature variations with depth and across the width of the Missouri, and development of a mathematical method of analyzing a fluctuating temperature so as to detect a non-fluctuating change of a few degrees such as might be introduced by nuclear or fossil fuel power plants. A secondary objective is to determine the feasibility of using thermal characteristics and remote sensing aerial infrared imagery to trace possible polluted masses of water as they progress down the Missouri.

Little is known about present distribution of temperature in these rivers. An opportunity is now available to determine the background thermal base for these rivers which may be lost within two or three years as large power plants are installed along the rivers and thermal pollution is introduced. These data could be most significant in assessing effects on life forms as water temperature conditions change in the future.

A remote-reading Quartz thermometer will be used which will permit measurements accurate to 0.05 degrees C, and a program will be developed for the IBM 360 Mod 50 computer to analyze the available records.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0228, EVALUATION OF SUBSURFACE MOVEMENT OF LEACHATES PRODUCED FROM SANITARY LANDFILLS
J.D. ROCKAWAY, Univ. of Missouri, School of Mines, *Rolla, Missouri* 65401

To evaluate the movement through the ground-water regimen of leachates produced from sanitary landfills, and to determine the influence of various soil materials in controlling or retarding leachate movement.

Several sample sites in characteristic Missouri soil types have been selected for study, with respect to operation and procedures of development, ground-water regimen, geologic setting, and the nature and extent of dissolved-solids concentrations. Statistical modeling is to be applied to the data on leachate movement and subsurface conditions to provide a quantitative evaluation of the influence environmental conditions have in controlling groundwater pollution derived from sanitary landfills.

SUPPORTED BY University of Missouri

2.0229, STREAM SEDIMENT INVESTIGATION
P. MARCUSON, State Fish & Game Department, *Billings, Montana* 59101

Good trout populations in a stream depend upon suitable water quality. The 'Stream Sediment Investigation' to date on Bluewater Creek proved that agricultural siltation all but eliminated the trout population.

A pilot project on Bluewater Creek is proposed to demonstrate methods to improve land-use practices which cause agricultural-silt pollution. The effect of the reduction in silt pollution on the trout population will be evaluated.

Methods to be used in controlling siltation are lining irrigation return ditches, encouraging more efficient use of irrigation water and streambank fencing to protect streambank vegetation from livestock damage. A dense growth of trees, shrubs and grasses can become established, controlling lateral bank erosion. Areas to be fenced will be leased by the Fish and Game Department for a minimum of ten years to encourage cooperation with the individual landowners.

Effects of the improved land-use practices will be evaluated at five permanent sampling stations located along Bluewater Creek starting at a clean-water station.

Sediment samples analyzed by the U. S. Geological Survey will provide sediment concentrations and water quality at the sampling stations.

Fish populations of the stream within the sample areas will be sampled periodically with electrofishing gear.

Quantitative and qualitative bottom fauna information will be obtained from the permanent stations.

Water temperatures and flows will be recorded at the sampling stations.

Man-made redds placed in Vibert boxes in the sample areas will test trout-egg survival under various sediment concentrations. The Mark VI standpipe apparatus will be used to measure the rate of deterioration in apparent velocity and intragravel oxygen concentrations in the man-made redds under various sediment concentrations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0230, WATER RESOURCES IN SOURDOUGH AND MIDDLE CREEK WATERSHEDS - A COMPARATIVE STUDY OF QUALITY AND HYDROLOGY
R.L. SANKS, Montana State University, School of Engineering, *Bozeman, Montana* 59715

Bozeman Creek (or Sourdough) and Middle Creek watersheds are two adjacent drainages of 39.8 and 48.2 square miles respectively, located about 10 miles south of Bozeman, Montana. The two watersheds are rather similar in size, elevation, and topography, but entirely different as to land use. Since 1917 Bozeman Creek watershed has been closed to public use, since it is one of the sources of water for the city of Bozeman. Hyalite (or Middle Creek) has always been open and has been widely used for grazing and recreation. There has been some logging on each watershed. There is currently much pressure to have Bozeman Creek watershed opened to the public. A target date of August 1968 was set for opening. Water samples which have been collected from selected points on both watersheds since 1964 have shown that Bozeman Creek consistently has higher counts of microorganisms than does Hyalite Creek.

The present study has been inaugurated to provide answers to the question of whether Bozeman Creek and similar watersheds which are used for municipal water supply should remain closed to human use, to pinpoint areas of potential erosion and sedimentation problems and to evaluate the severity of erosion and sedimentation on the watersheds, and to determine some knowledge of the basic hydrology of the watersheds, which will aid in planning studies on these, and on similar watersheds throughout the Pacific-Northwestern United States.

Hydrologic data to be collected includes information from a series of raingages, weather stations and streamflow recorders on each watershed. Water quality data to be collected includes pH, suspended and dissolved solids, and concentrations of various ions from selected sampling stations on both watersheds.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0231, CYANIDE METABOLISM BY MICROORGANISMS
G.A. STROBEL, Montana State University, School of Letters, *Bozeman, Montana* 59715

During the past five years various aspects of cyanide production and utilization by microorganisms have been investigated. It has been shown in all cases that the first product of active (enzymatic) cyanide fixation is a nitrile. In many cases the nitrile is an alpha-amino nitrile which in turn is hydrolyzed to the corresponding alpha-amino acid. The proposed research would investigate and compare enzymes capable of hydrolyzing these alpha-amino nitriles to their corresponding amino acids.

In the fungi, ammonia and cyanide condense with aldehydes to yield the alpha-amino nitrile. The work proposed in this research project would clarify the origin of these aldehydes in the fungus mycelium.

Investigations on additional pathways of cyanide utilization in other microorganisms will be continued. Work on cyanide metabolism should be of benefit to people interested in the following scientific areas: water pollution, cyanide is one of the top ten pollutants of fresh water streams, metabolic biology, cyanide is a commonly used inhibitor of respiration, soil microbiology, cyanide as a contributor to the C and N cycles in nature, and, prebiotic chemistry, cyanide as a prebiotic gas on the earth's surface.

SUPPORTED BY U.S. National Science Foundation

2.0232, AN INVESTIGATION OF THE EXTENT AND CAUSE OF EUTROPHICATION OF CANYON FERRY RESERVOIR, MONTANA
J.C. WRIGHT, Montana State University, School of Letters, *Bozeman, Montana* 59715

There are indications that Canyon Ferry Reservoir, Montana, a main stem impoundment of the Missouri River has become more eutrophic since its impoundment in 1953. Increased severity of blue-green algal blooms and deterioration of water quality are cited as evidence. Agricultural pollution has been blamed for the situation.

It is proposed to prepare a nutrient budget for the reservoir by sampling nutrient input from the river, nutrient input from irrigated agricultural, nutrient storage and output from the reservoir.

Standing crops of phytoplankton and zooplankton and concurrent concentrations of available phosphorus and nitrogen will be determined. These will be compared with similar baseline data gathered in 1956-1959.

On the basis of this data it will be determined if the reservoir has become more eutrophic and if so, what is the cause and source of the excessive nutrients.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0233, THE LIMNOLOGY OF YELLOWTAIL RESERVOIR AND THE BIG HORN RIVER
J.C. WRIGHT, Montana State University, Graduate School, *Bozeman, Montana* 59715

An investigation will be made of the physical, chemical and biological limnology of Yellowtail Reservoir, Montana and Wyoming and its downstream effect if the Big Horn River. The cycle of events in the reservoir will be related to the water regime which involves deep water discharge and the creation of internal density currents. The effect of this regime on the heat budget, salinity budget, and the nutrient budget will be compared with the effects that could be expected from surface water withdrawals. The downstream effects of nutrient- rich cold water discharge will be related to the productivity, benthic algal production and the heat budget of the Big Horn River. The population dynamics of zooplankton will be followed over a period of five years in order to determine if changes occur that could explain the decreasing productivity of reservoirs following their initial high productivity. Changes in the zooplankton populations will be correlated with reciprocal changes in the phytoplankton population which in turn will be related to nutrient, temperature and light conditions. The

areal hypolimnetic oxygen deficit of the dead storage zone of the reservoir will be used as an index of the overall productivity of the reservoir, over a period of five years. The project started July, 1969 and it is anticipated that it will be finished January 31, 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0234, NATURAL WATER SYSTEMS IN WESTERN MONTANA

A.R. GAUFIN, Univ. of Montana, Graduate School, *Missoula, Montana* 59801

The principal objective of the program is to determine the water quality of aquatic systems west of the continental divide. These parameters which constitute criteria for the quality of water in a particular system are being analyzed. The biota and chemical and physical characteristics of the water are being studied to provide criteria as to the quality of water and degree of pollution in various drainage systems throughout the region.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0235, SILTATION RATES AND LIFE EXPECTANCIES OF SMALL HEADWATER RESERVOIRS IN MONTANA

R.L. KONIZESKI, Univ. of Montana, School of Forestry, *Missoula, Montana* 59801

Increased emphasis must be placed on the silting and building of small, headwater reservoirs in Montana. A major problem is the present inability to predict life expectancies of such structures. Principal siltation controls are apparently geological, topographic, climatological and vegetational. The immediate objectives of this study are to: categorize the most common 'type' watersheds, select sample reservoirs, define environmental controls, and describe siltation rates. The ultimate objective is to devise procedures to make accurate predictions of life expectancies of proposed headwater reservoirs. Additional objectives are to determine the effects of environmental controls on the water chemistry, and to determine possible radioactive contamination from nuclear fallout.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0236, INVESTIGATION OF THE EUTROPHICATION PROCESS OF LAKE MCCONAUGHY, WESTERN NEBRASKA

N. STUCKY, State Game & Parks Commission, *Lincoln, Nebraska* 68509

Objective: Design a comprehensive study to determine the rate of nutrient enrichment of Lake McConaughy.

Procedures: 1. Conduct an extensive review of literature pertaining to the eutrophication process. 2. Examine other investigations which have been and are presently being performed on Lake McConaughy by other agencies and institution 3. Determine which water quality parameters will best depict the rate of eutrophication of Lake McConaughy. 4. Conduct preliminary sampling to determine the sample size necessary for each parameter to detect a change over a given period of time which is statistically significant. 5. Design a study to determine the rate of nutrient enrichment of Lake McConaughy.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0237, POLLUTION OF SURFACE AND GROUND-WATER RESOURCES

D.M. EDWARDS, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-11-023)

OBJECTIVE: Quantitatively and qualitatively study, in the laboratory and in the field, different components of potential contamination to water and the effect of these constituents on changing soil and water characteristics. Specific objectives are: evaluate the effects different agricultural chemicals and wastes may have upon surface and subsurface waters, determine what effect contaminated water supplies have upon the characteristics of the soil, devise improved and/or new methods of water pollution prevention and control, train graduate and undergraduate students for research in the area of water pollution, supply, treatment, and quality as related to agricultural production and rural and urban water supplies and sanitation.

APPROACH: Laboratory and field studies will be conducted to determine the level and type of natural and artificial water contamination, objective 1. This information will be compiled and evaluated to allow building to simulated laboratory models. The models will be used for qualitative studies of the basic parameters of these waters and their effect upon soil conditions, as well as upon surface and subsurface water pollution, objectives 2 and 3. Finally, the information gathered from the laboratory studies will be used initially in the laboratory, and, if promising there, in the field for improved and/or new methods of water reuse and pollution prevention and/or control, objective 4. Radiological and electrokinetic techniques of electrophoresis, streaming potential, and electroosmosis will be extensively used for the study.

PROGRESS: The studies of applying nitrogen fertilizer to surface irrigation tests areas consisted of mechanical application and in the irrigation water. Results were initial run-off contains most nitrates, little or no loss of nitrates from within the soil, and proper irrigation management can minimize nitrate losses in run-off and deep percolation waters. A study completed was the influence of electrokinetic potentials upon the development of incrustation and corrosion on water well screens. A study completed was the feasibility of using chemicals to clarify runoff waters from beef feedlots using Zeta-potential techniques. A study underway is the feasibility of sub-surface irrigation in the Northern Great Plains. This would reduce the needed size of water source, and control the amount and placement of potential pollutants.

SUPPORTED BY U.S. Dept. of Agriculture

2.0238, EUTROPHICATION OF SMALL RESERVOIRS IN THE GREAT PLAINS

M.J. HAMMER, Univ. of Nebraska, School of Engineering, *Lincoln, Nebraska* 68508

Very little is known about eutrophication in small reservoirs and virtually nothing is known about the eutrophication of Nebraska's waters. What species of algae are present (including indicator organisms) in what quantity, and how does this quantity change with time? What is the present level of eutrophy in existing small reservoirs? What are the nutrient levels and nutrient sources, and what is the existing water quality? Answers to these questions are presently unavailable.

The proposed research is to gain information on reservoir eutrophication by studying flood control reservoirs constructed near Lincoln, Nebraska, in the Salt Valley Watershed District. The four reservoirs included in this study are well suited for this research since their ages vary from one to six years and their sizes range from 100 to 1800 acres of water surface.

The specific objectives of the proposed research are: 1. To determine the present trophic condition in selected reservoirs in the Salt Valley Watershed by monitoring several biological and physio- chemical parameters, to determine the rate of eutrophication in these reservoirs by observing changes in the above parameters over a three year period, and to evaluate the future usefulness of these reservoirs for recreation. 2. To identify sources of nutrient input into these reservoirs, both agricultural and domestic. 3. Based on the data collected from these studies, to evaluate preventive and remedial measures to improve water quality and retard the rate of eutrophication.

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SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0239, SOILS, PESTICIDES AND THE QUALITY OF WATER

T.L. LAVY, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-12-071)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to (i) pesticide transport through the soil in infiltrating water, and (ii) pesticide desorption from eroded soil into surface waters. Determine the kinetics and degradation mechanism of picloram and identify the principal degradation products.

APPROACH: The effect of soil properties such as base saturation, soil type, pH, and temperature on the mobility of pesticides in soil columns will be studied. The degree of pesticide adsorption which occurs when various amounts of water are added to the soil in the columns will be measured by assaying sections of the column for the pesticide or its degradation product(s). Nutrient uptake by plants growing in soil-water systems may be altered by an accumulation of the mobile pesticide around the plant roots. The degradation rate of picloram and other mobile pesticides positioned at various soil depths will be evaluated using chemical and bioassay methods. The use of 14(C) labeled pesticides and liquid scintillation counting will permit the detection of trace amounts of pesticide. Extent of degradation of the parent molecule will be assayed using thin layer and gas liquid chromatographic techniques.

PROGRESS: Atrazine was degraded 2 to 3 times faster in topsoils than in subsoils. Each 10 C temperature rise from 15 C to 35 C caused the degradation rate to increase 2 to 3 times. Pesticides will be deactivated more rapidly if they do not move below the surface six inches. Dissipation of dicamba was greater in Sharpsburg silty clay loam soil than in lighter textured low organic matter, Anselmo sandy loam soil. Degradation occurred more rapidly at 35 C than 15 C. Dicamba was most phytotoxic to corn seedlings at pH 4. Although dicamba was taken up by both roots and shoots, root uptake caused greater growth reduction. In laboratory studies the acid form of amiben was more mobile in soils than the ester form which was adsorbed more strongly. This adsorption appears to be closely associated with soil organic matter. Root uptake was more important than shoot uptake. Amiben derivatives which were not susceptible to leaching in laboratory studies provided poor weed control with excessive rainfall.

SUPPORTED BY U.S. Dept. of Agriculture

2.0240. SOIL AND WATER MANAGEMENT SYSTEMS FOR PREVENTION OF SOIL AND WATER POLLUTION
T.M. MCCALLA, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (SWCW8-DLI-4)

OBJECTIVE: Measure the magnitude of and develop soil and water management systems for the prevention of pollution of soil, surface and ground waters by harmful nutrients, organic wastes, and toxic chemicals arising from various kinds of land use in subhumid areas, including land use for livestock feeding, industrial and municipal waste disposal.

APPROACH: Laboratory and field investigations, often on a watershed basis, will be conducted to study the movement and decomposition of nutrients, agricultural chemicals and organic waste resulting from different kinds of agricultural land use, with emphasis on concentrated live-stock feeding in feeding in relation to water balance investigations where runoff, evaporation, percolation, rate and direction of groundwater movement are measured.

PROGRESS: Highest solubility and suspensibility of cattle feedlot manure was found on samples collected near feedlot bunkers. Appreciable numbers of organisms regarded as pollution indicators were present. These remained suspended after 24 hours of settling, and the nitrate and inorganic phosphate remained in solution. Decomposition studies on manure over a three-month period, wetted with urine simulating stocking rates of 50 and 250 square feet per animal, showed 80 to 90% loss of the nitrogen as ammonia, loss of 50% of the volatile solids, little nitrification, and complete destruction of the E. coli and Enterococci. More washoff of solids occurred on 13 than on 8% slopes using simulated rainfall, but there was no difference in runoff. Loss of solids from a 13% feedlot slope was less than from a conventionally planted cornfield on the same slope. Studies on a flat feedlot where no manure is hauled away show little runoff, accumulation of pollutants in the profile with both aerobic and anaerobic decomposition occurring, and high concentrations of organic pollutants in the surface of the water table. On a sloping loess hills feedlot site, 12 inches of the 26 inches of annual precipitation ran off. Runoff was high in solids, total phosphorous and nitrogen, and microorganisms. Aeration in the profile is good and nitrification occurs. Nitrate in the surface of the water table was higher than under surrounding cultivated fields.

SUPPORTED BY U.S. Dept. of Agriculture

2.0241. ASSESSMENT AND CONTROL OF POLLUTION OF SURFACE AND GROUND WATER BY FERTILIZERS
T.M. MCCALLA, Univ. of Nebraska, U.S.D.A. Soil & Wa. Cons. Div., *Lincoln, Nebraska* 68503 (SWC-027-DLI-3)

OBJECTIVE: Assess the hazard of eutrophication of surface and ground water by deep percolation, runoff, and sediment transport of nitrogen, nitrate and phosphate from fertilizers applied to crop and grassland in the subhumid loess hills in Iowa and Nebraska.

APPROACH: Measurements of downward and surface movement of phosphorus, nitrogen and nitrate will be made on instrumented watersheds treated with recommended and excessive rates of fertilizer on contour planted continuous corn, corn on a benched watershed, and a bromegrass meadow at Treynor, Iowa. Samples of runoff, sediment and spring flow, and samples obtained by periodic core drilling will be analyzed and calculations of amounts made from data on water flow and sediment transport. Additional core drilling will be done in Nebraska for fuller assessment of the potential hazard from overuse of fertilizers. Laboratory chemical studies will be made on sediment, core and soil samples for better interpretation of the field data.

PROGRESS: Laboratory analysis of samples of base flow and runoff water and of sediment from the differentially fertilized watersheds at Treynor, Iowa showed no seasonal changes in nitrogen or phosphate concentration of baseflow or concentration changes that could be related to recommended vs. extremely high rates of fertilization of corn. Soluble phosphate in runoff is greatly reduced by the adsorption of phosphate by sediment in eroding gullies. Relatively high concentrations of ammonia are found in runoff water from snowmelt. Nitrate concentrations in deep cores were extremely variable and often high on watersheds with a long history of corn production. High rates of nitrogen fertilization have not changed nitrate concentrations in profiles significantly, but the sampling variation is so great that possible differences cannot be detected.

SUPPORTED BY U.S. Dept. of Agriculture

2.0242. WATER AND SOIL POLLUTION FROM BEEF CATTLE FEEDLOTS IN NEBRASKA
T.M. MCCALLA, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-12-074)

OBJECTIVE: To determine amounts and characteristics of pollutants being deposited on, in runoff from, in soil profile, and in ground water of beef cattle feedlots, and to determine microbial decomposition patterns of animal wastes.

APPROACH: Select typical feedlot sites; instrument sites for measuring runoff and determining water table depth; collect feed, urine, and runoff samples from sites and ground water; make laboratory determinations of pH, fecal coliform, total counts, and routinely total P, N, and COD, and other selective determinations as deemed necessary.

PROGRESS: The runoff from beef cattle feedlots at the University of Nebraska Field Laboratory, Mead, resulting from rainstorms and snowmelt, is highly variable, both in the quantity of runoff and the concentration of materials. Feedlot slope and density of stocking did not appear to affect the total material resulting from rainstorms. In 1969, winter runoff from 130 ft/animal lots yielded an average of 4.5 times more total solids than from 200 ft/animal lots. An estimated 6% of the volatile solids deposited on the feedlot surface was transported in runoff for lots with stocking rate of 200 ft/head and 3% with stocking rates of 100 ft. If winter runoff is included, the corresponding percentage values are 14 and 26.8. Results of 1-year study indicate that the movement of pollutants under research feedlots has been minimal, however, there was a buildup of nitrates in profiles adjacent to the feedlots. On a flat, river-bottom feedlot that had not been cleaned since 1956, nitrate-nitrogen in feedlot ground water samples exceeded the Public Health water standards on only 3 occasions in 2 years. The hazard was minimal as these levels were detectable only for a short time after the initiation of irrigation pumping. In the soil, the low oxygen level, low oxidation-reduction reading, and the organic layer buildup appear to be responsible for the low nitrate levels. Data indicate that surface conditions and stocking rate both affect the pollution potential of a feedlot.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Agriculture

2.0243, A STUDY OF RELATIONSHIPS BETWEEN CERTAIN ORGANIC WATER-QUALITY PARAMETERS, WATERSHED CHARACTERISTICS, & LAND-USE MANAGEMENT PRACTICE
R.J. MORRIS, Univ. of Nevada, School of Agriculture, *Reno, Nevada* 89507

This study is designed to test relationships between certain stream water-quality parameters (notably, organic nutrients, suspended sediments, and pesticides), watershed characteristics, and land use. Sampling sites will be selected from the Tahoe-Truckee, Carson and Walker River watersheds along the Sierra Nevada Range. Should these watersheds not produce the desired land-use and vegetation units the geographic range of the study will be expanded. Thus, the project will coordinate closely with current inorganic and organic water-quality and hydrologic modeling studies at the Center for Water Resources Research and elsewhere.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0244, DISSOLVED CONSTITUENTS OF NATURAL WATERS - CONTRIBUTIONS FROM MINERALIZED AREAS
J.V SHARP, Univ. of Nevada, Desert Research Institute, *Reno, Nevada* 89507

Geologic terranes where ore metals and substances occur in abundance relative to usual occurrence are possible sources of unusually high concentrations of trace and certain gross constituents in natural waters. These constituents may be harmful for human consumption or for agricultural or industrial use. Ground and surface waters are sampled from selected mineralized districts and surrounding areas and analyzed for gross and trace constituents. Spatial and temporal occurrence of dissolved constituents is related to sources in mineralized rock and mine and mill disposals. Transport of consituents is interpreted in light of hydrodynamic and geochemical characteristics of flow systems. Results are related to water utilization, particularly cases where deleterious constituents may be a limiting factor on water use.

Phase II involves completion of studies in silicate geologic terranes and of acid mine drainage.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0245, DETERMINATION OF THE STAGES OF EUTROPHICATION OF SOME OF NEW HAMPSHIRES LARGE LAKES PHASE II
P.J. SAWYER, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

The determination of the stages of eutrophication has been carried out on only one of New Hampshire's lakes, it is proposed to extend this knowledge. Five lakes will be investigated, one of them in two different places. Attempts will be made to gather information on the chemical, physical, and biological characteristics of the lake. The chemical characteristics to be determined will be oxygen, carbon dioxide, alkalinity, phosphates, nitrates, and possibly some ionic determination by atomic spectroscopy. Physical characteristics to be identified will be pH, light penetration, temperature stratification, and conductivity. Finally, primary productivity will be measured by the carbon-14 technique, and the zooplankton and phytoplankton components will be identified. Additional work will be done on the impact of copper sulfate on lake communities.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0246, AN INVESTIGATION OF APHANIZOMENON FLOS-AQUAE, A TOXIC BY-PRODUCT OF EUTROPHICATION
P.J. SAWYER, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

An investigation of the toxicity of Aphanizomenon flos-aquae, is proposed. The project is divided into three parts. Part I, to be executed by Prof. Ikawa, will be an attempt to isolate and identify chemically the endotoxin found in the algae. Part II, under Dr. Sasner's direction, will be a study of the physiological effects of the toxin at the cellular level particularly among the excitable tissues. Part III, to be accomplished by Dr. Sawyer, will be a study of the effects of the toxin on members of the aquatic communities associated with eutrophic lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0247, ABNORMAL TRACE METALS IN CARDIOVASCULAR DISEASE
H.A. SCHROEDER, Dartmouth College, School of Medicine, *Hanover, New Hampshire* 03755

Environmental exposures of man to selenium, molybdenum, chronium and strontium have been ascertained by analyses of a large number of foods, waters, human and animal tissues. Age linked changes in human tissue concentrations of molybdenum, chromium and strontium have been ascertained. Total body burden of selenium was calculated at 14 mg.

Mice have been exposed for life from weaning time to low concentrations of selenite, selenate, tellurite, tellurate, scandium, gallium, yttrium, indium, rhodium, palladium in drinking water. Selenium, rhodium and palladium were carcinogenic.

Rats have been simularly exposed to selenate, tellurite, molybdate, zirconium, niobium, antimony, vanadium, lead. Selenate was carcinogenic, antimony was toxic in terms of survival. Chromium deficiency was associated with aortic plaques, elevated serum cholesterol and fasting glucose. Manganese deficiency was associated with hyperglycemia, which was antagonized by copper. Elevated serum cholesterol was produced by white sugar; it was depressed when brown sugar was given.

Toxicities of airborne metallic pollutants were evaluated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0248, BIODEGRADATION OF OIL SLICKS IN THE MARINE ENVIRONMENT
R. BARTHA, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00504)

OBJECTIVE: Determine the rate natural biodegradation of oil slicks in various marine environments; to identify predominant degradation pathways, intermediary products and their biological activity to evaluate currently used emergency measures as to their effect on the ultimate biodegradation of the polluting oil; and to develop new techniques for accelerating the biodegradation of oil slick in the marine environment.

APPROACH: A 'model petroleum' will be used in laboratory test with sea water, beach sand and sediments added. Hydrocarbon degradation will be monitored by periodic sampling and gas chromatograph. Oxygen consumed or carbon dioxide produced will be measured. Pure cultures of marine microorganisms will be used in studies of degradation pathways. Detergents used to clean up oil slicks in emergency situations will be tested for effects on biodegradation of crude oil and of model petroleum in laboratory and field studies. Results of these studies will be used to develop new techniques for accelerating the biodegradation of oil slicks.

PROGRESS: To find ways for prediction and improvement of biodegradation rates of polluting oil in the sea, in the first year of the project water and sediment samples were collected from polluted and nonpolluted marine environment. Enrichment with various hydrocarbons and hydrocarbon mixtures yielded several cultures of hydrocarbon- degrading marine bacteria, actinomycetes and fungi. Media consisting of natural or amended seawater supplemented with representative hydrocarbon mixtures of known composition were tested under controlled incubation conditions for their suitability as a model system for the quantitative measurement of oil biodegradation in the sea. For the same purpose, conditions of qualitative and quantitative analysis of the representative hydrocarbon mixtures by gas chromatography were developed.

SUPPORTED BY New Jersey State Government - Trenton

2.0249, HYDRODYNAMICS AND DISCHARGE MEASUREMENTS OF STORM SEWERS
E.L. BOURODIMOS, Rutgers the State University, School of Engineering, *New Brunswick, New Jersey* 08903

This research project will be carried out through three major procedures and converging steps to a central objective: (a) Hydrologic and Hydrodynamic Analysis: Mathematical modeling and theoretical analysis of spatially varied unsteady (or steady) sewer flow. (b) Laboratory Experimental Study: use of tracer techniques in the field and in the laboratory will be attempted in order to verify the analytical predictions of the study. The theoretical analysis will contribute in understanding of the mechanism of flow while the field work will provide the practical objectives of the project. (c) Field work: measurement of storm sewer flow and comparison of actual data with the theoretical and experimental predictions of the study.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0250, THE POTENTIAL CONTRIBUTION OF FERTILIZERS TO WATER POLLUTION

L.A. DOUGLAS, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00037)

OBJECTIVE. Determine the ultimate distribution of fertilizer materials after fertilizers are added to the soil, with specific concern to ground and runoff water and to develop a model for predicting the ultimate distribution and subject it to field testing.

APPROACH: Fertilizers will be applied to controlled field plots. The movement of the fertilizer will be monitored by collecting soil water at various depths, runoff and soil material eroded from the plots. Fertilizer materials recovered from the plots by leaching, runoff and erosion will be determined and related to soil properties. A model will be developed from the data for the purpose of predicting such distributions from applied fertilizers.

PROGRESS: This study was initiated on July 1, 1969, with the principal objective of evaluating the contribution of fertilizer nitrogen and phosphorous to water pollution. This first season was devoted to: leaching nitrogen from an experimental site, and developing field sampling and analytical techiques. The turf was removed from the plots and the plots planted to Sudan grass in July. Sampling of soil water and runoff was started. The NO(3) contents of the soil water varied between 5 and 250 ppm NO(3). The higher values were obtained after several rain-free, warm days, followed by a good rain. Apparently the wetting front contained a high level of NO(3), contrasted with low NO(3) levels a short distance behind the wetting front. In September soil water NO(3) values dropped to below 5 ppm. No PO(4) values greater than 1 ppm were observed.

SUPPORTED BY New Jersey State Government - Trenton

2.0251, URBANIZATION AND ITS EFFECT ON WATER RESOURCES

M. MARCUS, Rutgers the State University, Graduate School, *New Brunswick, New Jersey* 08903

The proposed research is intended to identify, describe, and project major processes of urbanization in relation to land use and water pollution aspects of water resource development. The study will define urbanization in terms of industry and households as the two major urban water user groups.

Dr. Marcus proposes to analyze the aggregate area (New Jersey) economy as a set of industries in which urbanization characteristics can be examined and for which projections can be attempted. Existing industry, employment and population data will be used. The analysis will be organized to describe anticipated changes in the economic dimensions of newly urbanized areas and project industrial growth into the future.

Test projections of increased population and densities will be made for periods of 10 to 20 years in duration, based upon state projections of county populations.

Gen. Whipple and Dr. Yu have studied the development of the new organic pollution load over a period of years in three key watersheds, i.e., the Millstone-Stony Brook, The Raritan, and the Passaic. These results have shown that a large proportion of organic pollution comes from sources other than effluents. A statistical analysis and correlation is being carried out to determine the relationship between growth of pollution load on one hand and growth of population and of specific types of industry on the other. These projections to determine what growth of raw organic pollution load may be expected in key river basins of the state up to the year 2000.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0252, MOSQUITO CONTROL - TIDAL MARSHES

F. FERRIGNO, State Div. of Fish & Game, *Trenton, New Jersey* 08625

Objectives: Chemical and physical evaluation to provide adequate control of mosquitoes on tidal marshes. Also, to evaluate their effects on other marsh organisms as well as the water, soil, and other interests.

Procedures: Over the years this study has supplied us with much information on the problems associated with coastal mosquito - wildlife management interests. Studies to be undertaken pertaining to transporting and building up of residual insecticides on marshes or within marsh organisms. Accordingly, it is urgent that an organization equipped with facilities to determine the chemical analyses of water, soil, salt bay eggs, micro and macro-organisms, and tissues, cooperate in the study. Every effort should be made this year to determine the 'hidden effects' of these chemicals in this environment. In addition, experimentation will continue on open marsh water management in an effort to provide long-lasting control of mosquitoes and a better environment for fish and other wildlife. Ponding and ditching will be evaluated.

This study will eventually lead to control of pestifereous insects, improvement of the tidal food web, and eventually elimination of insecticide from tidal marshes. Over 2000 acres of heavy mosquito breeding marshes have been controlled by open marsh water management.

Chemicals are no longer needed on these areas and organisms of the food web are increasing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0253, SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II

P.J. WIERENGA, New Mexico State University, School of Agriculture, *Las Cruces, New Mexico* 83001 (C-2165)

Saline soils constitute a large fraction of irrigated soils in the western United States and in other irrigated areas throughout the world. The conventional method for controlling soil salinity is to leach soils by applying large amounts of water. This process is a costly use of water, and contributes furthermore to salt pollution of groundwater supplies and to high salt levels in drainage water. Recent studies indicate that soil profiles may be leached more efficiently by applying smaller quantities of water.

The proposed study involves use of large, well instrumented lysimeters to determine the magnitude and nature of soluble salt movement under unsaturated soil water conditions. During each of several irrigation treatments continuous measurements will be made of the soil temperature, the soil-water content, the salt content, the composition of the soil extract and the concentration and composition of the leachate. Treatments will consist of irrigating with various quantities of irrigation water differing in salt concentration and ionic composition. The movement of nitrogen, phosphorus and pesticides will be studied in homogeneous and stratified soil profiles. The data obtained from the lysimeters will be used as input datas for a computer simulation program for predicting salt movement under unsaturated flow conditions. Comparisons will be made between observed and computed rates of salt movement under various irrigation regimes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0254, POLLUTION STUDIES OF THE REGIONAL OGALLALA AQUIFER AT PORTALES, NEW MEXICO

R.G. TAYLOR, Eastern New Mexico University, School of Liberal Arts, *Portales, New Mexico* 88130

Preliminary investigations have demonstrated the presence of bacterial organisms of fecal pollution in the aquifer at Portales. It is proposed to examine the aquifer in both the chemical and bacterial parameters and extend observations to elucidate any possible seasonal variations. Bacterial examination is proposed by use of Millipore filtration, analyzing for fecal coliforms, total coliforms, Pseudomonas and total bacterial numbers. Chemical analyses of aquifer water will include nitrate, organophosphate, sodium, calcium , magnesium, total hardness and pH employing

Standard Method's procedures. Identification of any seasonal variations in either the chemical or bacterial parameters will permit elucidation of the pollution source as to its possible origin coming from recharge.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0255, MORPHOLOGY AND STABILITY OF STREAM CHANNELS IN SOUTHWESTERN SEMIARID RANGELANDS

J.C. DRISSEL, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Santa Rosa, New Mexico* 88435 (SWCW2-GSR-2)

OBJECTIVE: Methods for predicting and control of gully and stream channel erosion, and sediment deposition damage.

APPROACH: Evaluate processes of channel aggradation, degradation, horizontal realignment, and changes in cross-sectional shape and net sediment yield in relation to types of bed and bank materials, upstream sediment sources, streamflow regimes and control measures.

PROGRESS: Channel scour at seven study sites selected and instrumented with vertical ropes attached to an anchor. Scour on individual flows is highly variable and related to peak discharge. Bed found to scour during early portion of hydrograph and refill on recession and varied from 6 inches to 4 feet. Headcuts and bank scour and sloughing are major sources of sediment in this watershed. Bed material samples collected at visible changes in stratification in vertical sections have been correlated with peak discharges. Coarse material at stratification change is overlaid with successively finer layer deposited on hydrograph recessions. Coarsest material probably represents scour depth for particular flow.

SUPPORTED BY U.S. Dept. of Agriculture

2.0256, CANADARAGO LAKE EUTROPHICATION STUDY

L.J. HETLING, State Dept. of Env. Conserv., *Albany, New York* 12205

The nature and courses of eutrophication of lakes is being studied. A detailed study is being made on Canadarago Lake, Otsego County, New York. Data collection and sampling on the lake began in May, 1968, in order to establish its physical, hydrological, chemical, and biological characteristics. From this basic data more specific engineering control mechanisms such as advanced waste treatment, improved individual summer home waste disposal methods, agricultural practices, diversion of land run-off, etc., will be evaluated. A nutrient balance has been constructed and the temporal and spatial variations in nutrient loading to the lake have been determined. A modern sewage treatment facility for Richfield Springs capable of nutrient removal is planned for construction in late 1971.

The objectives of the 1971-72 FY are: 1. Determine the relationship of land use to nutrient land run-off, and attempt to control nutrient run-off by land use practices. 2. Determine the dynamic effect of nutrient reduction at the sewage treatment plant and subsequently by land run-off control on the lake's. 3. Develop a model relating the lake's eutrophic state to man's activities which could be used in lake management.

To accomplish the above, continual surveillance of the biological, chemical and hydrological system over the next several years is planned as well as several specific studies.

SUPPORTED BY New York State Government - Albany

2.0257, MECHANISM FOR THE CONCENTRATION OF BACTERIA IN JET AND FILM DROPS

D.C. BLANCHARD, State University of New York, School of Arts, *Albany, New York* 12224

Research by Professor Blanchard has found that bubbles breaking at the surface of water which has been inoculated with bacteria Serratia marcescens eject jet drops into the air whose concentration of bacteria is 10 to 1000 times that of the water in which the bubbles burst. This suggests that high concentrations of bacteria are to be found in the surface microlayer. A part of this layer is skimmed off by the bursting bubble and ejected into the air. Not only do bacteria concentrate at the bulk water surface but they have been found to concentrate at the surface of the bubble as it rises through the water. A bubble aging tube will be used to investigate the increase in bacterial concentration on jet drops as a function of bubble age. The bacteria concentration in film drops will also be studied. A final aspect of the research is a study of the concentration of airborne bacteria upwind and downwind of bubbling regions (waterfalls, etc.) in polluted bodies of water.

SUPPORTED BY U.S. National Science Foundation

2.0258, BUFFALO RIVER OIL POLLUTION PROGRAM

R.C. ZIEGLER, Cornell Aeronautical Lab. Inc., *Buffalo, New York* 14221

The Buffalo River Project is a two-phase program for preventing and eliminating oil pollution of the Buffalo River. Phase I is concerned with specifying oil containment and removal equipment which includes air barriers, surface booms, debris catchers, and skimmers, both portable and fixed. This phase also provides for evaluation of performance and cost analysis of operation of this equipment under various climate and flow conditions. Sampling and analysis techniques to determine quantities and types of oil present will be developed. Phase II is a development and evaluation of instrumentation to detect oil in a sewer system. Methods will also be investigated to prevent oil from entering the River at times of sewer overflow.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0259, INVESTIGATION OF THE MERCURY POLLUTION OF LAKE ERIE AND ITS AQUATIC LIFE

K.K. PILLAY, Western N.Y. Nucl. Res. Center *Buffalo, New York* 14214

A program of investigation to provide an insight into the factors involved in the mercury contamination of lake Erie and its aquatic life is proposed.

The field studies will investigate the existing mercury levels in water, sediment, plankton/algae and fish and the variation in the levels over the proposed five-year period of the study. The sampling points have been selected to provide a clear understanding of the distribution and variation with time of mercury in the three basins of the lake. The mercury concentrations in three species of fish - Walleyes (a non- migratory predator), Coho Salmon (a migratory predator) and Channel Catfish (a non-migratory non-predator) - will be investigated.

The laboratory study will investigate the effects of mercury on the development, growth rate and viability of the three fish being considered in the field studies and the mechanism involved in the metabolism of mercury in these fish. The metabolic studies will include investigation of the uptake, release, sequestration and concentration of mercury.

The results of the studies will be used to predict the future course of mercury contamination in water, fish and aquatic life of the lake.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0260, TRIBUTARY SUPVEY OF LAKES ONTARIO AND ERIE

W.A. PEARCE, State Conservation Department, *Cape Vincent, New York* 13618

Objective: Obtain information on Lake Ontario and Lake Erie tributaries required for an anadromous fish management program.

Procedures: Project personnel will review existing stream data. Streams needing more data will be selected for detailed surveys. Study streams will be mapped for use in identifying areas of special need. A suitable stream survey sheet will be designed that will complement existing forms in use by other agencies such as lamprey control units.

Survey schedules will coordinate with other agencies working on individual streams including lamprey control surveys in May or June, Regional Fish Management surveys, spawning run checks. Study streams must be checked during critical periods of high and low flow, winter ice conditions, times of high water tem-

peratures and irregular flows from hydro-power plant controls. Individual plans for each of the important streams and tributaries include: 1. General physical and chemical data. 2. Barrier sites - both permanent and temporary. 3. Existing and potential salmonid spawning and nursery sites. 4. Potential spawning channel, rearing pond, weir and fish ladder sites. 5. Acquisition needs. 6. Sources of pollution. 7. Regulated flow recommendations where applicable.

An overall tributary plan encompassing individual stream plans will be completed for Lake Ontario. A similar plan will be completed for New York's section of Lake Erie.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish

2.0261, KINETICS OF MICROBIOLOGICALLY MEDIATED TRANSFORMATIONS OF HEAVY METALS IN AQUATIC ENVIRONMENTS

A.W. LAWRENCE, Cornell University, School of Engineering, *Ithaca, New York* 14850

The objective of this project is to investigate the fate of heavy metals in the aquatic environment for the purpose of developing qauntative models for engineering management of water quality. Mercury, a heavy metal which is the subject of intensive current interest will be studied first. Its use as a model of heavy metal behavior will be considered. Subsequent study of other metals such as zinc will follow procedures developed in the mercury studies.

The proposed project will consist of: 1) a thorough review of the literature on the fate of mercury and other heavy metals in the aquatic environment (lakes and estuaries), 2) a laboratory study of the kinetics of microbially mediated transformations of mercury including the effects of pH, temperature, and organic carbon concentration, on these kinetics, 3) literature review and laboratory investigations of the role of microbially mediated sulfide production in the distribution and relative avalability of mercury and other metals, and 4) development of a mathematical model to describe microbially mediated transformations and subsequent distribution of mercury and other heavy metals in the water column and benthos.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0262, EUTROPHICATION TIDAL WATERS

J.P. BARLOW, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00588)

OBJECTIVE: To determine the effects of nutrients on the growth of estuarine phytoplankton.

APPROACH: This will be done by placing natural phytoplankton populations under various experimental conditions in which the effect of light, nutrients, etc. on rate of photosynthesis may be determined.

PROGRESS: No Progress Reported This Period (Active Project).

SUPPORTED BY New York State Government - Albany

2.0263, EUTROPHICATION IN WATER RESOURCES OF NEW YORK STATE

J.P. BARLOW, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00805)

OBJECTIVE: To determine the nutrients that limit major components of the existing plankton population in Lake Cayuga and probable effect of additional nutrients on the growth and composition of this population.

APPROACH: Environmental conditions will be described by bi-monthly samplings at several depths to determine plankton abundance and concentration of plant nutrients, phosphorous, nitrogen, silicon, potassium, and other factors such as transparency and temperature.

PROGRESS: No progress reported this period (Active project).

SUPPORTED BY New York State Government - Albany

2.0264, MICROBIOLOGY AND WATER QUALITY IN A TRIBUTARY OF CAYUGA LAKE

N.C. DONDERO, State University of New York, School of Agriculture, *Ithaca, New York* 14850

The effect of a large cattle feedlot on the quality of the water of a tributary to Cayuga Lake, N. Y., will be studied. Microorganisms and microbial growth factors stimulatory to algae are expected to be abundant. Samples for microbiological assay for biotin, thiamin, and cyanocobalamin will be collected. The basic chemical and physical parameters of pollution and eutrophication will be ascertained as well as bacteriological parameters. Samples will be taken weekly below and above the feed lot and at six other stations along the stream. Analyses will be made for the following: dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, conductivity, alkalinity, Kjeldahl nitrogen, nitrates, ammonia, phosphate, pH, total solids, total plate counts, coliforms, fecal coliforms, streptococci, Salmonella, and nitrifying and denitrifying bacteria.

The data will be shared with others working on invertebrates and periphyton of the stream and those working on the water quality of Cayuga Lake.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0265, LIMNOLOGICAL INVESTIGATION OF ONEIDA LAKE

D.J. HALL, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00110)

OBJECTIVE: Investigate current nutrient conditions in Oneida Lake in light of possible nutrient enrichment. Examine relationship between continuous nutrient recycling and plankton production. Determine the fate of the zooplankton in Oneida Lake.

APPROACH: A two-year study is proposed in which extensive year- round water analyses, quantitative plankton and fish collections will be made in order to ascertain fundamental relationships in the food chain dynamics of Oneida Lake. Analyses of phosphorous, nitrogen and other selected nutrients will be routinely carried out. The rate of nutrient regeneration will be examined in relation to the unusual summer circulation (mixing) pattern in the Lake. The primary production of phytoplankton using the C-14 technique and zooplankton population turnover rates will be estimated from appropriate field experiments and analyses.

PROGRESS: The entire year has been devoted to data analysis (counts, computations and graph construction) and manuscript preparation. Pre-final results indicate striking numerical and size effects of fish predation (Yellow Perch) upon Daphnia populations.

SUPPORTED BY U.S. Dept. of Agriculture

2.0266, EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II

H.F. MULLIGAN, State University of New York, School of Agriculture, *Ithaca, New York* 14850

This project involves the study of the effects of enrichment with ammonium, nitrate, and calcium monobasic phosphate hydrate on the growth of plankton algae and selected species of aquatic weeds in twenty, 1/10 acre experimental ponds. The aquatic weeds are being studied in the ponds include Elodea canadensis, Potamogeton crispus, and Myriophyllum spicatum var. exalbescens. Enrichment replications have been established in these ponds during the summers of 1968 and 1969. In the summer of 1970, no fertilizer will be added and bi-monthly estimates of the rates of growth of plankton algae and bottom weeds will be obtained. The species composition and succession of plankton algae and records of bottom weed populations will be noted.

In this way, effects of prior fertilization or species diversity and density of plankton algae and bottom weeds can be evaluated. Residual effects of nutrient enrichment on the entire aquatic ecosystem will be estimated by measuring nutrient composition of the soil and water on a bi-monthly basis.

2. WATER QUALITY

These data will be summarized so as to provide information on the ecological consequence resulting from a reduction or cessation in nutrient enrichment to surface waters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0267, EUTROPHICATION AS A PROBLEM IN THE FINGER LAKES
R.T. OGLESBY, State University of New York, School of Agriculture, *Ithaca, New York* 14850

Existing data will be combined with a limited summer sampling program to define the state of eutrophication of the Finger Lakes of New York. Transparency, chlorophyll, phytoplankton, nitrates, phosphates, dissolved oxygen, pH, and alkalinity measurements will be compared for the lakes and nutrient analyses will be performed on the principle tributaries. Together with a consideration of land use patterns, basin morphometry and lake flushing times, these observations will be used to develop hypotheses to account for the observed production levels. A more comprehensive study will be designed to verify the postulates thus generated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0268, LOSS OF ORGANIC AND INORGANIC MATERIALS FROM ABOVE-GROUND PLANT PARTS BY LEACHING
H.B. TUKEY, State University of New York, School of Agriculture, *Ithaca, New York* 14850 (AT(30-1))

Appreciable quantities of inorganic and organic metabolites, including growth regulators, are leached from above-ground plant parts by rain, mist, fog, and dew. Mineral nutrients, amino acids, organic acids, and carbohydrates are leached from a wide range of plant species. Young plants, including economically important food crops, are grown in radioactive nutrient solutions that are leached with a water mist. The leachates are collected on resins and the losses by leaching are determined quantitatively by radioactive analysis, and qualitatively by chromatographic, photometric, and bioassay techniques.

Important areas of investigation are, 1. effect of leaching upon flowering, 2. effect of leaching upon leaf senescence and dormancy, 3. involvement of leaching phenomena in chemical ecology, that is plant/plant chemical interactions, 4. influence of leaching in environmental quality, as a method of decontamination from certain pollutants, and as a method of dispersal of environmental pollutants.

Results: Leaching is influenced by species, metabolites being leached, leaf morphology and age, nutrition, and environmental factors. Substances leached from one plant can be utilized by other nearby species. Leaching is an important ecological factor in plant development, and it plays a role in the distribution of contaminants.

SUPPORTED BY U.S. Atomic Energy Commission

2.0269, AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER
P.J. ZWERMAN, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00342)

OBJECTIVE: Determine the effects of selected farming practices on the forms and amounts of nutrients contributed to water and determine the availability of the different forms to aquatic plants.

APPROACH: Runoff and tile flow from 24 0.8-acre plots receiving differential fertilization, manuring, and management will be measured and sampled. Particulate matter will be separated, and both soluble and particulate material will be analyzed for nutrients. A portable rainfall simulator will be used to create runoff from other differentially treated areas to be similarly analyzed. Algae and bottom-rooting plants will be grown in greenhouse environments to evaluate availability of nutrients in organic extracts from farm manure, soil organic matter, and in particulate matter from the field experiment described above.

PROGRESS: Two separate experimental fields are being utilized. One is a relatively long-time study of nutrient losses under high and low fertilization. 1000K(2)O/A is applied on all plots. High fertilization receives in addition, 2000N and 1000P(2)O(5) per acre. Low fertilization receives approximately 1/3 of these amounts. Tile drainage waters contained 9.5 and 24.5 mg/l NO(3) expressed as N under low and high fertilization respectively. This condition existed where some vegetative cover was growing in early April. In 'clean cultivated' corn in July, the corresponding numbers were 40.4 and 153.5 mg/l. A second experimental area was studied from a former crop rotation experiment terminated in 1968. A 'rainmaker' was utilized to study runoff and erosion rates. Infiltration rates were 20% greater following 10 years in a rotation of wheat-4 years of alfalfa than following other rotations or continuous corn. On plots cropped continuously to corn, manure at a rate of 6T/A/yr increased infiltration rate 20%.

SUPPORTED BY U.S. Dept. of Agriculture

2.0270, STRONTIUM-90 FALLOUT OVER THE OCEAN
H.L. VOLCHOK, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

Ocean water samples collected by the Woods Hole Oceanographic Institution are analyzed for Sr-90 under AEC contracts administered by HASL. The data are used for ocean circulation studies. Most of the samples are collected at four Coast Guard Weather Stations in the North Atlantic.

Four Coast Guardship stations are equipped to sample fallout over three-week periods. Data from this project allow estimates to be made of total fallout delivery to the sea surface and the source of seawater to be traced at specific locations.

A stationary platform has been erected 25 miles northwest of Andros Island 12 feet above the shallow water on the Great Bahama Banks. Fallout collectors and rain gauges have been mounted on the platform to measure the Sr-90 deposition rate. Seawater samples are collected monthly in the Gulf Stream and near the platform.

Results: Both the amount of precipitation and the total Sr-90 in the rain are lower at the platform on the Bahama Banks than at nearby land stations. Available results suggest that isolation of the Bahama Bank water takes place in the first half of each year and that the water is gradually mixed with the open ocean in the seond half.

SUPPORTED BY U.S. Atomic Energy Commission

2.0271, SEASONAL VARIATIONS OF SOME LIMNOLOGICAL FACTORS IN LITTLE SODUS BAY, NEW YORK
G. ENGEL, State University of New York, Graduate School, *Oswego, New York* 13126

The southern shoreline of Lake Ontario is interrupted by numerous small to large size bays. The openings of these bays into Lake Ontario are regulated by wave action of the lake or by dredging operations and breakwaters. Little Sodus Bay is located in the northwest corner of Cayaugo County and covers approximately 630 acres. With the Town of Fair Haven at its southern end, the bay provides a recreational facility and protected area for small boats and fisherman. Little is known about the biological productivity of this and similar bays on Lake Ontario, about physical and chemical factors that determine the productivity, or about the possible effect of the productivity of these shallow bays on Lake Ontario as an aquatic environment.

Thus it is proposed to study the protected waters of Little Sodus Bay to determine the seasonal variations of biological productivity and an analysis of the causitive factors. The data will provide an illustration of a special eutrophic situation and the possible influence of pollution from the surrounding area. The collected information will also be useful when studies on the adjacent open lake are undertaken. Because we lack a suitable research vessel at the present time, limnological investigations initiated by the field biology station must be carried out in protected waters.

Samples (from different locations and depths will be analyzed for dissolved oxygen, carbon dioxide, hardness, alkalinity, pH, phosphates, nitrates, and total dissolved solids) will be taken once every two weeks during the open water season and monthly when there is an ice cover. Physical factors of light transmittance, temperature (air and water), wind, current and turbidity will be observed.

SUPPORTED BY State University of New York - Albany

2.0272, EXTENT OF LAKE ONTARIO POLLUTION CAUSED BY THE OSWEGO RIVER
R. ENGEL, State University of New York, Graduate School, *Oswego, New York* 13126

It is proposed to undertake a short term study to determine the feasibility of a pollution investigation of the Oswego River where it flows into Lake Ontario. The extent of the effect on Lake Ontario would be determined by the dilution rate which in turn is regulated by several factors which may fluctuate daily.

By determining the distribution of benthic organisms at the mouth of the river it is possible to eliminate the effects of fluctuations of river discharge. The numbers and kinds of benthic organisms can be compared to known pollution tollerant and pollution sensitive forms.

Once it is known that this can be done, the information will be used in application for outside support from the U.S. Army Corps of Engineers or the Federal Water Pollution Control Administration.

This project is being carried on under the auspices of the Lake Ontario Environmental Laboratory (LOTEL) of the State University College at Oswego.

SUPPORTED BY State University of New York - Albany

2.0273, MOLECULAR INTERACTIONS AT THE OIL-WATER INTERFACE AND THE FORMATION OF MICROEMULSIONS
D.O. SHAH, Columbia University, Graduate School, *Palisades, New York* 10964

1) Studies on molecular interactions at the oil/water interface and the formation of oil-in-water or water-in-oil microemulsions have been of a great interest in relation to water pollution by detergents and oils, as well as to disasters such as the wreckage of an oil tanker. 2) New techniques will be devised in this investigator's laboratory to study molecular interactions at the oil-water interface by measuring various parameters such as interfacial tension, potential, and viscosity. 3) Influence of the following factors on formation of microemulsions will be studied: the nature and concentration of various electrolytes present in sea-water; the structure and chain length of various hydrocarbons; the structure and surface charge of various anionic, cationic, and nonionic detergents. 4) The molecular interactions governing the formation of microemulsions will be deduced from parallel studies on mixed monolayers at oil-water interface. 5) The mobility of hydrocarbon chains and water molecules in these microemulsions will be investigated by using nuclear magnetic resonance spectroscopy, and the structure of microemulsions will be studied by optical and electron microscopy.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0274, ALGAL POPULATIONS RELATED TO WATER QUALITY IN LAKE CHAMPLAIN
G.K. GRUENDLING, State University of New York, School of Arts, *Plattsburgh, New York* 12901

The project involves studies of the species composition, periodicity, and abundance of phytoplankton populations of selected areas of Lake Champlain and measurement of related physical and chemical parameters. Special emphasis is being placed upon the evaluation of stations near populated centers and areas which receive runoff from large rivers. These are being compared with the results obtained from stations in the deep, open portion of the lake. In addition to the identification and enumeration of phytoplankton populations, the seasonal and vertical distributions of nitrate, silicate, phosphate, total phosphorus, calcium, potassium, magnesium, sodium, and selected trace metals are being determined.

SUPPORTED BY State University of New York - Albany

2.0275, CONTROL OF POLLUTION FROM OUTBOARD ENGINES EXHAUST: A RECONNAISSANCE STUDY
W.W. SHUSTER, Rensselaer Polytechnic Inst., School of Engineering, *Troy, New York* 12181

A reconnaissance study will be made to determine the extent of pollution which results from the operation of a two-cycle outboard engine. It is proposed to investigate the effectiveness of a pollution control device in alleviating the impact of exhaust products upon a water system.

The study will entail the development of sampling and analytical techniques for the evaluation of exhaust products evolved. The studies will be conducted in a tank with timed increments of engine operation producing a variety of oil contamination in the water. Tests will be made both with and without the pollution control device on the engine. Analyses of the products will be accomplished with gas chromatographic techniques as well as thin layer chromatography. These analyses will be supplemented by a technique utilizing piezoelectric quartz crystal resonators currently being used on oil studies.

Investigations will be performed on the presence and abundance of hydro-carbon bacteria as an indicator of the extent of self-purification of the exhaust products by indigenous bacteria.

With the development of this initial information it should be possible to estimate the potentials of pollution from two cycle outboard engines.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0276, MODIFICATION OF CHRONIC MANGANESE POISONING
G.C. COTZIAS, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

The aim of this project is to discover the means by which the hitherto irreversible neurological picture can be ameliorated in chronic manganese poisoning. These aims are being pursued in collaborative studies between Brookhaven National Laboratory and Catholic University of Santiago, Chile.

Results: It appears that L-Dopa is even better in the treatment of chronic manganese poisoning than it is for Parkinson's disease. Patients suffering from the dystonic or the Parkinsonian-like pictures of chronic manganese poisoning have remarkably benefited with regard to all symptoms except the dysarthria which did not respond. One individual who become worse on L-Dopa improved on 5-hydroxytryptophane. The therapeutic effects were well sustained with passing months. They were maintained diurnally throughout each day.

Animal investigations are being conducted in support of these studies.

SUPPORTED BY U.S. Atomic Energy Commission

2.0277, ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS
G.M. WOODWELL, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

The objective is measuremet of the total inventory and rates of flux of nutrient elements through both terrestrial and certain aquatic ecosystems of Long Island. Studies have included an inventory of DDT residues in a Long Island estuary. One of the principal tools in the measurement of nutrient flux in the forest is a lysimeter plate, capable of collecting water that would normally percolate into the water table. Studies with these plates have shown that a forest has mechanisms for retaining nutrient elements; these mechanisms break down under irradiation and other disturbances. Nutrients lost in this way to the water table contribute to the eutrophication of the estuarine bays along the South Shore of Long Island.

Results: Data are now available on the total inventory of nutrients in the forest, inputs in precipitation and certain data on losses of nutrients into the water table.

SUPPORTED BY U.S. Atomic Energy Commission

2.0278, DISTRIBUTION OF RADIONUCLIDES IN A SERIES OF OCEAN WATER PROFILES AND SURFACE WATER STATIONS IN THE SOUTH PACIFIC OCEAN
T. RAFTER, New Zeal. Dept. Sci. Ind. Res., *Lower Hutt, New Zealand*

2. WATER QUALITY

Investigation of the distribution of radionuclides in a series of ocean water profiles and surface water stations in the South Pacific Ocean (part of a coordinated programme of research in marine radioactivity studies).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0279, ACCUMULATION OF RADIONUCLIDES BY VERTEBRATES

J.P. BAPTIST, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Beaufort, North Carolina* 28516

Estuaries and brackish water areas provide a nursery ground and habitat for many commercially important fish. They also provide receiving waters for waste products, including radioactive effluents from power reactors, hospitals, and laboratories. Marine vertebrates can concentrate radioactive elements which could be harmful to them and render them useless as seafood for man. Since the marine environment is complex and each estuary is different, in some way, from all the others, various factors influencing accumulation must be studied under laboratory conditions.

The objectives of this project are to measure under controlled laboratory conditions, the accumulation and retention of radionuclides by marine fish, to study the importance of various factors which may affect accumulation, and to observe the feeding processes of commercially important fish through the use of radioactive tracer techniques.

Experiments are conducted with several marine fishes such as croakers, Micropogon undulatus, mummichog, Fundulus heteroclitus, pinfish, Lagodon rhomboides, bluefish, Pomatomus saltatrix; and flounder, Paralichthys sp. Accumulation of radionuclides both from sea water and from natural food containing radioactivity in known concentrations is determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

2.0280, ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES

T.J. PRICE, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Beaufort, North Carolina* 28516

The rapid growth of atomic energy industries and the increased use of nuclear reactors for power production have increased the possibility of the contamination of the marine environment with radioactive materials. Also, radioisotopes used in research and medicine may be disposed of in coastal waters, which are habitats for many species of commercial marine invertebrates.

Since many invertebrates are filter-feeders, omnivorous predators, and scavengers, it is probable that these animals come in contact with most components of the ecosystem. If one or more of these components contain radionuclides, it is probable that this radioactivity eventually would become associated with these animals.

Laboratory research is being done to determine the uptake, accumulation, and retention of specific radioisotopes (zinc-65, iron-59, iodine-131 and others) by marine invertebrates, including clams, oysters, scallops, and crabs. From these experiments, one can ascertain the importance of various factors which may affect accumulation; observe the metabolism of specific elements by invertebrates through the use of radioactive tracers, and study the foods and feeding activities of marine invertebrates.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

2.0281, THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH

T.R. RICE, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Beaufort, North Carolina* 28516 (AT(49-7)-5)

Objective: The cycling of elements in the estuarine environment is being followed by observing the movement of radioisotopes in the water, biota, and sediment phases of the estuary. Quantitative data on the cycling of radioactive elements are being taken. With such data, it should be possible to predict the pathways taken by the radioactive elements.

The potential importance of cord grass, Spartina alterniflora, in conveying radioisotopes of zinc, manganese, and iron into estuarine food chains was evaluated. An environmental tracer experiment was carried out in which naturally-occurring fallout radioactivity in the estuary served as the tracer isotopes. In the laboratory the influence of certain environmental factors on the concentrations of zinc accumulated by an experimental community was tested. Finally, the interactions of radiation, salinity, and temperature on the physiology of the estuarine fish, the mummichog, was observed.

Results: Spartina production was found to approach one-third the total phytoplankton net production of adjacent estuaries and is thus potentially important in estuarine food chains. The unusually high iron content (5,000 ppm. dry wt.) of the dead material suggested that Spartina may be especially important in the movement of radioisotopes of iron from water and sediment into estuarine animal populations. Concentrations of gamma-emitting fallout radioisotopes were monitored in Rangia over a 30-mile stretch of river and a salinity range of less than 0.1 to greater than 15 ppt. Ruthenium 106 and ruthenium 103 were concentrated more in Rangia from downstream stations (salinity range 6- 15 ppt), whereas cesium 137 was more abundant in the same species from fresher water (salinity range 0-8 ppt). It was found that a high salinity and zinc concentration suppressed the concentration of zinc 65 in animals and sediment, while high temperature and pH had the opposite effect. In experiments testing the interaction of salinity, temperature, and radiation, it was observed that both salinity and temperature changed the LD-50. Above 20 degrees C. fish were more sensitive to radiation at high salinities, while below 20 degrees C. fish were more sensitive to radiation at low salinities.

SUPPORTED BY U.S. Atomic Energy Commission

2.0282, PRODUCTIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

R.B. WILLIAMS, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Beaufort, North Carolina* 28516

All life ultimately depends on autotrophic organisms. Therefore, knowledge of primary production in estuaries is required for evaluation of their potential to produce commercially important fish and shellfish and for elucidation of the movement of radionuclides through estuarine food chains into edible species. The primary production of phytoplankton and benthic algae, two groups of autotrophs important in the characteristically shallow southeastern estuaries, is being measured at regular intervals in inshore waters near Beaufort, North Carolina. Phytoplankton production is estimated by the light and dark bottle technique. Bottles of seawater (with zooplankton removed by filtration) are incubated for 24 hours at several fractions of surface illumination, and changes in dissolved oxygen are determined by titration. To estimate benthic production, areas of bottom are enclosed (in situ) for 24 hours beneath clear and opaque plastic bell jars, and changes in dissolved oxygen within the jars are obtained by titration of water samples withdrawn from them. In addition, measurements of standing crop accompany the measurements of production.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

2.0283, CYCLING OF TRACE METALS IN THE ESTUARINE ENVIRONMENT

D.A. WOLFE, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Beaufort, North Carolina* 28516 (AT(49-7)-5)

Information on the cycling of trace metals in an estuarine ecosystem is necessary to establish which components of the biotic and abiotic systems serve as reservoirs for these elements. The application of the specific activity concept, which can be used to establish the maximum permissible concentration of certain radionuclides in the aquatic environment, requires a knowledge of the distribution and concentration patterns of stable elements. We have chosen manganese, iron, and zinc for our studies because each of these have neutron- induced radionuclides which are accumulated to relatively high levels by aquatic biota and are present in atmospheric fallout and in discharge waters of nuclear power plants and ships. This research consists of both field and laboratory studies. Our field studies are

conducted in the Newport River estuary and consist of describing the concentrations of manganese, iron, and zinc in estuarine sediment, water, and biota and constructing a budget of the movement of these elements through the estuary as a result of physical and biological processes. Laboratory research deals with the dynamics of exchange of these elements among sediment, water, and biota, so that, ulimately, we will have the information required for the development of prediction equations for the distribution of contaminant radionuclides in the estuarine ecosystem.

Results: Concentrations of manganese, iron, and zinc in sediment and water samples collected from the Newport River estuary decrease in a seaward direction and have considerable temporal variations. Concentrations of these elements in estuarine fish varied with both body size and species. A comparison of physical and biological transport of manganese, iron, and zinc in the Newport River estuary showed that biological export of manganese and iron was less than 0.1 percent of the total import of these elements from river flow. Biological export of zinc, however, was estimated to be about 10 percent of total import.

Part 1 of 3.

SUPPORTED BY U.S. Atomic Energy Commission

2.0284, SEDIMENT MINERALOGY
D.A. WOLFE, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Beaufort, North Carolina* 28516

Sediments have the capacity to scavenge many radionuclides from sea water. There is, however, little agreement as to the effect of this phenomenon on the food web of the sea. Will this scavenging action enhance or reduce the uptake of radioactivity by the biota? If organisms have the capacity to utilize the organic matter in sediments as a source of nourishment, sediment-sorbed activity could be passed along the food web to eventually reach man. Conversely, by adsorbing radioactive materials from sea water, sediments could reduce the possibility of contamination in many pelagic animals.

In order to determine the role of sediments in the cycling of radionuclides in the estuarine environment and to gain some insight into sediment-animal relationships, experiments on sediment-sorption of radionuclides are being carried out in the laboratory and in the field. Observations are made on the capacity of natural sediments and selected clay minerals such as montmorillonite, to scavenge radionuclides (zinc-65, cesium-137, and chromium-51) from sea water of varying salinity. Also, the partition of these radionuclides between the sediments, and biota of outdoor ponds will be studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

2.0285, FATE OF POLLUTANTS IN ESTUARIES AND MARINE BAYS
C.R. OMELIA, Univ. of North Carolina, School of Engineering, *Chapel Hill, North Carolina* 27514

This project will investigate and establish a means for predicting the distribution and effects of particulate and colloidal pollutants in coastal waters.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0286, ENVIRONMENTAL INVENTORY, AQUATIC AND TERRESTRIAL, BELEWS CREEK-BELEWS LAKE, N.C.
C.M. WEISS, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

The environmental impact of a 2.8 megawatt fossil fuel steam power plant on the aquatic environment and surrounding terrestrial environ of a 3000 acre cooling water pond is under study. As the lake is filling and the power plant is under construction detailed baseline studies of the aquatic biota and water chemistry of both the inflowing streams and lake are in progress. Particular attention is being made to nutrient levels in the aquatic environment as well as population characterisitics of the aquatic biota. Detailed botanical transects will be made on shore line areas to establish baselines for long term trends. Aereal mapping of the region is scheduled each year with photographs being made in black and white, true color and reversed color.

SUPPORTED BY Duke Power Company - Charlotte, N.C.

2.0287, WATER QUALITY MANAGEMENT OF IMPOUNDMENTS
C.M. WEISS, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

The proposed investigation will establish potential levels of eutrophication in New Hope Lake following completion of New Hope Dam. This will be accomplished by a systematic water quality sampling in the Haw and New Hope rivers which will fill the basin behind the dam. Both rivers now carry a considerable pollution load. Since the proposed lake will undergo thermal stratification, during summer months, with rapid deoxygenation of deep levels, pilot studies will be carried out on University Lake, the near-by water supply reservoir of Chapel Hill, on which ten years of limnological data have been accumulated, to ascertain methods and procedures for destratification by air-lift or mechanical pumping. The information gathered on University Lake will be extrapolated to New Hope. In Phase II, a second three-year period, a suitably scaled-up installation will attempt to improve water quality by destratification of New Hope Lake.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0288, QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA
E.H. BRYAN, Duke University, School of Engineering, *Durham, North Carolina* 27706

The objective of the proposed research is to determine the relationships between land use and the quality of storm water drainage in an urban area of North Carolina. The drainage basin selected for study will typify the pattern of land use in an urban and urbanizing setting in North Carolina. Quality of storm water from commercial, residential, industrial, public and institutional sub-basins with respect to selected parameters such as alkalinity, pH, chlorides, solids, nitrates, phosphates, pesticides, herbicides, coliforms, biochemical oxygen demand, organic carbon and others will be related to existing and changing patterns of land use. The project will be aimed at furnishing a background of information as to sources and amounts of pollutional substances contributed in a diffuse pattern to natural drainage channels.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0289, ANALYZE PRECIPITATION SAMPLES FOR SELECTED COMPONENTS
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine selected pollutants in precipitation samples.

Approach: To determine those pollutants which are wash-out or incorporated as rain-out, particularly the pollutants which are of interest to NAPCA.

Goal: To determine pH and other pollutants in precipitation in samples collected biweekly at 16 stations.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

2.0290, SOURCE, FATE AND EFFECT OF NUTRIENTS ADDED TO NORTH CAROLINA ESTUARIES
B.J. COPELAND, Univ. of North Carolina, School of Liberal Arts, *Raleigh, North Carolina* 27607

To study the effects of sewage and industrial wastes on the water quality of North Carolina's sounds and estuaries.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0291, NUTRIENTS AND EUTROPHICATION IN A NORTH CAROLINA ESTUARY
J.E. HOBBIE, Univ. of North Carolina, Graduate School, *Raleigh, North Carolina* 27607

A continuation of Project B-004-NC relative to the Pamlico estuary of North Carolina with the following specific objectives: 1. To measure the annual cycle of concentrations of nitrogen compounds (nitrate, nitrite, ammonia, dissolved organic

nitrogen) throughout the estuary as well as some physical and chemical factors that might be influencing these concentrations (e.g., stratification, anaerobic layers). 2. To measure the sources and quantities of phosphorus and nitrogen entering the estuary from the Tar River and other smaller tributaries. 3. To investigate in detail nutrient factors limiting phytoplankton photosynthesis throughout the year and in different parts of the estuary. 4. To follow the spring algal bloom in detail in order to determine, if possible, if this bloom is correlated with recent eutrophication or is a natural phenomenon.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0292, PHOSPHATE MINING EFFLUENT IN ESTUARINE ECOLOGY
D.B. HORTON, Univ. of North Carolina, Graduate School, *Raleigh, North Carolina* 27607

As part of a broader program in estuarine ecology we propose here specific experimental studies of the effluent from phosphate mining operations and its effect on selected component species of the biota. Experiments will be on a scale bridging the gap between observational studies on the estuary as a whole and laboratory studies. At our Estuarine Laboratory a series of pools, and artificial estuaries, will be subject to experimental control, but still much more nearly natural than in the laboratory. This experimental facility will use the phosphate mining operations and the effluent settling basins through experiments described here, with measurements of four principal biological parameters; the bottom fauna; the periphyton, the plankton, and the rooted plants. Immediate experimental questions include: 1. What is the biological activity of untreated effluent of the mining operations as measurable upon these selected components of the biota? This integrates with our present investigations of chemical and physical characteristics. 2. What is the effect on biological activity, of suspended clays (principally Montmorillonite)? 3. Why does settling reduce biological activity of the effluent? 4. What is the effect of differing substrates upon biological activity of the effluent? Present investigations suggest that most primary production takes place on the bottom where we may expect the nature of the substrate to govern the effect of chemicals added to the system. 5. What is the biological effect of effluent from a sewage treatment plant on estuarine ecology, both alone and in combination with effluent from phosphate mining?

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0293, ROLE OF ANIMAL WASTES IN AGRICULTURAL LAND RUNOFF
D.H. HOWELLS, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

The principal project objectives are to (1) investigate the pollutional aspects of agricultural land runoff from confined and unconfined animals growing in well defined small watersheds (2) develop relationships between water quality and environmental factors such as animal pollution and hydrology for application to other areas with similar conditions.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0294, WATER CONTAMINATION BY FERTILIZER NITROGEN AND PHOSPHORUS
J.F. LUTZ, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

The objectives of this project are to determine the direct contribution of fertilizers to nitrogen and phosphorus contamination of surface and subsurface runoff, as affected by: (a) Form of fertilizer applied; (b) Time of application; (c) Rate of application; (d) Crop to which applied; (e) Soil physical and chemical properties; and (f) Meteorological and hydrological conditions. At different times during the period of study, different forms and rates of nitrogen and phosphorus fertilizers will be applied to two completely enclosed watersheds, and to surface runoff plots superimposed on them. Surface losses of nitrogen and phosphorus will be determined by analyzing the soil and water caught in the tanks at the bottom of the runoff plots. Total losses from the watershed will be determined by analyzing the water that passes over the weir at the bottom of the watershed. Soil and plant samples from the watersheds, and water from water wells on the watersheds, will be analyzed.

The two watersheds are on the branch Experiment Station of the North Carolina Agricultural Experiment Station at Waynesville, North Carolina. All analyses will be made in the Analytical Service Laboratory of the Soil Science Department, North Carolina State University, Raleigh, North Carolina.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0295, SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT
J.F. LUTZ, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03043)

OBJECTIVE: Determine draw-down patterns of water table by use of electric analogue. Attempt to measure hydraulic conductivity of undisturbed soil cores and relate it to soil properties. Study nature and magnitude of forces holding water films on clays and relate these to hydraulic conductivity.

APPROACH: Further work will be done on the effects of phosphate on the colloidal-physical-chemical properties of clays especially on the hydration of the clay studies will be made on a number of North Carolina soils with emphasis on field capacity and wilting percentage determination. Soil moisture and bulk density determinations will be made on soils under a number of different cultural management and tillage practices to determine the effects of these different practices upon the properties mentioned.

PROGRESS: A. Studies were made on the residual effects of heavy applications of P on the physical properties of soils. Unfortunately the original check plots (1956-64) were fertilized in 1965 and in 1966, so there is no longer a true check plot. The heavily-phosphated plots still have about the same good physical properties as during the 1956-64 period. Fertilizing the original check plots improved their physical properties, thus eliminating differences between the 'check' and the high-P plots. The high-P plots had high total, and available, water- holding capacities, with the greatest increase being in the loosely held water that would be more readily available. The increase in water- holding capacity is caused by an increase in charge of the clay particles, as shown by work with pure clay minerals. Modulus of rupture of packed briquets was correlated with the ratio exchangeable-Ca/exchangeable-Al. B. Soil physical properties that affect water- holding capacity and water movement in soils have been determined on many of the major soil series in the State. The determinations include total porosity, pore-size distribution, bulk density, and a soil moisture characteristic curve from 0 to 15 bars. This information will be useful in soil management, particularly with respect to irrigation, drainage, and leaching of fertilizers, herbicides, etc. Leaching of the chemicals is important because the losses reduce their effectiveness, and may cause contamination of groundwater. This information will serve as a basis for work currently being done on herbicide and fertilizer losses from soils.

SUPPORTED BY U.S. Dept. of Agriculture

2.0296, NUTRIENT EXCHANGES AND SOURCES OF NITROGEN AND PHOSPHORUS IN THE UPPER SHEYENNE RIVER WATERSHED
F.G. DUERR, State Game & Fish Department, *Bismarck, North Dakota* 58501

Objective: To determine the sources nutrient material entering Lake Ashtabula from the Upper Sheyenne Watershed.

Procedure: Obtain flow data and volumetric exchanges of reservoir waters. Take weekly water samples from Sheyenne Watershed from pre- selected sampling stations. Analyze samples of nitrates and nitrites, total nitrogen, inorganic phosphorus and total phosphorus and miscellaneous inorganic ion. Part 2 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0297, INFLUENCE OF WATER QUALITY IN MAINTAINING WHITENESS WHEN LAUNDERING WHITE FABRICS

C.M. JANECEK, North Dakota State University, Graduate School, *Fargo, North Dakota* 58102

Objectives: (1) To identify the factors that influence the discoloration of white fabrics when laundered in hard water and/or waters containing iron, manganese or organic coloring. (2) To determine methods that prevent discoloration of white fabrics during laundering. (3) To determine whether any of the methods used to retain whiteness cause a decrease in residual strength or cause other undesirable effects.

It is planned to work with State Extension personnel in enlisting cooperating homemakers. Swatches of white test fabric will be given to each cooperator to be laundered a specified number of times. The swatches will be returned to the laboratory for determination of the degree of discoloration. Information on water supply, iron removal and softening equipment, washing agents and methods will be obtained from each cooperator.

After the factors causing discoloration have been identified, various methods for preventing discoloration will be evaluated. These methods include removal of iron, water softening and the use of selected types of bleach and detergent. Laboratory analyses of the swatches will determine whether or not methods used to attain whiteness are detrimental to the fabric.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0298, NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE

J.K. NEEL, Univ. of North Dakota, Graduate School, *Grand Forks, North Dakota* 58201

The primary objective is determination of the effects of weed harvesting upon nutrient level and utilization in a waste enriched lake. The general approach is acquisition of a limnological baseline prior to weed removal and then determination of changes attributable to biomass removal and reduced weed populations. Pre- and post-harvest evaluations will rest upon variation in physical and chemical lake characteristics and weed and phytoplankton populations, primary production by planktonic and attached vegetation, nutrient interactions among water, organisms, and sediments, inflow and outflow of nutrients via surface streams, and overall controls exercised by basic lake and weather conditions. These data should also indicate fundamental consequences of long term enrichment, particularly as affecting lake succession, conditions favoring ascendancy of weeds and phytoplankton, and potential of intra- lake cycling of waste nutrient residues.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0299, THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA

J.R. REILLY, Univ. of North Dakota, Graduate School, *Grand Forks, North Dakota* 58201

This information is designed to investigate the importance of the food chain in the initiation and continuance of epornitics of botulism intoxication among waterfowl and to evaluate possible control methods.

Investigations will involve the following: 1. Examination of natural outbreaks of botulism to determine the type involved, the sources of intoxication and the mechanism of transmission, via the food chain. 2. Determination of the mode of entrance of the organism and its toxin into the food chain. 3. The role of invertebrates in the intraspecific transfer to vertebrates. 4. The possible use of marsh inoculation with B. licheniformis as a control measure to reduce or eliminate botulism epornitics.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0300, THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICRO-ORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE

R.M. PFISTER, Ohio State University, Graduate School, *Columbus, Ohio* 43210

Particulate matter in Lake Erie has been examined on a physical, chemical and biological base and characterized using density gradient centrifugation, and electron microscopy. Microbial portions of the Lake Erie ecosystem are also being characterized on the basis of physiological types. Data from these experiments will be correlated in an attempt to establish cause and effect relationships.

SUPPORTED BY Ohio State University

2.0301, ROLE OF FUNGI & ALGAE IN FORMATION AND HYDROLYSIS OF LAKE ERIE SEDIMENTS

V. SANGER, Ohio State University, School of Biological Sciences, *Columbus, Ohio* 43212

The proposed research involves determining the functional role of algal and fungal cells on both formation of and decomposition of the bottom sediments of Lake Erie. The primary approach in this scheme is to elaborate extracellular polymers synthesized by bloom-forming species of blue-green algae and determine its relation to sedimentation. Also, to critically examine the hydrolytic activities of the fungi on Lake's sediments once they have formed. This project will be carried out along the following lines: 1. Species of 'Nostoc', 'Microcystis' and 'Anaebaena' will be examined under laboratory conditions with regard to elaboration of the polymers, and for the polymer interraction with lake particulates and sedimentation. 2. To isolate and grow aquatic fungi in pure culture to study their hydrolytic activities on the bottom sediments (microparticulates) of Lake, taking several parameters into consideration.

Laboratory results would be tremendously helpful in a definite understanding in the biological role of algae and fungi with reference to bottom sediments of Lake Erie.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0302, CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE

G.O. SCHWAB, Ohio State University, School of Agriculture, *Columbus, Ohio* 43210

Both field and laboratory studies will be involved in measuring the quantity and kinds of soluble and suspended constituents in drainage water from agricultural lands. Precipitation, runoff, soil and air temperature, solar radiation, and other hydrologic factors will be recorded. About eleven common soil chemicals, including nitrogen and phosphorus, and pH, electrical conductivity, atrazine herbicide, and aldrin insecticide in the runoff and in the sediment will be evaluated. In the field studies near Sandusky, Ohio, water samples will be obtained from tile and surface drains installed in one-half acre plots. The land will be cropped in corn with no tillage and conventional tillage practices as variables.

In the laboratory leaching of phosphorus from columns of soil from the field plots will be conducted using various applications of phosphorous. Runoff from small bins containing a fine- and a coarse- textured soil will be analyzed for phosphorous and other ions. The objective of the leaching studies is to identify discrete compounds formed and to determine threshold concentrations where soil contributes phosphorous to lake water.

Water samples taken during the 1969 growing season were high in sediment, and nitrates, but low in phosphorous and dicamba. Atrazine and dicamba losses averaged about 13 percent and 32 percent, respectively, of the amount applied. Water from tile was generally much lower in pollutants than surface water.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0303, A PILOT-SCALE STUDY OF ACID MINE DRAINAGE

E.E. SMITH, Ohio State University, School of Engineering, *Columbus, Ohio* 43212

2. WATER QUALITY

The project activities are designed to establish a systems research approach to the investigation of acid mine drainage. The study will attempt to define the controlling factors and to assess the significance of acidic conditions in abandoned mines, currently inactive ones, and in future mining areas. Attempts will be made to assess the characteristics of acid formation, to establish systems to monitor adequately the variables selected, and to attack the problem with suitable abatement measures.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0304, STRIP-MINING AND WATER QUALITY
J.P. VIMMERSTEDT, Ohio State University, School of Agriculture, *Columbus, Ohio* 43210

Since 1965 when strip mining began on Little Mill Creek Water Shed, weekly samples of storm water have been taken at four sampling points. Two of the points are receiving effluent from the strip mining operation and two are not. The water samples have been analyzed for concentration of manganese, iron, aluminum, sulfate, calcium, and magnesium. These chemical analyses have shown large differences in composition between those sampling points receiving strip mine drainage and those unaffected by these mining operations. Manganese and sulfate concentrations have shown the largest increases.

A sprinkling infiltrometer has been constructed and is being used to measure rate of rainfall in filtration on spoil banks of varied composition.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0305, ENVIRONMENTAL EVALUATION OF A NUCLEAR POWER PLANT
L.S. PUTNAM, State Dept. of Nat. Resources, *Columbus, Ohio* 43212

This study is designed to evaluate the changes in the fish, benthic, and planktonic populations caused by heated-water discharges from a nuclear electric plant.

Collections have been coordinated with the Environmental Protection Agency and the Ohio Geological Survey Study on lake currents. Data collected from June 1, 1969 - May 31, 1971 is in the process of being statistically analyzed and interpreted. Relative abundance and species composition of the fish populations will be estimated. Changes in the populations on a monthly and seasonal basis will be analyzed.

Feeding habits of the fishes as determined by stomach content will be correlated with benthic and planktonic populations near the plant discharge site. Benthic populations will be correlated with substrates.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0306, ENVIRONMENTAL EVALUATION OF A NUCLEAR POWER PLANT
L.S. PUTNAM, State Dept. of Nat. Resources, *Columbus, Ohio* 43212

This study is designed to determine the response of fish and other aquatic animals to heated discharges and relate laboratory estimates to actual changes occurring near a large nuclear powered electrical plant. Temperature preferences of all fishes in the discharge area will be estimated on a seasonal and size class basis. Predictions based on laboratory estimates will be checked during plant discharge.

The effects of sudden temperature shocks within the range of the heated discharge will be studied to estimate the destructive effect of the hot water plume. Standard bioassay tests will be conducted for animals that die as a result of temperature shocks. A wet laboratory at F.T. Stone biology station will be used to test the animals. Handling and adaptation times should be minimized because of the close proximity of the laboratory to the discharge site.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0307, RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION
L.L. HARROLD, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Coshocton, Ohio* 43812 (SWC-027-CCOS-2)

OBJECTIVE: Determine the transport rate of sediment, nitrogen, phosphorus, and selected chlorinated insecticides from agricultural lands into surface and subsurface waters and the transport mechanism thereof.

APPROACH: Develop techniques and equipment for sampling soils, crops, surface runoff, and groundwater recharge and discharge on agricultural watersheds having surface application of selected insecticides and plant nutrients. Relate concentration of pollutants in samples to flow rates. Quantify for various periods total pollutant delivery to surface and subsurface water and relate same to rainfall, soil moisture, soil, geology, and land treatment.

PROGRESS: Great care must be exercised in collecting, preparing, and storing runoff samples to be used in studying the loss of pesticides and other chemicals from agricultural lands. Several individual samples must be collected at variable predetermined time intervals throughout the runoff hydrograph of each storm. Each sample must be related to runoff rate at the time of sampling. A detailed description of the construction and operation of automatic sampling equipment installed on experimental watersheds at Coshocton, Ohio, has been prepared. The equipment remains on a standby basis until the onset of runoff. A predetermined sampling sequence collects samples in 1-gallon glass jugs, which are stored in a refrigerator. Sampling is automatically terminated. Greenhouse and field experiments were conducted in which corn was grown on Muskingum silt loam to which dieldrin had been added. The plants grown in the greenhouse were protected from aerial contamination, whereas no attempt was made to control this in the field. The corn was harvested at maturity and the dieldrin contents of the leaves, stalks, kernels, and cobs were determined. Only slight differences were found between the two experiments in the dieldrin contents of the stalks, kernels, and cobs. But the leaf to stalk ration of dieldrin concentrations in the field-grown plants was 50 times higher than that found in the protected plants. This large difference is attributed to aerial contamination of the foliage.

SUPPORTED BY U.S. Dept. of Agriculture.

2.0308, SPOILS WEATHERING - WATER, SOILS GROWTH
J.P. VIMMERSTEDT, Ohio Agric. Res. & Dev. Center, *Wooster, Ohio* 44691 (OHOO0382-S)

OBJECTIVE: Study the physical and chemical properties of weathering coal spoils: composition of leaching ground water as it changes with time, rain fall distribution between runoff and infiltration, composition of spoil air, variation in spoil temperature with season, depth, and aging, rate of settling of fresh spoil material and change in particle size with spoil weathering determine the spoil factors affecting tree seedling survival growth, and mineral composition.

APPROACH: Continue lysimeter studies and field measures of rainfall. Analysis for chemical composition of leachates collected from lysimeters during 8 years.

PROGRESS: During 1969, we continued collection and analysis of leachate from a battery of lysimeters containing weathering spoil material. The total soluble salt content of the leachate was less than in previous years. All spoil samples, including those initially toxic, now support some plant growth. In view of this, we plan to dismantle the lysimeters and examine the characteristics of the leached spoil material.

SUPPORTED BY Ohio State Government.

2.0309, STRIP-MINING AND WATER QUALITY
J.P. VIMMERSTEDT, Ohio Agric. Res. & Dev. Center, *Wooster, Ohio* 44691 (OHOSS-145)

OBJECTIVE: Determine changes in chemical composition of water in Little Mill Creek following strip-mining for coal; study relationships between reclamation measures and water quality.

APPROACH: Periodic water samples taken at 4 weirs will be analyzed for chemical composition. Three weirs receive water from mined area while one does not. Comparisons will be made between water from mined and unmined area. A portable rainfall simulator will be used to study runoff and erosion from spoil banks, and infiltration of water into banks.

PROGRESS: Chemical analysis of water samples from Little Mill Creek continued. These analyses show large differences in

chemical composition between samples from mined and unmined parts of the watershed. For example, sulfate concentrations at the sampling point nearest the stripmine average 50 ppm higher than those at points unaffected by mining. Even more striking are the very large fluctuations in sulfate concentrations resulting from mining activity. At times, sulfate levels increase to more than 10 times the average level found in the streams receiving mine effluent. The streams unaffected by mining do not have these violent fluctuations. A sprinkling infiltrometer is yielding information relating infiltration rates on stripmines to spoil and reclamation variables. This information will aid in planning improved reclamation methods.

SUPPORTED BY Ohio State Government

2.0310, THE CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PETROCHEMICAL WASTES
J.A. HORN, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

Preparation of a comprehensive report reflecting the status of present knowledge regarding pollutional problems associated with petrochemical wastes discharged to the aquatic environment and the effects of such discharges upon water quality of surface streams and groundwater resources in the United States.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0311, CHEMISTRY OF MINERALIZED WATERS
A.G. COLLINS, U.S. Dept. of the Interior, Bureau of Mines, *Bartlesville, Oklahoma*

This project is oriented toward the development of techniques to permit a better knowledge of the chemistry of mineralized waters. Methods previously developed by this group are used to analyze representative oilfield formation waters for Eh, pH, S ion, thiosulfate ion, SO_4 ion, PO_4 ion, NH_4, Li, Na, K, Rb, Cs, Be, Mg, Ca, Sr, Ba, Mn, Fe2, Fe3, Ni, Cu, Zn, B, Si, As, Se, F, Cl, Br, and I. The data, plus geologic data, and associated petroleum data are correlated and interpreted in reference to origin of the mineralized waters, origin of petroleum, and water pollution. The research has revealed new sources of valuable elements such as iodine and bromine. All the results are published thus establishing mineralized fomation water reference data.

As time permits the solubilities of certain inorganic constituents such as barium sulfate, and strontium sulfate and organic constituents in mineralized waters and determined. These data are very useful in developing better methods to produce petroleum.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

2.0312, GEOCHEMISTRY OF OILFIELD BRINES
A.G. COLLINS, U.S. Dept. of the Interior, Bureau of Mines, *Bartlesville, Oklahoma*

The project is oriented toward the development of knowledge concerning the origin of oilfield brines, how they are related to petroleum and gas, what economically recoverable constituents do they contain, and how to dispose of them so that they will not pollute fresh waters and land. Samples of oilfield brines are obtained from most of the sedimentary basins of the United States and analyzed to determine their chemical and physical characteristics. These data are made available to the National Office of Water Data Coordination so they can be used in pollution control. Additionally, geochemical studies are made with the data through the use of maps and automatic data processing correlation techniques. Significant findings are published to aid federal and non-federal agencies in improving exploration and production techniques, in evaluating brines as sources for valuable and strategic constituents such as iodine, lithium, bromine, etc.

Modern methods of analyzing brines are developed using new types of instrumentation. The project leader is chairman of an American Society for Testing and Materials Section and every effort is made to provide ASTM with acceptable standards for publication, and in addition he works with three task groups to develop acceptable standards for the Federal Advisory Committee on Water Data.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

2.0313, SEDIMENT YIELD IN RELATION TO WATERSHED FEATURES IN THE SOUTHERN PLAINS
P.B. ALLEN, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Chickasha, Oklahoma* 73018 (SWC-014-ECH-3)

OBJECTIVE. Develop procedures for predicting the sources, amount, rate, and character of sediment yield and delivery from agricultural watersheds of varying sizes in the principal physiographic and climatic regions of the area; and determine the effects of upstream watershed protection programs on sedimentation along the main stem of river systems.

APPROACH. Before and after basin treatment collect and analyze sufficient floodwater samples to define continuous suspended sediment transport by size ranges at enough gaging sites to accomplish objectives. Compute unmeasured load with one or more of the applicable methods. Use available flow, land use, cover, and rainfall data to relate variables. Periodically survey reservoir ranges for sediment accumulation; determine inflow with continuous stage record; determine trap-efficiency with occasional outflow water samples.

PROGRESS. Of the land uses being studied it appears that overgrazed rangeland and rangeland in poor condition are the major sediment production areas. Sizable reductions in sediment yield occurred on each of four watersheds when flood retarding reservoirs were installed. The magnitude of the reduction varied from 40 to 60 percent. Due to inherent inaccuracies in the analysis methods and the short period of data, reduction magnitudes must be viewed with some reservation. The fact that general agreement was found by two computational procedures lends some credulence to the findings, however. On Winter Creek some of the yield reduction resulted because channel bank erosion was stopped by the regulated flows through the reservoirs. Although reservoirs greatly reduced yield at the Sugar Creek gaging station, no change could be detected on the Washita River. The sanded-in Sugar Creek channel caused most of the transport to be spilled on to the flood plain before it reached the river. Sediment transport on the Washita River sharply increased when the Sugar Creek channel was dredged.

SUPPORTED BY U.S. Dept. of Agriculture

2.0314, EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS
R.G. MENZEL, U.S. Dept. of Agriculture, Agriculture Water Mgt. Lab., *Durant, Oklahoma* 74701 (SWC-027-EC-1)

OBJECTIVE. Determine when, under what conditions, and what extent the use of agricultural chemicals is impairing the quality of our water resources; develop practices to minimize the movement of contaminants into ground and surface waters.

APPROACH. Studies will be conducted in laboratories for the development of principles and concepts which will then be tested on field plots or small watersheds. Soil and water samples from treated plots and watersheds will be collected and analyzed to determine loss of chemicals by runoff. Soil profiles of selected areas will be sampled and analyzed to assess the effect of past management practices on the movement of nitrate and other contaminants through soil.

PROGRESS. The three staff members of the U.S. Agricultural Water Quality Management Laboratory occupied the newly completed buildings during the closing weeks of 1969. Therefore, accomplishments during 1969 were mainly in research planning, recruitment, and instrumentation of the Laboratory rather than in technical results. Goals for the Laboratory research program are: (1) a continuing national evalutation of potential agricultural soil and water pollution problems; (2) establishment of reliable sampling and processing methods for field studies on such pollution; and (3) obtaining field data on movement of agricultural chemicals through cooperation with various locations of the Soil and Water Conservation Research Division. Attempts are being made to recruit scientific and support staff within strong personnel and financial limitations. Because of these limitations, most recruitment involves potential transfers of Division personnel. An agricultural engineer and a biochemist will join the staff in June, 1970. Instruments that have been installed and tested include a radiation analyzer, spectrophotometer, atomic absorption flame

photometer, microscopes, and pH meters. Work has started on the design of a moisture flux meter which is to be used in studies on movement of agricultural chemicals in ground water.

SUPPORTED BY U.S. Dept. of Agriculture

2.0315, PLANKTON PRODUCTIVITY OF LAKE ATITLAN, GUATEMALA, IN THE TROPICAL SAVANNA HIGHLAND OF CENTRAL AMERICA
T.C. DORRIS, Okla. St. Univ., Graduate School, *Stillwater, Oklahoma* 74075

This is a study of productivity and structure of the plankton of Lake Atitlan, Guatemala, a large, highland lake in the tropical savanna of Central America. The lake was formed as a result of volcanic activity. Tropical lakes are expected to be very productive because of the potentially large solar influx and the year-round uniformity of temperature. Development of a major hydroelectric project in the near future will bring river flows into the lake to replace the water taken out for generation. It seems likely that the clarity of the lake will be greatly changed, with consequent changes in the biotic populations. The sampling program will be completed about twice each month. Information will be obtained on solar input and penetration, air and water temperature, precipitation, phosphorus, nitrate, silicate, dissolved oxygen and carbon dioxide, pH, alkalinity, plankton pigments, plankton populations, primary productivity and community respiration by in situ and light-dark bottle oxygen measurements.

SUPPORTED BY U.S. National Science Foundation

2.0316, SEPARATION AND IDENTIFICATION OF TOXIC COMPOUNDS IN OIL REFINERY EFFLUENTS
T.C. DORRIS, Okla. St. Univ., Water Resources Research Inst., *Stillwater, Oklahoma* 74075

Toxic organic compounds will be removed from oil refinery effluents by steam distillation, liquid-liquid extraction, and adsorption on activated carbon. Toxicity of these fractions will be evaluated with bioassays. The toxic fractions will be resolved into individual compounds by chromatographic techniques and the resolved compounds identified with a combination gas chromatograph-mass spectrometer and/or infrared spectroscopy. Toxic cations will be quantified by atomic absorption spectrophotometry.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0317, BENTHAL SULFIDE RELEASE IN AQUATIC SYSTEMS
D.A. BELLA, Oregon State University, School of Engineering, *Corvallis, Oregon* 97331

The objectives of the proposed study are: 1. To modify the methods of sample collection and free sulfide analysis developed by the investigators of this proposal so that these methods might be effectively utilized by regulatory agencies, 2. To investigate the extent of significant benthal free sulfide release within a variety of aquatic systems and, 3. To attempt to gain federal funding for a more comprehensive study into the causes, extent and methods of control of benthal free sulfide release. (Objective 3, will only be done if the results of objective 2 indicate that benthal free sulfide release is significant.)

The release of free sulfides from tidal flat deposits into overlying waters has recently been investigated. It was found, under certain conditions, the free sulfide concentration in the overlying waters often exceeded, by significant amounts, levels found to be toxic to many desirable species. Significant free sulfide concentrations were often measured in waters which contained 4-6 mg/L of dissolved oxygen or more. These results indicate that free sulfides released from benthal deposits may often be a more serious water quality problem than the benthal oxygen demand. An extensive literature search has demonstrated that, while benthal oxygen uptake has received a considerable amount of study, benthal sulfide release has been almost totally ignored.

The 'Ten-Year Program' points to the need for detecting and identifying pollutants in water if water quality is to be managed properly. The effect of free sulfides on Oregon's many lakes, streams, reservoirs, and estuaries is not clearly understood.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0318, USE OF REACTOR COOLING WATER FROM NUCLEAR POWER PLANTS FOR IRRIGATION OF AGRICULTURAL CROPS
L.L. BOERSMA, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The proposed research plan involves laboratory investigations directed at determining the feasibility of using water heated in nuclear power plants for irrigation of agricultural crops. The main approach in the proposed investigations is to determine the influence of soil temperature and heated water on rates of photosynthesis, transpiration and respiration under controlled laboratory conditions.

Methods employed are: A special experimental arrangement has been designed in which soil water content and soil temperature can be maintained constant or can be varied at a programmed rate. Above ground conditions can be maintained constant or can be varied at a programmed rate independent of below ground conditions. The rates of photosynthesis, transpiration and respiration can be monitored on a continuously recording basis or measured at certain time intervals. The experimental arrangements provides for the simultaneous observation of 36 separate plant systems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0319, REACTOR COOLING WATER FOR AGRO-INDUSTRIAL DEVELOPMENT THROUGH SOIL WARMING
L.L. BOERSMA, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The proposed research plan involves laboratory and field investigations directed at the determination of the potential use of cooling water from nuclear power generating stations in agriculture. The main objective of the investigations is to measure the temperature and moisture regimes in soils with buried pipes through which warm water is flowing. Results will be analyzed to arrive at design criteria for the construction and operation of an underground pipe network for maximum heat disposal efficiency and optimum plant growth.

Laboratory investigations would employ the following methods: 1. Simultaneous transfer of heat and water would be measured in soil slabs where both heat and water are added to the soil from a point source below the soil surface. 2. Mathematical models would be developed for the predictions of heat and water movement for a range of soil physical and meteorological conditions.

Field investigations would involve experiments designed to verify laboratory results under field conditions and to compare crop growth on plots with different thermal and moisture regimes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0320, ECOLOGICAL AND RADIOECOLOGICAL STUDIES IN THE COLUMBIA RIVER, THE ESTUARY AND THE ADJACENT PACIFIC OCEAN
N. CUTSHALL, Oregon State University, School of Science, *Corvallis, Oregon* 97331 (AT(45-1))

This project involves studies of radionuclide and trace element cycling in the Columbia River system. The overall objective is to increase understanding of the dynamic partitioning of trace materials between solution, sediment and biota in fresh, brackish and seawaters. This objective is sought in two ways, through direct measurement of radionuclides and trace elements in various phases of the system and through mechanism-route inferences drawn from these direct measurements coordinated with measurement of other ecologic' parameters.

Sorption onto suspensoids and bottom sediments affects availability of trace materials to organisms and transport rates. Sorption mechanism determines the liklihood for subsequent desorption when new conditions are encountered. Flow rates and mixing rates must be known as they affect distribution of trace materials. Living organisms are important not only as a focal point but also as they influence trace materials cycles directly.

Population structure and variability in pelagic and nektonic communities and relationships of these communities to the physical environment are being elucidated.

Important reservoirs for Zn65, Cr51, Co60, Mn54 and Sc46 in the Columbia River system have been identified and some of the transfer routes determined. These radionuclides have been used to estimate rates of ecological processes such as: flow, biological utilization and transport of suspensoids and to estimate food-chain transfer efficiencies for isotopic trace elements.

SUPPORTED BY U.S. Atomic Energy Commission

2.0321, STUDIES ON EFFECTS OF WATERSHED PRACTICES ON STREAMS
J.D. HALL, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

Objectives of this study are to determine the effects of timber harvest practices on the physical and chemical characteristics of coastal streams and on fixation of energy by stream periphyton and inflow of organic detritus. Mean levels and variabilities of suspended sediment discharge, stream temperature, net solar radiation, chemical water quality, primary production by periphyton, and inflow of plant detritus will be established during a two year pre-logging period 1966 through 68. Studies will continue during logging in 1966 and for two years after harvest.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0322, EFFECT OF WATERSHED PRACTICES IN COASTAL STREAMS
J.D. HALL, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00526)

OBJECTIVE: Determine relationships of land use practices to quantity and quality of water and to biotic resources of coastal streams, determine if land use practices can be modified in order to increase and improve water sources in coastal watersheds.

APPROACH: Cooperate in pilot soil-vegetation survey (resource inventory) of Alsea River watershed led by Soils Department, Oregon State University. Conduct study of the effects of timber harvest upon the physical-chemical and biotic resources of three small coastal streams. Conduct water resource inventory of major Alsea River tributaries, obtaining base data for watershed research.

PROGRESS: Rapid regrowth of vegetation on the slopes and along the stream in the completely clearcut watershed has caused an amelioration of the severe environmental conditions noted after logging in 1966. Stream temperatures have moderated significantly, the maximum temperature noted in 1967 was 85 F, 1968 - 80 F, 1969 - 75 F. Suspended sediment levels were reduced in the 1968-69 winter in comparison with the first two winters following logging. Hydrologic research has indicated that a significant increase in peak flow for a given rainfall intensity accompanied clearcutting of the large watershed, Needle Branch. Lesser effects were noted on the patch-cut units in Deer Creek. A study of changes in the intragravel environment following logging was completed during the year. Dissolved oxygen levels in the gravel water were significantly lower on Needle Branch than in Deer Creek. Fluctuations in the temperature of intragravel water paralleled those of surface water in the completely clearcut stream, but were significantly reduced in magnitude. The resident population of cutthroat trout in the clearcut stream showed a significant increase this year, after three years at about 75% of their prelogging abundance, but the level was still below the unlogged mean. Outmigrant cutthroat, also reduced for two years following logging, have increased in abundance in the last two years to higher than pre-logging levels. The Coho salmon seaward migrants continue to show no significant effects of the clearcut logging.

SUPPORTED BY Oregon State Government

2.0323, SEDIMENT-WATER-BACTERIA INTERACTION IN EUTROPHICATION
R.Y. MORITA, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Current research is oriented toward towards the basic contributions of microorganisms in the water and sediment to the process of eutrophication--mainly in terms of recycling of matter so that they will be available for the photosynthetic forms. In Upper Klamath Lake, Aphanizomenon flos-aquae is the dominant photosynthetic organism. Unfortunately, we have not been able to obtain a bacterial free culture of this organism. By employing C^{14} compounds, we have been able to determine the rate of microbial activity on amino acids, glucose and glycollic acid; that is the flux status of these compounds. New techniques have been developed to determine the rate of respiration in relation to these compounds as well as their incorporation. We are currently trying to develop new techniques so that we can determine the rate of activity of microorganisms in the sediment.

We have also been able to demonstrate phosphate solubilization by bacterial action as well as by cryptic growth along with the ability of many of the bacteria to hydrolyze RNA and DNA which are the main phosphate organic molecules. Many of the organisms have been shown to produce B12 and most of the bacteria associated with the blue-green algae do produce B12. B12 is never limiting in this lake as it is found in sufficient amounts both in the water and sediment.

This project was started on April 1, 1968 and the grant terminates March 31, 1971. Unfortunately, this study cannot be completed within the three year period of this grant and renewal will be requested when the appropriate time arrives.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0324, SEDIMENT-WATER-BACTERIA INTERACTION IN EUTROPHICATION
R.E. PACHA, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00895)

OBJECTIVE: The major objective is to investigate the microbial activity in lake sediments to determine the effect of this activity on eutrophication. In particular it is of interest to define the importance of bacteria found in bottom muds in the recycling of plant nutrients between sediments and overlying water.

APPROACH: The vertical and horizontal occurrence of various physiological types of bacteria in the bottom sediments of upper Klamath Lake, Oregon will be determined. From the bacteria isolated in the field studies, a few of the organisms will be selected and their activity on the substrates in the sediments investigated. The effect of environmental parameters on the activities of the organisms will also be examined.

PROGRESS: The various physiological types of bacteria present in a natural eutrophic lake (Upper Klamath) have been completed. The vitamin B(12) and phosphate problems have been investigated and it appears that these are not limiting in a natural situation. B(12) is produced by many isolates from the lake as well as those contaminating Aphanizomenon flos-aquae. A bacterial free Aphanizomenon has not been obtained as yet. Cryptic growth of bacteria releases phosphate. Isolates from the lake can dissolve various phosphate minerals to release phosphate. We are looking at the organic flux in the lake also.

SUPPORTED BY Oregon State Government

2.0325, THE AUTECOLOGY OF SOME BLUE-GREEN PLANKTON ALGAE
H.K. PHINNEY, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Autecological and synecological studies using both uni-algal and mixed cultures of selected species important in nuisance blooms. The study will determine 1) requirement for major and minor nutrient minerals, 2) effects of naturally occurring organic nutrients, and 3) possible biotic effects as antagonism and synergism or competition in mixed cultures.

Analysis of the effects upon growth of the factors under consideration will be by the following determinations: 1. Dry weight. 2. Percent organic matter. 3. Caloric value. 4. Pigment content. 5. Dry solids by interferometry. 6. Direct mineral analysis, and 7. Direct determination of production rates.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0326, SOIL STABILIZATION AND RUNOFF REGULATION IN CONIFER WATERSHEDS OF WESTERN WASHINGTON AND OREGON

J.S. ROTHACHER, Oregon State University, U.S.D.A. Pac. Nw. Forest Sta., *Corvallis, Oregon* 97331 (PNW1602)

OBJECTIVE: To determine how logging methods, road construction, and forest management practices can be improved to curtail erosion, prevent channel impairment, maintain water quality, and regulate quantity and timing of runoff.

APPROACH: The project will study erosion production and mass soil movements resulting from logging and road building; quantity and timing of runoff; and water quality. Various cutting methods will be investigated to determine their comparative effect on streamflow, soil movement, sedimentation, and chemical quality of water. Forest management in the Douglas-fir region will be studied in relation to soil moisture and water yield.

PROGRESS: In the conifer watersheds of western Washington and Oregon vegetation is a key factor that the land manager can control to protect the soil and water resource. Successful land management requires an understanding of the successional and environmental relationships of the various plant communities. Logging and slash burning of mature forests drastically modify the existing vegetation and establish a changed environment for a new succession of plant communities. Fortunately, regrowth is rapid in western Washington and Oregon where vegetation cover was found to reach almost 50 percent by the end of the second growing season. During the first years after logging and burning, elimination of vegetation that previously shaded the stream channel resulted in increased maximum water temperatures during the summer. June, July, and August maximum increases in water temperatures may exceed 12 to 14 F. Vegetation plays an important role in maintaining infiltration of water into the soil mantle. The soil characteristics influence the hydrologic properties of the soil including retention and detention storage of water. Research results from small experimental watersheds in western Oregon showed that the single most important factor causing variation in storage capacity was the stone content of the soils. Transpiring vegetation utilizes the soil water during the dry summers characteristic of the Pacific Northwest. Maximum storage capacity available at the end of the dry season is estimated to range from 30 to 40 percent of the total retention capacity values for the soils studied.

SUPPORTED BY U.S. Dept. of Agriculture

2.0327, INFLUENCE OF LOG RAFTING ON WATER QUALITY

F.D. SCHAUMBURG, Oregon State University, School of Engineering, *Corvallis, Oregon* 97331

Water storage of logs is a common practice in the Pacific Northwest. Pollution problems associated with such storage practices have been the subject of a three year study in the Department of Civil Engineering of Oregon State University.

During the first two years of the project, controlled laboratory experiments and well-defined field studies were undertaken to identify types and quantities of pollutants resulting from individual log segments and small groups of logs.

The remaining year will be used (a) to determine the magnitude of the storage problem in the Pacific Northwest and (b) to evaluate the actual degradation of water quality resulting from storage at three selected sites in the region. The methodology and information generated during the first two years of research will be extrapolated to field situations.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua Adm.

2.0328, IMPAIRMENT OF THE FLAVOR OF FISH BY WATER POLLUTANTS

D.L. SHUMWAY, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The objectives of the project are 1) to develop appropriate standard methods for the evaluation of the flavor-imparting capacity of freshwater contaminants (organic compounds) and 2) to determine the flavor-imparting capacity and degree of flavor impairment of a substantial number of organic compounds that may be capable of imparting objectionable flavor or odor to the flesh of fish.

The project plan of investigation has two distinct phases. The first phase encompasses a construction period (2 months) and a methodology evaluation period (10 months). During this phase 5 organic compounds (o-cresol, 2,4-dichlorophenol, pyridine, n-butanol, and n- butyl mercaptan) will be used in tests designed to determine threshold concentrations, degree of flavor impairment and the influence of light conditions, pH, oxygen concentration, and temperature on these. Also, the rates of pickup and loss of each of these compounds will be studied. During Phase 2, the standard testing procedure deemed most appropriate in phase 1 will be utilized to determine safe levels (do not impart flavor to fish flesh) for 80-100 organic compounds. The second phase will require two years to complete. Rainbow trout and largemouth bass will be used as test animals.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0329, EVALUATION OF PROPERTIES AND QUALITIES OF OREGON SOIL SERIES

G.H. SIMONSON, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00476)

OBJECTIVE: Provide for Oregon soil series a reliable estimate of: properties, such as field morphology, other significant physical and chemical properties, and mineralogy, and qualities such as crop yield potential, fertilizer response, irrigation and drainage behavior, natural vegetation, slope stability, etc.

APPROACH: Compilation of existing characterization and interpretive data from many scattered sources, and organization of the data into a systematic file. Consultation and assistance in planning and execution of research related to soils to achieve selection of experimental and sample locations typical of important soil series. Determination of properties and qualities of selected benchmark series and publication of reports of these data. Identify and map soils of existing experimental areas and sites. Preparation of the list estimate of the properties and qualities of all Oregon soil series.

PROGRESS: Samples were collected for chemical, physical and mineralogical characterization. The results will be useful in making genetic and use interpretations of the soils and used in survey reports for Washington and south Wasco County. The Washington County sample sites were selected according to geomorphic surface to be used for study of landscape-soil relationships in cooperation with project 568. The following samples were collected: 1. profiles of the Fronhofer, Boardtree, Currant, Era, and Day series from Jefferson and Wasco counties. 2. Profiles of the Laurelwood, Helvetia, Kinton, Aloha and Woodburn series from Washington County. A study of septic tank drain field performance in Benton County was started on the Amity, Woodburn, and Willamette series. Effluent dispersal and water table effects were studied. Permeability tests were run by auger hole and double-tube methods for comparison. A more accurate evaluation of septic tank suitability in these soils is expected. A report was prepared for the soil survey of Section 5 Experiment Station in Harney County.

SUPPORTED BY Oregon State Government

2.0330, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

V.V. VOLK, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The objectives of the project are to identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to 1) pesticide transport through the soil in infiltrating water, and 2) pesticide desorption from eroded soil into surface waters.

Soils have been collected and characterized. Desorption and adsorption studies have been completed with 2,4-D on several Oregon soils. Picloram adsorption studies on nine Oregon soils as a function of surfactant concentration have been complete.

SUPPORTED BY Oregon State Government

2.0331, RADIONUCLIDE CYCLING IN NATURAL POPULATIONS OF AMPHIBIANS

D.L. WILLIS, Oregon State University, Graduate School, *Corvallis, Oregon* 97331 (AT(45-1))

Objectives: Amphibians are important links in both terrestrial and freshwater food chains. Thus, any concern for radionuclide cycling in terrestrial and freshwater ecosystems must include some consideration of their role. The objective of this study is to determine the patterns of uptake, retention and tissue distribution of ecologically important radionuclides in selected amphibians. This involves both laboratory and field studies, so that the effects of natural environmental factors on the metabolism of these radionuclides may be ascertained. The results of this study should serve to clarify the relative importance of amphibians in the transfer of radionuclide contaminants in freshwater communities.

Procedures: Newts (Taricha granulosa) are field-collected. Uptake of Cr51, Mn54, Fe59 and W181 from both labeled food and skin absorption from water, as well as subsequent retention, will be determined by periodic assays with a whole-body counting system. Biological half-life values and loss rate constants will be computer calculated from these data. Serial sacrifice of labeled animals will be used for tissue distribution determinations of the above nuclides and a beta-emitter, such as tritium.

RESULTS: Long term retention of Zn65 in two new newt species has been traced. In addition, extensive studies of uptake from water and/or food, whole-body retention, and patterns of tissue distribution in the newt (Taricha granulosa) for Mn54, Co60, Zn65, Sr85, Rb86, I131 and Cs134 have been completed. Techniques of solubilizing tissues containing tritium for liquid scintillation assay have been developed.

SUPPORTED BY U.S. Atomic Energy Commission

2.0332, EUTROPHICATION - EFFECT OF FLOW AUGMENTATION

A.F. BARTSCH, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

The immediate objective is to determine the effect on algal bloom production when a nutrient-rich lake is flushed with nutrient-deficient water. Ultimate objective is to decrease or eliminate algal blooms in Moses Lake, Washington. One of three branches of the lake will be flushed with low-nutrient water while the others remain as controls. After flushing during August and September, 1968, a year of no water diversion will follow to permit determining persistence of improvement. This approach will evaluate flushing as a remedial tool and will indicate the periods of future water diversion needed to permanently prevent bloom formation. Principal parameters to be investigated are as follows: 1. Water current studies at selected sites and depths. 2. Water budget studies at selected sites and depths. 2. Water budget studies to determine extent and efficiency of flushing. 3. Turbidity measurements and suspended solids analysis. 4. Chemical and physical parameters to determine existence and character of thermal stratification and also environment for algae. 5. Qualitative and quantitative determination of algae, including measurements of phytoplankton pigments, biomass, and species diversity. 6. Chemical analyses and oxygen demand studies of bottom muds.

Basic data collection and analyses will be conducted cooperatively by FWPCA and University of Washington personnel. Other cooperators will be the Bureau of Reclamation and a citizens group in the city of Moses Lake, Washington.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0333, EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS

A.F. BARTSCH, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

The objective is to determine if living organisms can be found which will harvest nuisance algae through grazing, or reduce them through disease and parasitism. A literature review will be made to determine the prospects for success and to identify North American or other species as prospective candidates for grazing trials. Promising animals will be evaluated in the laboratory or field as appropriate.

It was the consensus of most scientists attending the recent International Eutrophication Symposium in Madison, Wisconsin that this is a potentially fruitful area of research. It was felt that a biological control measure for algae could be found if sufficient effort were expended. This has not been done to date.

Much of the effort in the F. Y. 1968 will be desk work to learn what has been done by other researchers and to determine who might be interested in doing work with grant research funds. Other activities will include preliminary laboratory evaluation of grazer candidates.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0334, EUROPHICATION - PHYSICAL ECOLOGICAL CONTROL

A.F. BARTSCH, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

The objective is to determine if algal production can be inhibited by preventing thermal stratification of a lake. Prior destratification experiments have sometimes decreased and other times increased primary production. Because of this seeming paradox, it is necessary to understand this phenomenon and to utilize it if possible, as a means of preventing algal bloom formations. If total algal growth can indeed be retarded by mixing, it is necessary to learn if a lake has to be turned over every year or at lesser or greater intervals to give permanent relief.

Principal areas of investigation will include: 1. Measurements of water movements at selected sites and depths in a lake. 2. Measurements of chemical and physical parameters that are of importance to algal growth. 3. Measurements of algal growth.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0335, MARINE BIOLOGICAL ASSESSMENT OF POLLUTIONAL FATE

D.J. BAUMGARTNER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

In almost every pollution situation, a major consideration is the impact of the degraded water quality on the organism. This is especially true where it is suspected that the pollutant will harm aquatic organisms of primary importance to man. Interpretation of bioassay tests is complicated by the fact that there has been very little information obtained to relate the controlled observations in the laboratory experiments to the actual conditions existing in the environment in the absence of pollution. Attempting to overcome some of these difficulties, investigators have begun to consider and apply in situ bioassay procedures.

The difficulties associated with this research are related to selection and maintenance of the test animals, of knowledge of their population dynamics in thh natural unpolluted environment, and determination that the observations obtained under the test conditions are due to a pollutional stress rather than artifacts of the experimentation.

The first step in developing a series of procedures for analysis of problem areas is determining the amount and type of information necessary to describe the natural environmental populations. This developmental work is being tried on Yaguina Bay, Oregon, along two approaches.

Information on fish usually associated with bottom or midwater habitat will be obtained at each of ten sampling stations every two weeks by means of a trawl. Continuous recording of salinities on the surface at six stations convering the trawl areas will also be provided. In addition, weekly profiles of dissolved oxygen, temperature and salinity will be provided. Samples will be obtained for organic carbon analysis or PBI's or other appropriate analyses to detemine possible pollutants. It will be possible to test some of the methods of analysis after collection of data for one year. The second method of observation pertains to collection of crustacea in standardized substrate boxes and on substrate media suspended in the water column. These samples are analyzed after exposure to the environment for five weeks. Sub-samples of the organisms obtained in both methods will be analyzed for maturity, weight distribution, and stomach contents.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0336, EUTROPHICATION - SEDIMENT-WATER INTERCHANGE STUDIES
L.P. SEYB, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

Objectives are to determine mechanisms, rates and conditions by which algal nutrients in lake sediment interchange with overlying water and to treat lake sediment to prevent interchange. Sediment will be removed from the lake and tested for its nutrient release capacity in the laboratory. While most ion exchange work on soil has been done with cations, techniques for this do not take into consideration the possibility of anion exchange with humic and other materials present in organic soils. Ion exchange capacity of lake sediment with reference to anions containing phosphorus and nitrogen will be examined. Because the amount of humic acids in bottom deposits is a measure of the degree to which organic substances are stabilized in sediment and since dehydrogenase content of sediment is a measure of the extent of biological breakdown of organic substances, both parameters will be measured. Also, we may measure the vitamin B12 content since it has been proposed that this vitamin results from bacterial action in sediment.

Small areas of Klamath Lake which have shown dense algal blooms in past years will be isolated from the main body of the lake and used to determine the influence of sediment-water interchange on algal production and to evaluate procedures intended to prevent or impede interchange.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0337, POWER PRODUCTION
B.A. TICHENOR, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

The project staff acts as a 'core group' for coordinating the FWPCA's national research effort in the area of thermal pollution resulting from power production. Two activities are presently underway: 1. Development of a mathematical model and associated computer program for the prediction of water temperatures in the Columbia River from Grand Coulee Dam to Bonneville dam. 2. Preparation of a 'state of the arts' document describing the present and future problems, present and proposed solutions, and research needs in the area of thermal pollution from power production, with special emphasis on nuclear power plants.

Future plans include either 'in-house', contract, or grant research in the areas of: 1. Reservoir temperature prediction techniques (including stratification, density currents, release temperatures, design considerations for multiple level outlets, operating schedules for optimum downstream thermal conditions, etc.). 2. Dispersion of heat from power plant heated effluent outfalls, 3. New designs for cooling apparatus for thermal power plants, including improvements in methods such as cooling towers, cascades, sprays, cooling ponds, etc., 4. New operating methods or design changes for thermal power plants to produce cooler effluent, 5. Effect of heat on the biological, microbiological, and chemical quality of water.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0338, EUTROPHICATION - EFFECT OF WEED HARVESTING
A.F. BARTSCH, U.S. Environ. Protection Agcy., Office of Water Programs, *Corvallis, Oregon* 97330

The principal objective is to evaluate aquatic vegetation harvesting as a means of effectively reducing algal nutrient availability. Harvesting and removal of aquatic vegetation is one of the potential control measures in combating eutrophication of bodies of water. It is a means of 'cropping off' part of the excess nutrients. Although weed harvesters have been used in the past, no really scientific investigations have accompanied their use. In cooperation with the Pelican River Watershed District, Minnesota, City of Detroit Lakes, and University of North Dakota the effectiveness of the procedure will be evaluated. Attempt will be made to answer such questions as: 1. What is the amount of nutrients actually removed from a lake by weed harvesting? 2. What happens to the energy flow of nutrients that originally went into the plant growth? 3. What is the pattern of regrowth of the vegetation after harvesting and do other species replace the original ones? 4. Does the phytoplankton population change after the higher aquatic plants are removed?

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0339, THE MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY
D.W. HUBBELL, U.S. Dept. of the Interior, Geological Survey, *Portland, Oregon* 97208

Certain radionuclides enter the Columbia River from the Hanford installation of the U. S. Atomic Energy Commission. Part of the radionuclides remain in solution in the water, part are sorbed on the fluvial sediment, and part are taken up by the biota. As a result, each medium, by virtue of its motion, affects the distribution of the radionuclides.

Objectives of this project are to define the disposition and movement of radionuclides in the Columbia River estuary; to study the processes that influence the movement of radionuclides, particularly the sedimentation, flow and chemical processes; and to contribute to estuarine technology.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0340, HYDROGEOLOGY AND THE EFFECTS OF ACID COAL-MINE DRAINAGE ON GROUND WATER IN TOMS RUN, CLARION COUNTY, PENNSYLVANIA
G. MERRITT, State Bur. of Sanitary Engin., *Harrisburg, Pennsylvania* 17105

Available upon request. Coal mining and oil- and gas-well drilling have adversely affected ground-water quality. Detailed knowledge is not available as to the changes in chemical quality and the areal extent of these changes.

The ground-water flow system was delimited in a small drainage basin in which there were oil and gas wells and abandoned strip coal mines and deep coal mines. Water samples were collected to determine the chemical quality of the groundwater systems and to determine the effects and extent of pollution.

SUPPORTED BY Pennsylvania State Government

2.0341, SANITARY LANDFILLS IN COAL STRIP MINES
G.H. ENRICH, State Dept. of Health, *Harrisburg, Pennsylvania* 17120

Four operating sanitary landfills in the coal strip mines and one in a similar hydrogeologic setting have been drilled to determine the effect the landfills have on the underlying ground water and nearby surface waters. Wells were drilled through the landfill, immediately adjacent to the landfill in the direction of ground water movement, half way between the landfill and near by stream and a well removed from the landfill for background ground water quality. Samples of water were analyzed to determine the effects of the landfills. Leachate from landfill located above the ground water primarily moved laterally on discharge to the surface, having little or no affect on the ground water. Leachate from landfills located in ground water adversely affected the ground water in the immediate vicinity of the landfill. Sampling of the wells is continuing to determine seasonal and time variations.

SUPPORTED BY Pennsylvania State Government

2.0342, DELAWARE ESTUARY SEDIMENTATION STUDY
D.W. MOODY, U.S. Dept. of the Interior, Geological Survey, *Harrisburg, Pennsylvania* 17104

Sediment transport processes in the Delaware estuary are being studied to determine the rate of shoal development. Measured sediment loads delivered to the Delaware estuary by Coastal Plain streams are much less than the annual estimated volume of estuarine sedimentation. Therefore, other sources of sediment must be identified to balance the sediment budget.

Salinity, sediment concentration, turbulence, and many other parameters are known to affect the rate of sediment flocculation. However, little is known about the quantitative effects of the environment upon sedimentation rates. Through field and laboratory experiments the most significant parameters will be identified; these parameters will then be related to rates of sedimentation measured in the field. Results of this study will be used to estimate changes in the present shoaling pattern due to man-made modifications of water quality and the physical geometry of the estuary.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0343, POLLUTION OF SUBSURFACE WATER BY SANITARY LANDFILL

A.A. FUNGAROLI, Drexel University, School of Engineering, *Philadelphia, Pennsylvania* 19104

This study has as its overall objective the establishment of criteria for choosing landfill sites and the development of computer models for use in landfill design and evaluation. There are three long- range objectives: 1. To provide means for predicting the quantitative movement of contaminants to ground water from present and proposed sanitary landfills. 2. To appraise design methods and remedial procedures for reducing any undesirable contaminant movement to within specified limits. 3. To develop hydrologic criteria for evaluating site suitability for sanitary landfills.

An overall objective of this project is to meet these aims by development of mathematical design models that describe the hydrologic functioning of and the contaminant movement from a sanitary landfill in varied geological environments.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0344, SELECTED URBAN STORM WATER RUNOFF ABSTRACTS

U. SCHOENBACH, Franklin Institute, *Philadelphia, Pennsylvania*

The Contractor will catalog, expand and update 'Storm Water Runoff from Urban Areas' April 1966, by compiling selected abstracts from published and unpublished literature covering the subject of urban runoff, from the meteorologic source, through the collection, control, treatment and/or disposal of runoff, via storm sewers, combined sewers, or surface flow and the attendant pollutional effects on all types of receiving bodies of water. A separate listing of those articles or papers pertaining to the report subject and involving pollutional effects in estuaries will be provided. Abstracting and indexing procedures will follow those of the Water Resources Scientific Information Center (OWRR).

This is a joint venture of the Office of Estuarine Studies and the Storm and Combined Sewer Pollution Control Branch.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0345, ACID MINE DRAINAGE - PILOT PLANT EVALUATION

R.A. BAKER, Carnegie Mellon University, Mellon Institute, *Pittsburgh, Pennsylvania* 15213

This program is a pilot-pant study of the factors involved in acid mine drainage formation with emphasis on the effect of microorganisms. It is proposed to pass water of known properties over typical acid- producing mineral layers under controlled conditions in a pilot plant and to measure the rate and quantity of acid production as a function of aerobic and nonaerobic environments and with and without seeding with specific chemoautotrophic organisms. The central feature of the program is the use of actual mine core samples containing the sulfuritic material and/or associated rock strata. The pilot-plant serves as a model of a mine. Thus, results will be immediately relevant to the mine location(s) being studied. The study will simultaneously provide basic chemical and biological data to elucidate the reaction mechanism. This approach is expected to provide practical answers as well basic information in the shortest elapsed time. Other factors being studied include the effect of varying chemoautotrophic seed; recycle; forced aeration; supplemental carbon dioxide; surface area; and nature of pyrite.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0346, OPTIMAL RECREATIONAL DEVELOPMENT IN URBAN RIVERINE AREAS

H.J. DAY, Carnegie Mellon University, School of Engineering, *Pittsburgh, Pennsylvania* 15213

The development of a mathematical model to predict the optimal mix of investments for riverine recreational development in urban areas is the goal of the proposed work. Man-made and natural phenomena such as upstream reservoirs, municipal and industrial pollution, and both hydrologic and geomorphologic conditions would be included in the model. The design criteria would be cost and recreational use; the use levels would be defined according to different income and age groups. The model would be designed to be useful for a wide range of river basins that may require a comprehensive regional study of water based recreation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0347, USE OF GEL MATERIAL FOR SEALING DEEP MINE OPENINGS

D.R. MANEVAL, Dravo Corporation, *Pittsburgh, Pennsylvania* 15222

It is proposed to adequately seal the portal and adjacent entries of an abandoned drift mine. Reinforced concrete seals will be placed in the openings to provide the adequate safety measures to insure against structural failure of the proposed seal and the release of a large volume of highly acid water.

The proposed seal will be constructed of a chemical grout of low molecular weight polyphenolic polymer. The grout is produced by mixing two solutions; one containing polymer solids mixed with water, and the other containing a catalyst or reaction initiator of a formaldehyde donor and metal salt. The reaction occurring can be timed by use of additional catalyst, almost instantaneously or over a period of hours. Fly ash, on a dry weight ratio basis of 4.1 to the grout will be injected into the mine entries through boreholes from the surface.

Following the construction of both seals approximately 60 tons of fly ash will be pumped into the mine on the inby side of the proposed grout seal. This will insure against any possible leakage around the seal.

A surveillance program will be initiated before, during and after the sealing, to study the effectiveness of the seals and also to determine any changes in the ground water quantity or quality in the areas over and adjacent to the mine site. It is extremely important to know what effect sealing will have on ground water.

The work will be performed on an abandoned mine in Keystone State Park, Westmoreland County.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0348, SUBSURFACE WATER POLLUTION FROM SANITARY LANDFILLS IN CARBONATE ROCK TERRAIN

G.H. EMRICH, Penn. State University, Graduate School, *University Park, Pennsylvania* 16802

Ground water pollution from land disposal of wastes in carbonate rock terrain is a widley occurring problem through the humid United States. Critical information is still lacking of the physical and chemical parameters to be evaluated at land disposal sites.

Sample collecting equipmment has been installed at a sanitary landfill located in central Pennsylvania. The site has at least 50 feet of sandy loam soil derived from the underlying Gatesburg Dolomite. Ground water occurs at a depth of approximately 235 feet.

Liner was placed in the bottom of the sanitary landfill trench. The linear collects and directs all the leachate from the landfill to one side of the trench, where it is evenly spread through the soil. Seventeen suction lysimeters have been placed in the soil at depths up to 34 feet to monitor and collect samples of the leachate. The landfill and monitoring equipment were emplaced in November of 1967. Water was spread on the top of the landfill in order to quickly generate leachate. First leachate production occurred in January 1968 and has moved down to a depth of 12 feet. Chemical analyses of the leachate indicate high concentration of iron, choride, sulfate and B.O.D.

2. WATER QUALITY

A second landfill placed in 1962 is under study. New sampling facilities were installed in the fall of 1969 to compare leachate generation from an older and newer cell. Poor quality water has been traced to the 30 foot depth within soil below the 1962 cell and leachate has migrated to the 10 foot depth below the 1967 cell. Ground water samples beneath this landfill area also show that poor quality water has penetrated to the water table as well (235 foot depth).

SUPPORTED BY Pennsylvania State Government

2.0349, WATER QUALITY INVESTIGATIONS ON AGRICULTURAL WATERSHEDS IN THE NORTHEAST

W.R. HEALD, Penn. State University, U.S.D.A. Soil & Wa. Cons. Div., *University Park, Pennsylvania* 16802 (SWC-027-APSU-2)

OBJECTIVE: Study factors affecting accumulation and movement of pollutants in soils and water and its effect on water quality from an agricultural watershed.

APPROACH: The kind, amount, variation, source and fate of soluble mineral constituents in surface runoff waters will be determined. Hydrologic and climatic factors associated with the transport of these constituents will be evaluated. Management practices that lead to altering the concentration of these constituents in water will be investigated.

PROGRESS: The concentration of dissolved solids in rainfall in Pa. is an order of magnitude less than that found in the streams of the watershed and about two orders of magnitude less than the chemicals applied as fertilizers. The concentration of soluble P in the surface drainage system averaged less than 15 ppb. This low concentration is the result of very high adsorption capacity for PO(4) by soils of the watershed. Intensive sampling at the outlet of an agricultural watershed showed that one sample taken anywhere in the stream except very close to the banks, accurately represents the average chemical concentration of the stream at that cross section and at that time. Water quality of the stream is directly affected by the hydrology of the area. The stream chemistry responds quickly to changes within the storm hydrograph. Chemical variations in the watershed outflow are a direct reflection of the physical and chemical processes involved in the transformation of precipitation into direct runoff. Acid mine drainage is reflected in increased concentrations of Fe, Mn, Zn, Cu, Co, and Ni in the stream draining the area. However, periodic flooding of the land bordering the stream does not appear to be detrimental to crop growth. Studies on farm ponds revealed that the 10-ppb-P level, often considered the minimum concentration sufficient to promote algal growth, does not provide a demarcation between the eutrophic and non-eutrophic ponds. There is no discernible relation between the concentrations of Fe, Mn, Zn, and Cu on algal growth.

SUPPORTED BY U.S. Dept. of Agriculture

2.0350, GROUNDWATER QUALITY AND THE HYDROLOGIC BUDGET IN A VALLEY UNDERLAIN BY CARBONATE ROCKS

D. LANGMUIR, Penn. State University, Inst. for Res. on Land & Water, *University Park, Pennsylvania* 16802

To determine sources, magnitude, and timing of groundwater recharge, including pollution, and to show how detailed water quality information can provide insights regarding occurence and behavior of groundwater in a valley underlain by carbonate rocks. To determine if water quality information can be used to estimate rates of groundwater recharge, discharge, and movement. To determine in what ways quality information can be usefully correlated with rock mineralogy and other geohydrolic properties.

SUPPORTED BY Pennsylvania State University

2.0351, REDUCTION IN DAMAGES TO FOREST RESOURCES BY IMPROVEMENT OF STRIP-MINING METHODS AND REHABILITATION MEASURES

G. DAVIS, U.S. Dept. of Agriculture, N.E. Forest & Range Expt. Sta., *Upper Darby, Pennsylvania* 19082

Strip-mining disturbs extensive areas in the Appalachian Mountains and creates problems of runoff and erosion until stabilized and revegetated by proper reclamation measures. Weeping lovegrass provides the best initial cover on extremely acid spoils. Spoil pH may be used to predict manganese toxicity in legumes planted on strip-mined lands. Lime is essential to the establishment of crownvetch on coal breaker refuse.

Chemical pollutants in streamflow increase but suspended sediments decrease six months after mining a watershed. Load bearing strength of coal haul roads can be improved by the addition of asphalt compounds. Spoil slides are more likely to occur in the valleys and on steeper slopes in contour strip-mining.

Additional studies are underway which are aimed at evaluating various spoil treatment on runoff and erosion reduction from strip mined areas. Further research is being carried out in the evaluation of various grasses, shrubs, and tree species in conjunction with site preparation and fertilization. Aerial application of seed and fertilizer is being studied.

The actual studies are being carried out at Berea, Kentucky Princeton, West Virginia; and Kingston, Pennsylvania.

The project was started in 1963 with various studies being initiated and others completed at various times. No completion date has been set for the project as a whole.

SUPPORTED BY U.S. Dept. of Agriculture

2.0352, POTENTIAL BENEFITS OF INTEGRATING A NEW COMMUNITY AND A POWER REACTOR WITH SPECIAL REFERENCE TO THE WATER ECOLOGY

D. HAMMERSCHLAG, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

Much progress has been made during the last decade in reducing the cost of nuclear power generation of electric energy. Coupled with a steady increase in energy requirements large power reactors have been considered and built in many instances.

There is a possibility that such a reactor would be built by Narragansett Electric on land owned by them at Rome Point south of Wickford, Rhode Island. The waste heat, which is a by product in the power generation, would be removed by a coolant--in this case the water of Narragansett Bay. Under this arrangement, no benefit is derived from the heat so discharged. In fact, the 'thermal pollution' might create undesirable effects on the water ecology of the area. On the other hand, the excess energy could become a major positive determinant in a carefully conceived new community.

This study will investigate residential, commercial, industrial and public benefits of such a plan, with proper attention to water ecology if the development of a power reactor is fully integrated with and made the focal point of a new community at that location. Techniques developed in the study would not be restricted to this site.

Since this is a truly interdisciplinary subject, an advisory panel with expertise in oceanography, industrial engineering, resource economics and government has been asked by the applicants and agreed to provide guidance.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0353, YIELD OF NUTRIENTS FROM AGRICULTURAL LAND TO WATER SOURCES

J.E. SHEEHAN, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00239)

OBJECTIVE: Determine pollution of water sources from heavy fertilization of bridgehampton silt and fine sandy loam soils.

APPROACH: Soil samples for determining nitrogen, phosphate and potash will be taken from six soil levels from 4 to 50 inches every 10 days from May through October on fertilized and non-fertilized land. Water samples from surrounding areas will be collected at similiar times from nearby wells, streams and ponds. Soil and water samples will be chemically analyzed for nitrogen, phosphorus and potash. Data collected will be submitted to statistical analysis.

PROGRESS: Various laboratory and sampling techniques tried and tested for accuracy preliminary to initiation of project. Field data collected from June through October.

SUPPORTED BY U.S. Dept. of Agriculture

2.0354, PLANT PHENOLS AND RELATED ORGANIC COMPOUNDS IN PUBLIC WATER SOURCES, THEIR RELATIONSHIP TO CHLORINATION
Y. SHIMIZU, Univ. of Rhode Island, School of Pharmacy, *Kingston, Rhode Island* 02881

Contamination of water sources with organic materials such as fallen leaves or pollens is a common phenomenon in New England area.

The purpose of this research is to determine the potential hazards which may be caused by chlorination of water containing phenolic and other aromatic compounds eluted from plants and other organic materials. The eluted phenolic compounds, such as tannins and flavonoids are expected to inactivate the active chlorine instantly to form the derivatives of chlorinated phenols with potential acute and accumulative chronic toxicities.

The research will involve (1) model experiments on the chlorination of various plant phenols and other aromatic compounds of plant origins, and evaluation of short and long-term effects of the chlorinated products to mice and other organisms, (2) isolation and microchemical determination of phenolic and other organic materials in water before and after chlorination. This will be carried out spectroscopically and chemically with assistance of reference compounds.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0355, A STUDY OF SUSPECTED LEAD POISONING OF SWANS AND GEESE
M. PERRY, State Div. of Conservation, *Providence, Rhode Island* 02903

Objectives: 1. To determine if lead shot is present in sediments of Easton Pond. 2. To determine the concentration of lead in the liver, tibia, and blood of all swan. 3. To determine if acid-fast intranuclear inclusion bodies are present in kidney tissue of all swan. 4. To study the feeding behavior of swans and geese on and near Easton Pond.

Procedures: 1. Sediment samples will be taken at random throughout Easton Pond in Newport, R. I. and analyzed for lead shot contents. 2. All dead swans and geese will be collected and necropsied. Gizzards will be examined for lead shot. Blood, liver and tibia samples will be taken and lead concentrations in parts per million will be determined by use of an Atomic Absorption Spectrophotometer. Technique to be used will be similar to that described in 'Analytical Methods for Atomic Absorption Spectrophotometry,' Perkin-Elmer, Norwalk, Connecticut. 3. Kidney tissue from all dead swans and geese will be examined to determine if acid-fast intranuclear inclusion bodies are present (Lock, Bagley, Irby 1966. Bull. Wildlife Disease Assoc. 2:127- 131). 4. A comparison of lead concentrations will be made between birds at Easton Pond and resident birds from another part of the state.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0356, RADIONUCLIDE MOVEMENT IN GROUNDWATER
J.W. FENIMORE, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801

Large volumes of very low level radioactive wastes are discharged to two groups of earthen seepage basins. We have investigated both the horizontal and vertical distribution of radionuclides in groundwater between the basins and the nearest flowing stream. Flow paths to the creek were defined using tritium in the waste as a tracer. Results from one basin system show that basin water and trace radionuclides are carried to a maximum depth of 50 feet below the water table and then converge toward the seep line 1600 feet from the basins. At the other basin system, seepage is controlled by closeness to the outcrop zone, principal flow paths being to deep seep line re-entrants. Tritium and 90 Sr are both emerging into the stream. No other radionuclides have migrated more than a hundred or so feet from the basins; 137 Cs migration has not been well defined but is definitely very slow in comparison to 90 Sr and Pu has never been detected in groundwater.

SUPPORTED BY U.S. Atomic Energy Commission

2.0357, UNDERSTANDING OF THE INFILTRATION OF RAIN INTO BURIED WASTE
J.W. FENIMORE, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801

Solid radioactive waste is buried in the zone of aeration. With a better understanding of water flow in this zone, we can better protect waste from leaching. The waste is buried in trenches excavated to a depth of 20 feet. The frequency and extent of water saturated soil at the undisturbed soil-backfill interface at trench bottoms is being studied. Measurements are being made in 22 wells screened at the interface. Only four of the wells have contained more than a trace of water at a maximum depth of nearly 7 feet.

SUPPORTED BY U.S. Atomic Energy Commission

2.0358, CONCENTRATION OF RADIONUCLIDES BY AQUATIC BIOTA
R.S. HARVEY, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801

The objective is to determine the role of plants and animals in the distribution, transfer, and fate of radioactive materials discharged to the freshwater environs of reactor effluent streams.

The ability of these organisms to concentrate radionuclides under optimum growth conditions has been demonstrated. We intend to learn the effects of environmental factors on the radioecology of stream organisms.

Benthic algae were found to be high concentrators of radioactive materials and good qualitative indicators of the radionuclide content of ambient water. Differences in uptake among nine species were more closely related to cell morphology than to generic relationships. Algal radioactivity was influenced by factors such as light intensity, current velocity, and temperature which affect algal growth. Studies with midge larvae, clams, shrimp and fish are in progress.

SUPPORTED BY U.S. Atomic Energy Commission

2.0359, THERMAL INFLUENCES ON FATES OF NUCLIDES
L.J. TILLEY, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801 (AT(07-2)-1)

The objective of this program is to be able to predict the fate of radionuclides in lakes and reservoir ecosystems through knowledge gained by studying the distribution, seasonal variation, biological cycling and transport of several radionuclides in a large reactor cooling water reservoir.

This program together with a study of thermal effects forms an integrated program whose objective is a better understanding of structure and function in lake ecosystems in relation to waste heat and radionuclides released by nuclear power plants.

Results to date: Completed detailed determinations of the aerial distribution of total Fe, Mn, Cu, Cr, Sr, (also dissolved Ca, Mg, Na, K, Si, Cl, sulfate, phosphate, nitrate, and organic carbon) in surface water by synoptic surveys (52 stations) during two periods, March and July.

Preliminary work determined the radioisotopes present in the lake and those of ecological importance were selected for further work.

SUPPORTED BY U.S. Atomic Energy Commission

2.0360, GROUND WATER CONTAMINATION RESULTING FROM WASTE DISPOSAL
J.R. ANDERSEN, South Dakota State University, School of Engineering, *Brookings, South Dakota* 57006

Representative waste disposal methods in South Dakota including land disposal of liquid and solid wastes will be investigated to determine: 1. A recommended procedure for selection of waste disposal sites in order to minimize ground water con-

tamination problems. 2. The effects of waste disposal practices including: a. The nature and extent of ground water contamination. b. The effect of ground water contamination on proposed beneficial uses. c. The influence of such factors as climatic conditions, soil types and waste characteristics on the degree and extent of travel of pollutants. 3. A means of combatting undesirable contamination of the ground water.

It is also proposed that the project will investigate the long term effects of solid waste landfill on ground water quality in an area where adequate background data have been collected to observe the initial influence.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0361, POLLUTION POTENTIAL OF RUNOFF FROM LIVESTOCK FEEDING OPERATIONS
J.N. DORNBUSH, South Dakota State University, School of Engineering, *Brookings, South Dakota* 57006

Composited and grab samples of surface runoff from selected production feedlots will be analyzed and the results related to measured precipitation and runoff as well as feedlot characteristics. These data will be related to conditions in the stream receiving feedlot runoff. Analyses of BOD, COD, dissolved and suspended solids, nutrients and coliform organisms will be made.

The objectives of the investigation will be: 1. To determine the quantity and quality of runoff from livestock feeding operations in South Dakota. 2. To relate the above information to hydrological and geological considerations in order to appraise the overall influence of this runoff on specific beneficial uses of receiving waters. 3. To determine the influence of spring feedlot runoff as occurs in northern climates. 4. To determine the pollutional characteristics attributable to the suspended matter in the feedlot runoff in order to extrapolate the effectiveness of proposed lagooning methods of treatment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0362, QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF
J.N. DORNBUSH, South Dakota State University, School of Engineering, *Brookings, South Dakota* 57006

The project is designed to collect data concerning pollutants carried with agricultural runoff. The objectives of the project are: (1) To quantify the pollutional constituents in agricultural surface runoff; (2) To relate unit pollutant contributions to such factors as soil type, land uses, management practices, and climatological factors; and (3) To relate the portion of pollution constituents associated with both dissolved and suspended solids.

Samples of surface runoff will be collected from representative drainage basins using automatic selfstarting samplers. Spring runoff from frozen land surfaces will receive special attention. Rainfall on and flow from the areas will be measured. Drainage areas will have a variety of crops, and normal farming practices will be followed on the areas. Analyses of samples will include determination of nitrogen and phosphorous forms, pesticides, BOD, COD, dissolved and suspended solids, coliform and other fecal organisms.

Aerial photographs will be used to provide a permanent land use record. The amounts of fertilizer and pesticide applications to the areas will be obtained from the land users and correlated with pollutant contributions in the runoff.

The project was started in February 1970 and is expected to be concluded in January 1973.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0363, ECOLOGICAL FACTORS INFLUENCING THE PRODUCTION OF ALGAE IN NORTHERN PRAIRIE LAKES
L.S. HAERTEL, South Dakota State University, Graduate School, *Brookings, South Dakota* 57006

Four small lakes in eastern South Dakota will be regularly sampled for temperature, chemical characteristics, transparency, phytoplankton, and zooplankton populations. Phytoplankton production experiments will be undertaken. The possibilities of nutrient limitation will be investigated through nutrient enrichment experiments in both field and laboratory. The effect of zooplankton grazing will be examined through experiment and through measures of zooplankton abundance. Fish stomach contents will be analyzed to evaluate potential effects of fish on plankton populations.

The data from laboratory and field investigations will be used to assess the factors controlling the algae populations of the lakes. Whenever possible, correlations will be made involving major individual species as well as the entire algae population.

Project will begin July, 1970 and is expected to be of two years duration, at which time it will be reviewed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0364, A STUDY TO EVALUATE THE EFFECT OF SILT AND SILT REMOVAL IN A NORTHERN PRAIRIE LAKE
C.K. BRASHIER, Dakota State College, Undergraduate School, *Madison, South Dakota* 57042

The objective of this project is to determine the amount of lake eutrophication due to siltation. A study of variations of mineral quality of lake water due to siltation from various watersheds will be made. Eutrophication elements (and biota) of silted late will be compared with those of relatively unsilted, but domestically polluted lake.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0365, EFFECT OF DREDGING ON THE NUTRIENT LEVELS AND BIOLOGICAL POPULATIONS OF A LAKE
C. CHURCHILL, Dakota State College, Undergraduate School, *Madison, South Dakota* 57042

The proposed research project is designed to evaluate changes in nutrient levels and biological populations in a shallow, warm water lake due to the removal of sediments by dredging. This project will be carried out in Lake Herman, Lake County, South Dakota. Lake Herman, 1350 acres in size, in 1968 had an average of 4-1/2 feet of water and six feet of sediments. Considerable data has already been gathered on the lake mainly through surveillance projects funded by OWRR and FWPCA.

Included in the investigation will be an analysis of environmental factors such as phosphorus, potassium, nitrogen, sodium, pH, temperature, dissolved oxygen, alkalinity (Ca, Mg), turbidity, phytoplankton, and zooplankton. A comparison of these data will be made between dredged and undredged parts of the lake, between Lake Herman and similar types of lakes, and during dredging and prior to dredging.

This project will be a phase of an overall program that involves the following: (1) a surveillance study of a heavily silted lake; (2) the prevention of silt from entering the lake; (3) the elimination of silt from the lake bottom; (4) the study of nutrient and biological changes in the lake during dredging; adn (5) a surveillance program for a long-term duration after dredging.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0366, SEDIMENT YIELDS FROM RANGELAND WATERSHEDS IN THE NORTHERN GREAT PLAINS
A.R. KUHLMAN, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Newell, South Dakota* 57760 (SWC-014-DNI-2)

OBJECTIVE. Obtain measurements of sediment yield from rangeland watersheds in western South Dakota and to develop procedures for estimating sediment accumulation in stockponds in this area.

APPROACH: Periodic surveys are made of sediment accumulations in 74 stockponds in western South Dakota. Precipitation is measured at each pond with small orifice storage gages. All watersheds have been surveyed for range site and condition and will be resurveyed every three years. The data will be analyzed to determine mean sedimentation rates and to determine if differences in soils or vegetation result in significant differences in the mean annual rates.

PROGRESS: Sediment yields from rangeland watersheds have been measured near Newell in western South Dakota. Topographic resurveys have been made of 15 stock ponds. The interval between surveys varied from 5 to 8 years. The mean erosion rate

from 9 watersheds on moderately coarse-textured soils was 0.69 tons/acre/year with a range of zero to 4.87 tons/acre/year. The mean yield from six watersheds on fine-textured soils was 2.65 tons/acre/year with a range of from 0.21 to 6.51 tons/acre/year. For the period (1958-69) mean annual runoff was 0.59 inches from the moderately coarse-textured soils and 1.48 inches from the fine-textured soils. High erosion rates were associated with high runoff, poor vegetation and bad land topography on a portion of the watershed.

SUPPORTED BY U.S. Dept. of Agriculture

2.0367, HYDROGEOLOGY OF A WELL FIELD
P.H. RAHN, South Dakota School of Mines, School of Engineering, *Rapid City, South Dakota* 57701

The area investigated was that of the well field of the University of Connecticut in the valley of the Fenton River. The measurements showed the effect of flow from the wells on streamflow. Under some conditions as much as one-third of the water pumped from the wells was stolen from the river via induced streambed infiltration.

An extension of this investigation was concerned with the effect of induced infiltration on water quality. In the valley of the Naugatuck River near Waterbury, Connecticut, well water was found to contain relatively high concentrations of sulfate and copper, derived from the river water. Bacterial contamination, however, was absent. These observations suggest that chemical pollution is the biggest danger to wells in river valleys.

The knowledge gained in this project can be used in planning the location of future water wells.

SUPPORTED BY Connecticut State Government

2.0368, RADIONUCLIDE UPTAKE BY MARINE ORGANISMS IN ARTIFICIAL POOL AND ELIMINATION OF RADIOACTIVITY
J. ROS, Ministerio De Comercio, *Madrid, Spain*

1. Study of radionuclide uptake by marine organisms in an artificial pool and elimination of radioactivity under natural conditions. 2. Behavior of radiosotopes concentrated in the surface layer of sediments under quasi-natural conditions.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0369, CHANGES IN WATER QUALITY PARAMETERS OF RESERVOIRS DURING REGULATED FLOW CONDITIONS
F.C. LARSON, Univ. of Tennessee, School of Engineering, *Knoxville, Tennessee* 37916

Weekly sampling and testing is to be done at ten stations in Fort Loudoun Reservoir, Tennessee (a T.V.A. impoundment). The following tests will be made on all samples: The coliform count (membrane filter technique), pH, conductivity, dissolved oxygen, biochemical oxygen demand, apparent and centrifuged color, suspended solids, chlorides, iron, manganese, phosphates, ammonia N, nitrite N, nitrate N, and organic N. A portable continuous recording monitoring system will also be used in this investigation.

Inasmuch as the total organic loading on the reservoir will be greatly reduced this year, changes in water quality can be recorded and compared with previous results.

Additional information on iron and manganese build-up and eutrophication in a river-lake regime will be obtained and studied.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0370, ABSTRACT PREPARATION FOR THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER
P.A. KRENKEL, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

The objectives of this project are: to serve the scientific and technical needs of scientists, engineers, and others interested in the field of Thermal Pollution with respect to available literature; to establish Vanderbilt University as an information retrieval center for the area of Thermal Pollution; to make this information available to the scientific community; and to supply copies of requested abstracted articles at a nominal cost.

The tables of contents of journals and selected articles for abstracting which appear to be pertinent will be examined. The articles will then be obtained by one of the abstractors, and the abstract prepared in accordance with the instructions given by the Water Resrouces Scientific Information Center. The abstractor then will submit the material to the investigator along with two copies of the article. The investigator will edit the abstract and examine the article to insure that it is worthwhile for inclusion in the Selected Water Resources Abstracts publication. Upon completion, the abstract is attached to a copy of the article and sent to the Water Resources Scientific Information Center. These articles are submitted twice monthly, 25 abstracts being presented at a time.

Our abstracting endeavors will include information on: chemical and physical aspects; effects of thermal pollution; means of prevention; economics of cooling water use; and beneficial effects of heated discharges.

In preparing abstracts for the Water Resources Scientific Information Center, a wide variety of material on thermal pollution is being collected. This material is on file on index cards filed by author and date of accession, and in full size. We anticipate that this file will become the most comprehensive library and document collection on thermal pollution in the nation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0371, STATUS OF THERMAL POLLUTION AND RESEARCH NEEDS
F.L. PARKER, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

Specific Objectives: The specific objectives of this study are: 1. To compile an exhaustive bibliography on thermal pollution, including the effects of heat on chemical, biological and physical aspects of water quality, the effects of heat on waste assimilative capacity, alternative methods for the dissipation of excess heat from cooling waters, the hydrodynamics of heated water discharges, and the energy balance as related to the dissipation of heat from receiving waters. 2. After intensive review, to select the most meaningful and current references from the bibliography and subject these papers to critical review and summary. 3. To present a report derived from (2) which will contain the following items: a. Discussion of each topic in sufficient detain to give the reader insight into the current stage of development of that topic. b. Discussion of the major research needs in each problem area and an indication of the most fruitful approaches of these needs. c. Discussion of the existing and potential water quality problems due to heated discharges and their relationship to water pollution control requirements.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0372, SEPARATION OF SOLAR AND HEATED DISCHARGE EFFECTS
F.L. PARKER, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

When condenser cooling waters are discharged into shallow waters, it is sometimes difficult to determine that part of the temperature rise due to solar radiation and absorpton by water and river bottoms and that part due to the heated discharge. It is also difficult to determine whether or not the time profile of the temperature rise is materially affected by absorption of the bottom sediments and emergent rocks. When solar heating is significant, the measured cross-sectional temperature distributions may give mistaken impressions of the movement of the heated discharge. It would be beneficial to the analysis of induced temperature rises if these effects could be separated. To make a realistic assessment of the temperature rise due to absorption in the bottom sediments, basic information on the transmission of solar energy through water with various degrees of turbidity and uptake by sediments of different types will be needed. With this basic information, the amount of excess temperature rise and the resultant temporal displacement of the peak temperatures will be investigated. Field studies will be carried out to determine the validity of the results of the computer program which will predict

the temperature rise. Simultaneous dye and temperature studies will be performed to determine the path of the heated effluent. This project was begun in January 1970 and is scheduled for completion in September 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0373, ANALYSIS OF THE STRUCTURE AND FUNCTION OF ECOSYSTEM IN THE DECIDUOUS FOREST BIOME

S.I. AUERBACH, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831

An integrated ecological research program carried out by investigators from Oak Ridge National Laboratory and a number of universities, as a part of the Analysis of Ecosystem component of the International Biological Program. The long-term goal of the program is to evaluate the impact of man's activities on regional complexes of ecosystem and to derive a fuller scientific basis for improvement of environmental quality through rational use of land and water. Specific objectives of the research in the Eastern Deciduous Forest Biome region include (a) elucidation of the productivity, rates of nutrient and energy flow, and other ecosystem parameters; (b) determination of rates of change, transfer pathways, and food chain kinetics in major ecosystem types in eastern U.S.; (c) determination of the functional roles of animals and microorganisms in maintaining system stability; (d) determination of the rates and efficiencies of forested, agricultural, and aquatic ecosystems for cycling of nutrients and other mineral elements; (e) understanding of the influence of terrestrial ecosystems on water quality and on aquatic productivity; (f) evaluation of the actual and potential efficiency of natural and managed ecosystems for utilization and conversion of solar energy. During the initial phases, the research will be oriented chiefly toward the basic major processes that govern ecosystem structure and function. Modeling and systems analysis will be employed to redirect field activities in the course of the investigation and to provide a continuing synthesis of results. Field research and modeling activities will be concentrated at five sites: Oak Ridge National Laboratory Reservation, Tennessee; Lake Wingra, Madison, Wisconsin; Lake George, N.Y.; Coweeta Hydrologic Lab., Franklin, N.C.; and the Research Triangle area, North Carolina.

SUPPORTED BY U.S. National Science Foundation

2.0374, WATERSHED AQUATIC HABITAT INTERACTIONS

D.J. NELSON, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

The purpose of this research is to determine the factors and mechanisms governing the movement of water, mineral elements, and organic detritus from the landscape into surface streams. Knowledge of the fate of energy and mineral elements in production processes in both terrestrial and aquatic environments will contribute to our optimum utilization of these ecosystems for human welfare. Maintenance of terrestrial productivity depends on the coaction of biological and physical factors influencing the cycling of mineral elements on the landscape and flow of materials into the stream. The loss of material from the landscape determines water quality and productivity within the stream environment. The Walker Branch Watershed is considered as an input-output system with water as the vehicle for dissolved and suspended materials. Materials come into the basin as dry fallout, rainfall and rain-scavenged matter and enter biogeochemical cycles on the landscape before being transported downstream. The interactions between the biotic and abiotic features of the environment are being studied by an interdisciplinary team of biological and physical scientists. The final objective of these studies is to translate the experimental results gained from a small, controlled drainage basin into preceptive predictions of the potential impact of management alternatives on the total ecosystem.

Results: Water and material balance studies are continuing and one of the most striking features is the cyclical input of dry particulate matter. Soils have been characterized physically and chemically. Stand tables were developed from the forest survey data and forest stands were ordinated by use of principal component analysis. Calcium movement from leaf litter, tagged with calcium-45 was less than 1 meter into the soil profile after 18 months. The standing crop and productivity of periphyton were determined with a phosphorus-32 release to the creek. Sampling of stream benthic organis for community diversity, growth rates, emergence, and life history information was completed.

SUPPORTED BY U.S. Atomic Energy Commission

2.0375, METHODS OF CONTROL OF NITROGEN AFFECTING THE QUALITY OF UNDERGROUND WATER SUPPLIES IN RUNNELS COUNTY, TEXAS

P.E. HUDSON, Radian Corporation, *Austin, Texas* 78758

The Radian Corporation is conducting research to determine the source of nitrate pollution in Runnels County and will develop plans and implement methods for controlling nitrates affecting the quality of underground water supplies in the County. Included in the study are various test methods to determine the source of nitrogen, plus the collection, compilation and analysis of data related to the objectives in the project area. The study includes a determination of the location and extent of fresh-water bearing units and the chemical and biological quality of the water they contain. The report on the results of the study will contain recommendations for the elimination and/or control of the nitrogen problem which presently exists as well as preventing or minimizing further nitrogen contamination problems.

A 'First Phase' study, which consisted principally of inventorying and sampling water wells and measuring ground water levels throughout the county and studying the geology and hydraulic characteristics of the ground water aquifers was completed September 15, 1970 and culminated in a report. The project is currently inactive.

An application has been submitted to the Environmental Protection Agency for a R&D grant to provide for an extensive study of this problem. The application is currently being reviewed by the Environmental Protection Agency.

SUPPORTED BY Texas State Government - Austin

2.0376, PERMIAN BASIN - ORIGIN OF SALINE WATER DISCHARGE

P.R. STEVENS, U.S. Dept. of the Interior, Geological Survey, *Austin, Texas* 78701

Natural brine discharging through seeps, springs and salt flats contaminates the water in many streams in the Permian Basin. Previous investigations have ascribed this salt condition to the circulation of ground-waters through salt-bearing rocks and ultimately the discharging of the salt water in topographic low areas. Another hypothesis postulates that brine underlies the entire Permian Basin at a relatively shallow depth; the brine is overlain by relatively fresh water; the interface describes a surface of hydrodynamic equilibrium which also functions as a impermeable boundary separating the brine and fresh water into essentially discrete hydraulic units. The objective is to study all aspects of the occurrence of brine in this area and suggest measures that might alleviate the condition.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0377, PHYSIOCHEMICAL RESPONSES OF RIVERS TO NATURAL AND MANMADE ENVIRONMENTAL CHANGES

E.F. GLOYNA, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

The proposed research plan involves various interaction studies using closed ecosystems and a 'Model River.' The Objective is to evaluate the transport mechanisms which are operative in the waterway. Specifically, it is desired to develop a better understanding of the cycling effects of nutrients and conservative materials under various environmental conditions and to incorporate these uptake, release, and cycling effects into the total transport model. To accomplish this it is necessary to develop better approximations of the physiochemical system of a fertile waterway.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0378, PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS
A.D. SCHNEIDER, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Bushland, Texas* 79012 (SWC-012-EBUS-1)

OBJECTIVE: Develop methods, principles, facilities, and economical systems for conserving surface water supplies by ground water recharge including water clarification, wells, and surface spreading.

APPROACH: Water clarification by coagulants and flocculants is studied in the laboratory. Economical field water clarification systems are then developed and tested. Recharge wells, clogging, redevelopment, new drilling methods are studied by analog models, physical models, and field tests. Ground water pollution by recharge is studied in the laboratory and field and methods developed for control.

PROGRESS: Preliminary field and laboratory studies indicated the feasibility of recharging the Ogallala aquifer through the Pleistocene pluvial sediments when the slowly permeable Pullman clay loam or Randall clay is removed. Two basins, 0.1 acre in area, were excavated approximately 3.5 feet to expose the caliche and underlying sediments. Twenty acre-feet of well water was applied to the first basin in 46 days with a maximum percolation rate of 7.0 feet per day occurring at the end of the test. A mixture of well and runoff water, containing an average of 189 p.p.m. suspended solids, was used in the second basin. During the 66-day test period, 14.9 acre-feet of water was recharged with a final percolation rate of 1.5 feet per day. Deep percolation into the Ogallala aquifer 175 feet below the basin was clearly evidenced by a sharp rise in the water table. Recharge basins have a distinct advantage over recharge wells (or shafts) because the studies show that initial infiltration rates can be restored by removing the sediment sealed surface. To study the fate of herbicides introduced into recharge wells, picloram, atrazine, and trifluralin were added to water that was injected into a dual-purpose well for 10 days at 360 g.p.m. The ground-water mound created by recharging was allowed to dissipate for 10 days, and then the well was pumped for 12 days at 570 g.p.m. Ninety-three percent of the recharge water was recovered, and this water contained more than 90 percent of each herbicide injected.

SUPPORTED BY U.S. Dept. of Agriculture

2.0379, WATER QUALITY HYDROLOGY OF LANDS RECEIVING FARM ANIMAL WASTES
D.L. REDDELL, Texas A & M University System, School of Agriculture, *College Station, Texas* 77843

Livestock feeding operations are growing in size and are concentrating large supplies of feed and animals into smaller areas. Because the disposal of animal wastes in surface waters is undesirable, land disposal of manure is being advocated. However, with the increased use of large commercial feeding operations, the practice of land disposal of animal wastes presents two problems. The first problem concerns possible pollution of surface water and groundwater by the spreading of such wastes onto the land. The second problem concerns the nitrate accumulation which may occur in soil and water adjacent to land disposal systems.

This study is directed towards providing answers to such problems by carrying out the following program: 1. Field plots will be established with varying manure application rates. The physical, biological and chemical quality of surface runoff and deep percolation will be determined and used to evaluate the potential pollution from land disposal of manure. 2. Laboratory investigations will be utilized to determine the nature of the nitrate problem. Effects on the nitrogen cycle created by placing manure deep into the soil profile will be studied. Also, soil conditions for promoting dentrification will be examined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0380, GEOCHEMICAL BEHAVIOR OF URANIUM AND THORIUM SERIES NUCLIDES
W.M. SACKETT, Texas A & M University System, School of Geosciences, *College Station, Texas* 77843 (AT(40-1))

A continuation of studies aimed at understanding the behavior of uranium and thorium and their radioactive daughters in natural environments is proposed. Emphasis is being placed on (1) a study relating the high uranium in present day runoff from the U.S.A. to extensive phosphate fertilizer application to the land surface, (2) the carbonate 'uranium sink' in the Gulf of Mexico and (3) the Th-228 and Th-234 distributions in the ocean. Additional work is anticipated on the behavior of uranium-thorium series nuclides during weathering, stream and river transportation and deposition in near shore and deep ocean environments.

Uranium is determined by delayed neutron counting after activation. The amount and isotopic composition of uranium, thorium and protactinium are determined by carrier free separation, isotope dilution and alpha spectroscopy techniques.

RESULTS: A reasonably good balance of uranium between pre- fertilizer input and removal by shallow water carbonate deposits in the Gulf of Mexico; a direct relationship between phosphate and uranium in 27 fertilizers randomly sampled from a collection of 4000 and Th-234, Th-228 distributions that may give settling rates for suspended material in the ocean.

SUPPORTED BY U.S. Atomic Energy Commission

2.0381, EFFECTS OF FURROW, SPRINKLER AND SUBIRRIGATION METHODS ON POTENTIAL POLLUTION OF GROUNDWATER BY NITRATES AND OTHER SOLUTES
C.W. WENDT, Texas A & M University System, School of Agriculture, *College Station, Texas* 77843

This project will consist of a series of field and laboratory experiments and data interpretation to determine the effects of subirrigation, conventional irrigation methods and nitrogen fertilizers on underground water pollution. Laboratory studies will determine the applicability of existing models for water and ion movement to the soil and water conditions of the test site, and the rate of nitrogen releases from various mixtures of slow release materials and of materials treated with nitrifying bacteria inhibitors. Field studies will be used to determine movement of water, nitrate and other salts as influenced by amount and method of irrigation water application and amount and source of applied nitrogen, coefficients for the predictive ion movement model as influenced by irrigation and fertilization variability, and economics of fertilization practices and of the installation, operation, and maintenance of furrow, sprinkler and subirrigation systems. Quantitative effects of irrigation and fertilization methods on the potential pollution of underground water by nitrates and other salts, effects of the various practices on crops yield and quality, and the economic feasibility of practices reducing potential pollution will be determined. This study will begin June 1970 and end February 1974, with the work being conducted at Lubbock and Munday, Texas.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0382, NATURALLY OCCURRING TASTES AND ODORS IN WATER SUPPLIES
J.K. SILVEY, North Texas State University, School of Arts, *Denton, Texas* 76203

The taste and odor compounds produced by the aquatic actinomycetes may be satisfactorily concentrated by employing freeze-stir techniques. Samples produced by this method may result in approximately 2,000 times the original concentration of the organic components responsible for the tastes and odors. Low temperatures maintain the compounds in original chemical composition without altering the molecular structure. Gas chromatographic studies of the concentrates from laboratory-produced cultures indicate that six components are involved in the typical earthy, musty odors produced by these organisms. NMR investigations demonstrate that all compounds are neutral and polar. Studies on taste and odor components from the water sup-

plies subjected to the same techniques demonstrate that the compounds available in raw water are chemically identical with those produced by laboratory techniques. With the above information available, the use of gas chromatography with the proper instrumentation now available to use the mass spectrometer should make identification of the compounds relatively assured.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0383, EVALUATION OF ENGINEERING PROJECTS AND ESTUARINE DATA (ESTUARINE PROGRAM)
R.J. HOOGLAND, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Galveston, Texas* 77552

Estuarine-dependent species of the Gulf of Mexico coast comprise several of the nation's most valuable fishery resources. If the nursery grounds in the estuaries are to be preserved, it is essential that the estuarine habitat of these species be protected during and following construction of water-development projects in upland basins, estuarine systems, and coastal marshes. The increasing number, as well as complexity, of construction projects require a detailed understanding of estuaries.

It is the purpose of this project to (1) assist the Branch of River Basin Studies (BSFW) by reviewing all proposed construction and water- development projects affecting western Gulf estuaries and, when warranted, recommended remedial measures to reduce adverse project effects; (2) where practical, recommend changes in water-development projects whereby the habitat would be enhanced for the fishery resources; (3) inventory, organize, and keep current and published and unpublished data related to western Gulf estuaries; and (4) recommend basic research needed for protecting estuarine fishery resources.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0384, ECOLOGY OF WESTERN GULF ESTUARIES
W.L. TRENT, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Galveston, Texas* 77552

Demands upon water resources along the coast of the Gulf of Mexico are rapidly altering the estuarine environment. These combined alterations disturb the integrity of large estuaries to the extent that entire biological systems may be significantly affected. Basic to an evaluation of the effects of estuarine alteration is knowledge of the interrelations of factors, such as nutrients, bottom types, marine organisms, and vegetation.

Project objectives are to (1) compare the productivity of natural estuarine habitats with areas altered by dredging, spoiling, bulkheading and filling; (2) determine practical methods for rehabilitating altered habitats so that productivity can be reestablished; and (3) determine management procedures for maintaining or increasing the productivity of estuarine areas.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0385, VARIATION OF URBAN RUNOFF QUALITY WITH DURATION AND INTENSITY OF STORMS
D.M. WELLS, Texas Technological University, Water Resources Center, *Lubbock, Texas* 79409

This project will collect and analyze samples of stormwater runoff from an urban residential area to determine the quality of runoff and its variation with duration and intensity of storms. Samples collected will be analyzed for total solids, suspended solids, volatile suspended solids, BOD, COD, total nitrogen, and phosphorus. Selected portions of the runoff will be collected and treated in lab-scale model treatment plants to determine whether or not such treatment is economically feasible. An existing dense network of rain gages on the 1.5 square mile watershed will yield information regarding the areal variation of rainfall over a small area, and periodic sampling of runoff by an automatic sampling device will indicate the feasibility of segregating the most heavily polluted portion of storm runoff for separate treatment. The project will be started July 1, 1969, and will continue through August 31, 1971.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0386, EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA
J. VALLIANT, High Plains Research Found., *Plainview, Texas* 79072

The purpose of the study is to evaluate the effect of recharging with runoff water on the Ogallala aquifer and the ground water quality. By using pumping tests, the effect of suspended solids contained in recharge water upon the Ogallala aquifer are being determined for the area under study. The effect on transmissibility, specific yield, and other characteristics are being evaluated and determinations made as to whether additional desilting methods may be required to avoid clogging the aquifer. The study includes a determination of the movement of pesticides, herbicides, bacteria and other agricultural chemicals through the aquifer. A determination is being made as to whether the playa lake waters recharged are compatible with the ground water with respect to calcium carbonate equilibrium.

SUPPORTED BY Texas State Government - Austin

2.0387, SEDIMENT PRODUCTION, YIELD AND DELIVERY RATE IN RELATION TO CLIMATIC AND WATERSHED CHARACTERISTICS
R.W. BAIRD, Blacklands Expt. Watershed, *Riesel, Texas* 76682 (TEX08023)

OBJECTIVE: Determine the amounts and sources of sediment yields from small agricultural watersheds as affected by land use and treatment.

APPROACH: In the Blacklands near Riesel, measured runoff will be sampled and sediment yields computed by storm periods from six watersheds with different treatments and sized from 16.3 to 4,380 acres. Two are paired watersheds with major differences in treatment.

PROGRESS: During 1968 sediment yields were obtained from eight agricultural watersheds ranging in size from 16.3 to 4,380 acres. Weighted rainfall on the watersheds was from 46.70 inches to 51.18 inches. The 31-year average for the area is 33.16 inches. Monthly rainfall was above the average for all months except August, October, and December. Yearly runoff ranged from 11.13 inches to 18.34 inches. No storms of large amounts or unusually high intensities occurred. Sediment yields ranged from 0.03 to 0.24 tons per acre per inch of runoff. Sediment yields were much lower than in 1965 when runoff amounts ranged from 9.73 to 15.68 inches. In 1965, high intensity rainfall during thunderstorms in March and May when areas with spring planted crops were nearly bare of vegetation caused much larger sediment yields than those of 1968. The 1968 results show the major effects of crops, land use practices, and time of intense storms on sediment yields.

SUPPORTED BY Texas State Government - Austin

2.0388, SEDIMENT YIELD IN RELATION TO WATERSHED AND CLIMATIC CHARACTERISTICS IN THE WESTERN GULF REGION
J.R. WILLIAMS, Blacklands Expt. Watershed, *Riesel, Texas* 76682 (SWC-014-ETEM-3)

OBJECTIVE: Determine sediment yields, sources, and sediment accumulation in floodwater retarding structures. Develop prediction equations and routing technique.

APPROACH: Sediment yields are measured by sampling runoff from 10 Blackland watersheds with different treatments and areas of 5.2 to 4380 acres. In the Edwards Plateau, sediment is measured by surveys of 5 floodwater retarding structures with watershed areas of 686 to 10,787 acres. Develop routing procedures, temporal sediment distribution will be correlated with temporal flow distribution and flood routing procedures modified to include sediment. A prediction equation relating sediment to land use and treatment, and storm and watershed characteristics will be developed for use on ungaged areas.

PROGRESS: A technique was developed to predict sediment yields from small Blackland watersheds at Riesel, Texas. Factor analysis was used to reduce 27 variables to six important and rela-

tively independent factors for predicting average sediment concentrations for individual storms. The six factors are: weighted rainfall intensity; amount of rainfall; peakedness ratio; portion of watershed area unterraced but cultivated; product of the portions of cultivated area and Blackland area; and hypsometric integral. Prinicipal components regression was used to relate these six factors to sediment concentration. The resulting equation explained 63% of the variation in sediment concentration and had physically interpretable coefficients since it was developed from relatively independent factors. Sediment accumulations in four detention reservoirs in the Lowrey Draw watersheds were quite low during 1961-68. The average sediment concentration during this eight year period of near normal climatic conditions ranged from 483 to 1176 ppm for four rangeland watersheds. The sediment accumulation ranged from 0.009 to 0.019 acre-feet per square mile per year. If sediment continues to accumulate at the 1961-68 rate, the average time required to fill the sediment pools would be 1600 years. A comparison of concentrations of suspended sediment collected with depth-integrating and dip samplers showed significantly greater concentrations for the integrated samples when sampling fine-grained sediments. Concentrations of depth-integrated samples were 1.02 greater than concentrations of dip samples.

SUPPORTED BY U.S. Dept. of Agriculture

2.0389, URBAN GEOLOGY OF HILLSBORO, TEXAS
G.D. HOWELL, Baylor University, School of Arts, *Waco, Texas* 76703

Reasonable requests for information will be honored. To describe, map, and evaluate the geology of a small city, projected to undergo considerable growth because of its critical location on the major north- south route through the center of Texas.

Geologic mapping of the formations underlying the city and its projected growth area, correlating soils (mapped by the Soil Conservation Service) with engineering problems, and evaluating surface- water floods and pollution.

SUPPORTED BY No Formal Support Reported

2.0390, ENVIRONMENTAL TRACE ELEMENTS AND REGIONAL HEALTH AND DISEASE
J.M. SPENCER, Baylor University, Graduate School, *Waco, Texas* 76703

Reasonable requests for further information will be honored. A compilation of the biochemical and physiological effects of trace elements in man, regional diseases related to naturally occurring trace elements, and the geological significance of both.

Compilation and integration of available information on trace elements, primarily from medical and geological literature as well as from data on regional pathology.

SUPPORTED BY Baylor University

2.0391, MINIMIZING SOIL AND WATER POLLUTION FROM FERTILIZERS AND IRRIGATION WATERS--RIO GRANDE PLAIN
G.W. LANGDALE, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Weslaco, Texas* 78596 (SWC-027-EWES-5)

OBJECTIVE: Determine the NO(3)-N and NO(2)-N enrichment in drainage effluents and ground waters from nitrogenous fertilizers; and the frequency where irrigation waters are used to remove salts from moderately saline soil profiles of the Lower Rio Grande Valley.

APPROACH: Anion 'pulses' through heterogeneous soil profiles to drainage effluents will be measured as function of irrigation water and applied N-fertilizer. Nitrogenous contaminants, NO(3)-N and NO(2)-N, will be measured concomitantly with saline contributing anions and cations to evaluate their effect on the movement of former through soil profiles to drainage effluents. kates of applied N-fertilizer and irrigation water will be used to control NO(3)-N and NO(2)-N movement or enhance denitrification.

PROGRESS: Movement of residual-N (control) and N-fertilizer (448 kg/ha) through Hidalgo clay loam soil profiles to drain lines 2.4 m deep in an established citrus orchard was studied between April and December 1969. Approximately 50% of the N-fertilizer was accounted for as NO(3)- N between the 1.0 to 2.4 meter profile depth in December. Control plots contributed an average of 7.33 kg/ha of NO(3)-N to drainage effluents. An additional 1.82 kg/ha of N-fertilizer was accounted for in these effluents. Chloride-NO(3)-N relationships were developed since soil salinity may affect the nitrate content in the soil. The ratio of Cl:NO(3)-N removed in drainage effluents was 56:1 with a correlation coefficient of 0.93. Judicial use of applied N-fertilizers and irrigation water for citrus production appears to permit adequate salt leaching without the occurrence of excessive NO(3)-N concentrations in drainage effluents.

SUPPORTED BY U.S. Dept. of Agriculture

2.0392, RADIOECOLOGY OF THE KUCUK CEKMECE LAGOON
Y.M. UNLU, Cekmece Nucl. Res. & Tr. Ctr., *Istanbul, Turkey*

The Kucuk Cekmece Lagoon will likely receive some radioactive effluents from the Cekmece Nuclear Research Center in the near future. This study is concerned with radioactivity levels in the Kucuk Cekmece lagoon. Some biological factors concerning this region are: Geographical position 41 degrees OO'N-28 degrees 43'E, max. depth 25 m, area 15.22 km2 , salinity 37 to 6.85 parts per thousand, temperature 25 degrees C- 6.8 degrees C, phosphorus inorganic phosphate content max. 26.2 mg/m3, aquatic marine life.

The range of radioactivity studied over a two-year period from February 1968 to January 1969 was on average 8.2 pCi/l and a tenfold increase in activity 87.98 pCi/l was detected in 1970. Therefore in order to avoid unpleasant surprises it is necessary to determine the natural radioactivity level in the lagoon's biota and sediment and especially the pathway of selected radionuclides in economically important organisms of the lagoon (ecosystem).

The result obtained from the above research project will serve to describe the background information for the present situation of the lagoon and will be benefitial for effective future control. Experimental radioecology will be the central theme of the research planned. The influence of various environmental factors on the ability of these organisms to concentrate radionuclides will be studied.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0393, BEHAVIOUR OF CERTAIN RADIONUCLIDES IN THE AQUATIC ECOLOGY OF ISMAILIA CANAL
K. MAHMOUD, Atomic Energy Establishment, *Cairo, United Arab Republic*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0394, RESEARCH TO ELIMINATE AND PREVENT OIL POLLUTION OF THE SEA
UNKNOWN, Ministry of Technology, *Stevenage, England, United Kingdom* (000879)

Document provided to Science Information Exchange by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

2.0395, QUALITY OF IRRIGATION RETURN FLOW
L.G. KING, Utah State University, School of Engineering, *Logan, Utah* 84321

Irrigation return flow constitutes a very large portion of the water influent which reaches the streams of the Western United States. Since these influents invariably bear a load of dissolved solids and can contain nutrients, trace elements, and biocide residues, their impact from a pollution point of view is of major concern in the entire Western United States.

The primary objective of this project is to conduct research on the problems that affect the quality of irrigation return flow.

2. WATER QUALITY

This is to be accomplished by studies in four areas: (1) precipitation mechanisms in soils as they affect water quality - this phase will be concerned with the changes in the quality of water, as it moves through soils, as a result of precipitation of calcium carbonate; (2) to develop information for predicting the changes in the salinity content of soil and drainage water resulting in changes in the quality of irrigation water and in irrigation management; (3) managing water in the soil plant matrix to control the quality and quantity of return flow; and (4) contamination of surface and drainage waters with soil and foliar herbicides - there will be special emphasis on heavy rates used on canal banks, drains, waterways, etc.

During this year, a major part of the research will be conducted in the field on a farm in the Ashley Valley near Vernal, Utah, within the Colorado River Basin. The farm will be provided with a tile drainage system, sprinkler system, and intensive instrumentation to monitor the movement and quality changes of water from its application to its discharge from the drainage system.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0396, THE EFFECTIVENESS OF WATERFOWL IN CARRYING PATHOGENIC MICRO-ORGANISMS
J.B. LOW, Utah State University, State Coop. Wildlife Res. Unit, *Logan, Utah* 84321

Waterfowl because of their migratory habits fly from one water source to another in their early or seasonal movements. These birds are potential carriers of disease producing micro-organisms because of the common practice of Utah towns and cities of disposing of their sewage into streams of water. These streams usually drain into lakes or marsh lands which are utilized by the watefowl for nesting, brood rearing, and other normal activities. There is a large accumulation of organic sewage in these areas and may be a source of pathogenic organisms. Because waterfowl are in contact with this raw sewage they will be investigated as to the role they may play in the dissemination of micro- organisms.

The work will be carried out under the following objectives: (1) To determine the incidence of indicators of pathogenic micro-organisms present on waterfowl in western marshlands. (2) To study the effectiveness of waterfowl to directly discriminate organisms by carrying them on feet, feathers, and other body parts. (3) To determine the organisms available for transmission by waterfowl. (4) To determine the longivity of contamination of waterfowl by micro-organisms attached to feet, feathers and other parts of waterfowl.

SUPPORTED BY Utah State University

2.0397, LEAD SHOT, ITS SETTLEMENT, OXIDATION, AND AVAILABILITY TO WATERFOWL
J.B. LOW, Utah State University, State Coop. Wildlife Res. Unit, *Logan, Utah* 84321

This research is a 6-year study designed to accomplish the following objectives: (1) To determine the rate of settlement of lead pellets through the marsh soil. (2) To determine the rate of oxidation and decomposition of lead pellets in typical saline marsh soils. (3) To determine the availability of lead shot pellets to waterfowl in a 'typical' waterfowl feeding area. (4) To ascertain the general distribution of lead pellets in a typical western marsh and their availability to waterfowl.

The area selected for study is a part of the Unit 2-A located on the Bear River Migratory Bird Refuge at Brigham City, Utah

The experimental area is 23 feet by 11 feet and is composed of 24 plots with 4 sub-plots per plot (one sub-plot for each shot size).

To facilitate the deposit and recovery of the lead pellets the plots were arranged into rows, producing six rows of four plots each, with walkways between and around the rows.

Each fall, four of the main plots will be sampled. This will provide 16 sub-plots with 4 sub-plots for each sized pellet; if all pellets are recovered there will be 200 pellets for each sized pellet.

SUPPORTED BY Utah State University

2.0398, WATER QUALITY OF HYRUM LAKE AND ITS RELATIONSHIP TO ALGAL BLOOMS
R.I. LYNN, Utah State University, Graduate School, *Logan, Utah* 84321

The proposed research plan involves laboratory and field studies to determine, identify and locate the source of pollutants which we believe to be the cause of a recurrent algal bloom in Hyrum Lake. The proportion of the bloom during the late summer and early fall of 1969 resulted in a 75% decline in usage of the lake by boaters, skiers and swimmers of that year. Our basic approach will be to analyze the physical, chemical and microbial components and processes within the lake and to judge from these results a means of preventing or reducing the severity of future algal blooms. The bloom organisms has been identified as 'Aphanazemenon flosaquae', a member of the blue-green algae, some strains of which have been shown to be toxic to numerous animals. This aspect of the problem increases our desire to reduce the intensity of the bloom as soon as possible.

Laboratory and field studies will employ the following methods: 1. Using water collected from Hyrum Lake, during various times of the year, we will supplement with nitrogen and phosphorus singly and in combination to determine which, if either, is the limiting factor for growth of the 'Aphanazemenon' in the lake. 2. We will also monitor the numbers of the bloom organism in Hyrum Lake. 3. We will also monitor the relative efficiency of photosynthesis of the algae of the lake as part of the coordinated effort to establish the series of events preceding the appearance of the algal bloom. 4. Laboratory and field data will be correlated to pinpoint sources of nutrient input to the lake and suggestions made to moderte or eliminate the same.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0399, CARCINOGENS IN THE ENVIRONMENT
H.C. MILLAR, Utah State University, Utah Water Research Laboratory, *Logan, Utah* 84321

Suitable quantities of two carcinogens will be fed to a sample of goats. After a suitable time the animals and their embryos will be observed for teratogenic conditions for cancerous growths. The milk will be analyzed for the presence of the carcinogens as will their excreta. If the carcinogens appear in the manure a suitable pasture will be manured. Animals will be grazed and sacrificed to test for the presence of the carcinogens as will the drainage water from the field.

SUPPORTED BY Utah State University

2.0400, A STUDY OF THE BIOLOGICAL, CHEMICAL AND PHYSICAL NATURE OF WATER QUALITY FACTORS UNDER UTAH CONDITIONS
J.M. NEUHOLD, Utah State University, Utah Ctr. for Water Resour., *Logan, Utah* 84321

The characteristics and relationships of water quality factors pertinent to short, snow-fed mountain streams feeding to desert floors will be studied. Consideration will be given to: 1) watershed contamination 2) irrigation return and 3) domestic and industrial pollution. The relationship of the contaminant to volume of flow, rate of degradation and subsequent incorporation into the aquatic biomass will the matter of primary concern. Contaminant cycling, sedimentation and physical change will also be studied. The system under study will lend itself to model construction in terms of the environmental, physical, chemical and biological effects on contaminants. The information for such a model will be obtained from field observations and from experiments conducted on excised portions of the environment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0401, THE KINETICS AND ENERGETICS OF ADSORPTION AND DESORPTION OF PHOSPATE FROM SOIL MINERALS
R.L. SMITH, Utah State University, School of Agriculture, *Logan, Utah* 84321 (AT(11-1)-1392)

The objective of this proposal is to determine the kinetics and energetics of phosphate desorption from solid phase CaCo sub 3 by evaluating the activation energies of both adsorption and desorption along with the pertinent thermodynamic functions. The literature reveals only one study wherein the activation energies of desorption of phosphate were obtained from natural soils. These type of data are important because they provide an index of the energy input required in a system before phosphate ions are released from the sorbed state. This study not only has great implications in terms of phosphate pollution of surface waters but it also provides data useful in the availability of soil phosphate to plants. The procedure is to determine the rate constants of both adsorption and desorption at 3 temperatures; 10 degrees, 20 degrees and 30 degrees. How these rate constants vary with temperature will allow the activation energies to be evaluated. How the adsorption and desorption isotherm varies with temperature also allows the calculation of the differential heats of adsorption. The kinetics and thermodynamic functions will be measured at various surface coverages to ascertain the variation of adsorption site energy on the surface of calcium carbonate

SUPPORTED BY U.S. Atomic Energy Commission

2.0402, POLLUTION AS A RESULT OF FISH CULTURAL ACTIVITIES

R.N. HINSHAW, State Div. of Wildlife Resour., *Salt Lake City, Utah* 84116

Fish hatchery effluents, according to recent literature, have not been evaluated as sources of pollution. With large numbers of hatcheries in the Nation, this problem should no longer be overlooked. So a proposal was submitted and accepted by the FWPCA to determine if fish cultural activities were indeed polluting receiving waters.

Consequently, a sampling program on four State hatcheries, one commercial and one Federal hatchery was begun to determine characteristic water chemistries on inflow, effluent, receiving water above, 100 feet below, and 1000 feet below hatchery outfalls. Parameters sampled bi-weekly include B.O.D., MPN coliform, dissolved oxygen, pH, carbon dioxide, hardness, temperature, M.O. alkalinity, specific conductance, nitrates, nitrites, ammonia, turbidity, settleable, suspended and total dissolved solids. 'Standard Methods' were used throughout except where modified by the Hach Company for use with their Engineer's Chemical Kit.

Bottom fauna analyses are being used to assist in evaluating the influence of hatchery wastes on receiving waters.

The sampling programs for water chemistry and bottom fauna will terminate in October 1969 and March 1970, respectively. The water will have been analyzed chemically for fifteen months, and bottom fauna analysis will provide monthly data for a year.

It is anticipated that these examinations will provide sufficient information to assess the levels of pollution. If the data demonstrate that these operations are harmful to beneficial uses downstream, abatement and preventative measures will be undertaken to correct existing problems.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0403, REMOVAL OF DISSOLVED CONTAMINANTS FROM MINE DRAINAGE

J.D. MILLER, Univ. of Utah, School of Engineering, *Salt Lake City, Utah* 84112

Pollution from mine drainage is a serious problem in areas where substantial coal and metal mining have been carried out. Effective treatment of such drainage has not been achieved in most instances. Neutralization of these effluents with limestone followed by precipitation of the metal hydroxides has been found to be impractical, primarily from the standpoint of liquid-solid separation. Other approaches are required for a solution to this problem.

One technique that appears attractive and that should be studied is the removal of such contaminants as iron, aluminum, and other metal ions by their adsorption on inexpensive disposable substrates, such as mill tailings. Important parameters that will be investigated are: concentration of contaminant, pH of solution, surface area and type of substrate, and temperature.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0404, NUTRIENT BUDGETS, RECYCLING, AND WATER TRANSPORT IN LAKE CHAMPLAIN

E.B. HENSON, Univ. of Vermont, School of Arts, *Burlington, Vermont* 05401

The objective of this study is to begin obtaining reliable measures of the mineral budgets of Lake Champlain. Water samples are to be collected from the major tributaries of Lake Champlain on a regular schedule along with measures of stream discharge. Curves will then be constructed from each watershed in an attempt to associate mineral loading with discharge. The mineral input into the lake will be calculated on a monthly basis. The total load leaving the lake through the outlet will also be measured to balance the nutrient budget equation.

Water transport passing several transects across the lake will be measured, and the total mineral loading measured to determine the rate of transport through the lake.

Cycling of these mineral components within the lake will be approached by examining the concentrations, and changes of concentrations, in each trophic level.

Parameters to be measured are: the ions of Ca, Mg, Na, K, bicarbonate, carbonate, phosphate, nitrate, and Cl. Also, conductivity, dissolved oxygen, B.O.D., and total organic matter.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0405, DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950

C.S. HOUSTON, Univ. of Vermont, School of Medicine, *Burlington, Vermont* 05401

Snow cores will be obtained by snow augur drilling at the site of an established laboratory at 17,500 feet on Mt. Logan, Yukon Territory. Snow which has fallen over the past twenty years will be obtained and its date of fall approximately dated. The melted samples, in approximately three-year aliquots, will be returned to FWQA laboratories for analysis for DDT and other materials. The hypothesis is that such materials can have reached this high and isolated place only through fallout from the stratosphere.

The work will be done on Mt. Logan and analyses done in Cincinnati.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0406, SEDIMENT YIELD FROM AGRICULTURAL WATERSHEDS IN NEW ENGLAND

S.H. KUNKLE, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Danville, Vermont* 05828 (SWC-014-ADA-1)

OBJECTIVE: Obtain, assemble, and report data on the rate, quality, sources, and types of sediment transported in steep mountainous streams; relate sediment yield to land use, sediment properties, and hydraulic parameters.

APPROACH: Suspended sediment samples are taken at a number of gaging stations. Total load measurements will be made by measuring the accumulation of sediment in settling pools and measuring the suspended outflow from the pool. Movement of large particles is made by marking and accurately placing stones in channel reaches and periodically checking for movement.

PROGRESS: Surveys have been made of sediment accumulation in 9 weir ponds for drainage areas ranging from 116.5 acres to 16.8 square miles. However, the data are not yet analyzed. Three farm ponds in New Hampshire were surveyed to supplement the watershed data. 29,500 feet of bank along the Winooskie River from Essex Junction to Richmond, Vermont, was resurveyed to evaluate treatments of brush matting and riprapping established 25 to 30 years ago. Maximum deposition occurred at 8 to 9 feet above mean low flow stage. Bank deposition ranged up to 24 inches and overbank deposition up to 40 inches. In most respects the Winooski Project was successful in that seriously eroding banks were repaired and total erosion was reduced.

SUPPORTED BY U.S. Dept. of Agriculture

2.0407, URBANIZATION AND ITS EFFECT ON STREAM TEMPERATURE

E.J. PLUHOWSKI, U.S. Dept. of the Interior, Geological Survey, *Arlington, Virginia* 22209

2. WATER QUALITY

Man's impact on the hydrologic environment has received greater attention in recent years. Such factors as increased storm runoff, loss of valuable top soil, stream and atmosphere pollution have come under scrutiny owing to their rather obvious undesirable effects. Aside from large scale isolated instances of thermal pollution, however, little has been done to assess man's influence on the thermal patterns of streams. Alteration of the natural hydrologic environment of a stream may affect its heat energy balance causing substantial changes in water temperatures.

Five streams with varying degrees of urbanization in their drainage basins have been selected for intensive study. Connetquot River in central Long Island was chosen as a control for comparison purposes. This stream flows through a hunting preserve and is essential in its natural state. Five sites were selected along each stream and water temperatures obtained at each site. A statistical analysis employing a randomized block or latin square design will be utilized to test for significance between sites. Stream reaches yielding significantly different results will be subjected to an intensive field reconnaissance to isolate the cause of the anomaly.

An energy-budget approach will be utilized to assess the importance of urbanization factors on the overall flux of energy. Owing to the profound effect of certain meteorologic parameters on the heat balance it is likely that most studies will be restricted to periods of not less than 7 consecutive days. The most important factor in the energy budget is insolation which is being measured directly by placing a pyranometer just above the water surface of the control stream.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0408, EFFECTS OF DEICING COMPOUNDS ON VEGETATION AND WATER SUPPLIES
R.E. BLASER, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0808017)

OBJECTIVE: Investigate deicing salt effects on soils, plants, and water resources, and do an interpretation and review of the literature.

APPROACH: Investigate salt movement by depth and distance from roadsides and associate with plant morphological and physiological characteristics; study rate of salt absorption by plants; their salt tolerance and ion retention by soils.

PROGRESS: Although there are indications that build up of salts in them is not immediately hazardous to man, animal, and fish, roadside vegetation appears vulnerable. Studies on several deciduous and evergreen trees and shrubs to sodium and calcium chlorides in Virginia showed plant injury being associated with the amount of salt applied. The degree of injury caused by sodium and calcium chlorides varied among species. Salt tolerances of several deciduous and evergreen trees and shrubs have been evaluated and are now available. Research with silver maple on a Vergennes soil located in Vermont indicated that highway salting practices increased specific conductance, sodium, and chloride content of the soil solution, resulting in higher uptake and accumulation of these ions in damaged trees. During winter, sodium and chloride ions entered the soil and progressively penetrated and accumulated in deeper horizons with time. Deterioration of silver maples resulted from chloride toxicity and to some extent sodium rather than osmotic effects. Studies with grasses showed a close relationship between rates applied and amounts of sodium and chloride in tissues. Chloride accumulated several times higher than sodium. Kentucky 31 fescue maintained reasonable ground cover even at 4 to 6 tons of sodium chloride per acre. Potassium phosphate and sulfate in deicing salts tended to minimize salt injury to grasses.

SUPPORTED BY Virginia State Government

2.0409, ACID MINE POLLUTION
K.B. CUMMINGS, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0303238)

OBJECTIVE: Abandoned strip mines in Smith County, Virginia have contributed heavy loads of silt to the streams which drain them. Forest Service projects to improve the affected zones have been carried out but the indirect abatement of stream pollution has not been documented. The purpose of this research is to itemize the damage that has been done to stream biota and habitat, to present evidence for stream recovery, and to indicate the relative role of harmful components in the silt on two drainage systems adjacent to the affected lands.

APPROACH: Two stations each for tributaries of Cripple Creek and South Fork Holston River will be studies. Four categories of tributary will be designated: control, completely reclaimed, partially reclaimed, and unreclaimed. Chemical, physical and biological properties of all streams will be compared and evaluated for degree of damage or recovery.

PROGRESS: The objectives of this proposed research are to monitor water quality in four tributaries which represent various stages of recovery from strip-mine pollution and to conduct studies on the chronic physiological action of mine effluent on fishes of these waters. The change in water quality following different stages of reclamation work on National Forest Lands have been used to measure the rate of stream recovery as well as to document the continuing damage caused by unreclaimed mines. The sublethal action of suspended matter and manganese metal upon the growth rate and condition index of two representative species, rainbow trout and white sucker, in this watershed are being evaluated.

SUPPORTED BY Virginia State Government

2.0410, AN EVALUATION OF THE PRODUCTIVITY CHANGES ASSOCIATED WITH LIMING OF SHERWOOD LAKE, WEST VIRGINIA
K.B. CUMMINGS, Virginia Polytechnic Institute, School of Agriculture, *Blacksburg, Virginia* 24061

The increase of water hardness by artificial introduction of lime to Lake Sherwood has been studied over a period of four years. The objectives of the present study are: 1. To determine the pretreatment water quality, productivity, and harvest of Sherwood Lake. 2. To determine the effect of liming on water quality, productivity and harvest by periodic water checks, plankton and fish population sampling and creel surveys.

SUPPORTED BY Virginia State Government

2.0411, INVESTIGATION OF SURFACE FILMS - CHESAPEAKE BAY ENTRANCE
C.L. SMITH, Virginia Inst. of Marine Sci., *Gloucester Point, Virginia* 23062

This study involves determination of transport and fate of spilled oil in marine and estuarine waters. It includes the following primary tasks: 1) Document compositional changes in No.2, 4, and 6 oils spilled in the open ocean and in Chesapeake Bay by gas chromatography, infrared spectrophotometry, column chromatography and other techniques for oil analysis. Water and oil samples will be analyzed to investigate losses of volatile and water soluble components of the oils. 2) Determine the effect of weather and water currents on the movement, spreading, evaporation, and diffusion of these fuel oils in the open ocean and Chesapeake Bay.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0412, THE ROLE OF PAPER MILL ADDITIVES AS POTENTIAL STREAM POLLUTANTS
R.M. CHATTERS, Washington State University, School of Engineering, *Pullman, Washington* 99163 (AT(45-1)-2221)

During the course of producing paper, many chemical compounds are added to the paper process lines. These may serve the purpose of water repellency, high liquid absorbency, bleaching, chip digestion, filling, pigmenting, sizing, size precipitating, coloring, coating and run the gamut from simple natural substances to complex organic compounds.

Useful and necessary as these materials are to the paper industry, many of them are potentially harmful when introduced as effluents in public waterways. For example, bleaching compounds can increase the hardness of the receiving water; coloring materials can increase the B.O.D., impart color, some may be toxic thus upsetting natural purification of the streams, some may be carcinogenic while others impart taste and odors to the recipient waters; sizings may increase the B.O.D., interfere with reaeration,

or impart tastes and odors to the streams receiving them; some precipitating agents serve as nutrient media for algae and coatings may increase the turbidity of the waterways.

In the subject research, the principal aims are to determine how much additive is actually required by the fibers and how much of it leaves the paper mill as a potential pollutant or as an active primary pollutant. Neutron activation analysis techniques will serve as the main analytical tools in this research.

From these studies, then, it is hoped to provide information which will reduce the possibility of pollution from paper mills and at the same time reduce the paper industry's economic loss which results from unused additives leaving the production lines in the waste waters.

SUPPORTED BY U.S. Atomic Energy Commission

2.0413, OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS

E. HINDEN, Washington State University, School of Engineering, *Pullman, Washington* 99163

The method of transport to and the occurrence of pesticides in the aquatic environment is of extreme interest today. The increased use of pesticides for achieving higher agricultural and silvacultural productivity has allowed a greater amount of pesticides to enter into the aquatic environment. Though these amounts are generally in sublethal dosages, their presence constitutes a potential hazard. Certain pesticides can be concentrated in tissues of most organisms, thus entering in the food cycle of organisms in the aquatic habitat.

The purpose of this study is two fold. One purpose is to study the distribution of a chlorinated organic and organic phosphorus insecticide on an agricultural plot receiving insecticide application. A distribution budget will be made from analysis of soil, plant, and insecticide removal by irrigation runoff water and loss to the atmosphere taken throughout the growing season. Particular attention will be paid to that amount being carried off by the irrigation runoff water. During the second year insecticides will not be applied. A distribution budget will be made of the insecticides present on the plot. Emphasis will be placed on the insecticides leaching off the field in the irrigation runoff water.

The second purpose of the study is to determine the seasonal variation in the pesticide content of a dimictic and of a polymictic reservoir. Comparison will be made of the pesticide content of the water at specific depths, i.e. Epilimnion, Metalimnion and Hypolimnion. The surface inflows and outflows to the reservoirs will be sampled to better assess the pesticide variation. Samples of aquatic organisms, i.e., plankton, benthos, fish and snails, will be taken to determine the concentration of pesticides in organisms inhabiting the reservoir. Comparisons will be made of the pesticide content of those organisms feeding at specific depths.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0414, FRESHWATER ECOLOGY AT RATTLESNAKE SPRINGS

C.E. CUSHING, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The stream at Rattlesnake Springs on the ALE Reserve offers research opportunities in freshwater biology, particularly for studies on the rate of elemental cycling. It is proposed first to examine the physical, chemical, and biological characteristics to provide basic knowledge of the major inventories of the ecosystem. Studies of mineral cycling, using short-lived radionuclides and pesticide cycling with tagged isotopes, will then be made.

RESULTS: Quantitative and qualitative studies of the aquatic flora and fauna on a seasonal basis was started. The seasonal variations in air and water temperature, flow rates, dissolved oxygen, alkalinity, dissolved minerals and nutrients, total dissolved solids, dissolved, total and particulate organics, and organic import and export were examined. Using the pH-CO2 relationships with the upstream-downstream method, estimates of primary production of the autotrophic populations are being made. Primary productivity of the emmergent macrophytes is being estimated by the harvest procedure.

SUPPORTED BY U.S. Atomic Energy Commission

2.0415, PRECIPITATION SCAVENGING

M.T. DANA, Battelle Memorial Institute, *Richland, Washington* 99352 (AT)

The objectives of the study are to determine the magnitudes, understand the mechanisms, and develop predictive capabilities to describe the removal by precipitation of pollutants from the atmosphere. Such removal is a major factor in the cleansing of the atmosphere, but may lead to health hazards at the earth's surface. For the scavenging of natural and anthropogenic particulates, it is important to categorize their size, electrical-charge, chemical behavior and other physical properties such as solubility and wettability; for gases, it is of importance to know and account for their solubility in water. Further, the hydrometeors must be classified as to size, shape, electrical charge, temperature and purity, and significant meteorological parameters must be measured and identified: ranging from those which influence the climatology of a region, such as orographic lift and proximity of precipitation modifiers, to microscale parameters such as turbulence, temperature and humidity. Three facets of the program are pursued simultaneously. The major effort involves field measurements of scavenging coefficients, precipitation characteristics and atmospheric parameters; a second involves controlled parametric and technical- development laboratory work; finally, the results are interpreted and analyses are performed.

Results: Washout experiments for rhodamine dye particles with mass median diameter between 1.5 and 9.5 microns were performed. Dry deposition was evaluated and comparable values of the deposition velocities were obtained for similar conditions. Measurements were made at the Olympic Peninsula field research site of rainfall intensity, raindrop size spectra, and electrical charge on individual raindrops. It was demonstrated that thermophoresis can dominate both diffusiophoresis and Brownian diffusion in the scavenging of submicron aerosol particles.

SUPPORTED BY U.S. Atomic Energy Commission

2.0416, COLUMBIA RIVER SEDIMENT STUDIES

J. NIELSEN, Battelle Memorial Institute, *Richland, Washington* 99352

PNL provides analytical services for the Columbia River and estuary studies being conducted by the USGS for the AEC, aids in the evaluation of the fate of the radionuclides, especially in the area of effect of retention by sediments, and conducts geochemical studies involving mechanisms of radioactivity uptake by the sediments.

SUPPORTED BY U.S. Atomic Energy Commission

2.0417, IN-CLOUD SCAVENGING

R.W. PERKINS, Battelle Memorial Institute, *Richland, Washington* 99352 (AT)

The study concentrates on certain aspects of precipitation scavenging namely, the cloud processes which are instrumental in transferring airborne contaminants into the precipitation elements and which transfer the contaminants to the ground. Three major aspects of the field-experimental approach are used. In one, the flux of radionucides carried by precipitation to the ground is measured and used to interpret the time scales for cloud development and for the in-cloud scavenging of naturally occurring aerosol particles. A second aspect is to make airborne releases of artificial tracers and subsequently detect the tracer both in the cloud and on the ground. The third aspect is to obtain concurrent meteorological measurements.

There are also three closely related aspects of the theoretical analysis. One concerns the analysis of microphysical processes within the cloud. At a larger scale, in order to quantify the global aspects of in-cloud scavenging, investigations are necessary to evaluate entrainment, turbulent diffusion and transport within a cloud, and synoptic scale motions. The third aspect is the numerical modeling of moisture-laden orographic flow, to predict meteorological variables within the cloud.

Results: Three coastal rainstorms were monitored to determine the flux of cosmogenic radionuclides carried to the ground by precipitation. The framework of a two-dimensional airflow model was developed and programmed for the 1108 computer. Theoretical analyses were made to interpret the in-cloud scavenging of particulates tagged with Na-24, and to identify the role of thermophoresis in in-cloud scavenging.

SUPPORTED BY U.S. Atomic Energy Commission

2.0418, PHYSICAL AND RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS
D.E. ROBERTSON, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This study is designed to investigate the rates and mechanisms of the chemical and mixing processes in the ocean by use of the ocean's natural and artificial radionuclides or tracers and by application of the most advanced measurement techniques. Fallout radionuclides and neutron activation products, as well as their corresponding stable trace elements, are measured in seawater, marine organisms, and sediments to provide specific activities in various sectors of the marine environment. The ocean inventory of fallout radionuclides is determined by measuring the depth distribution over wide geographical areas. The physical and chemical forms of the radionuclides and trace elements (ionic, colloidal, chelate, particulate) are determined in an effort to describe the factors governing their concentrations and behavior in the ocean. Studies of the rates of vertical diffusion of surface waters across the established thermoclines are accomplished using the cosmic- ray-produced radionuclide Be-7 and the natural isotopes. The combined measurements will provide the necessary information to determine the rates at which the various elements and pollutants move through the marine food chain to man. Processes which lead to sedimentation will be clarified through measurement of the composition of sediments.

Results: The latitudinal influence on the deposition of cosmogenic Be-7 and fission products was measured in surface seawater samples. Vertical diffusion coefficients across the main thermocline in the open ocean between Hawaii and California ranged from 0.3 to 0.6 per square centimeter as determined from vertical concentration gradients of Be-7. The distribution of mercury in Atlantic Ocean water and its adjacent seas averaged 0.10 micro grain Hg/l, with a range from 0.06 to 0.19 micro grains/l. In oceanic waters, cobalt distributions are extremely variable, with the average concentrations in specific regions varying only two- to threefold.

SUPPORTED BY U.S. Atomic Energy Commission

2.0419, REVIEW OF THE SANTA BARBARA CHANNEL OIL POLLUTION INCIDENT
W.H. SWIFT, Battelle Memorial Institute, *Richland, Washington* 99352

Review and analysis of technical experience gained during the Santa Barbara Channel Oil Pollution incident in the areas of oil spillage control, restoration, environmental factors, and biological and ecological effects.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0420, RATES AND MECHANISMS OF BIOGEOCHEMICAL CYCLING PROCESSES OF THE COLUMBIA RIVER
D.G. WATSON, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

A major goal of the work is an understanding of the functioning of the river as a dynamic ecosystem. The exchange of nutrients and other chemical substances between the several compartments of the ecosystem is of particular interest, and when the rates of exchange can be described in quantitative terms, extrapolation to other ecosystems becomes possible. The study involves measurement of the rates of exchange of selected chemical elements between the water, the various trophic levels, and the substrate of the Columbia River. Radionuclides from the Hanford production reactors selected for the most intense study initially are phosphorus-32, zinc-65, and chromium-51. Measurements of uptake and loss of the radionuclides will be made on organisms actually living in the river. In this way, both the rate of accumulation and the retention of the radioelements are determined. In order to obtain definitive resolution of the field picture, companion studies are carried out in laboratory facilities.

Results: Zinc-65 cycling by periphyton was investigated, including the effects of varying ambient concentrations and competing stable divalent cations upon uptake. For varying ambient concentratons, the uptake curves exhibited equilibrium conditions typical of a closed system. These curves were a reflection of the decreasing ambient concentration and did not represent true uptake equilibrium. Zn-65 cycling was studied in a water-periphyton-fish food web, using laboratory streams. In streams in which the water concentration of Zn- 65 differed by an order of magnitude, a 3- to 5-fold difference in Zn65 concentrations was measured in the periphyton, and a 1.5- to 3-fold difference in the fish.

SUPPORTED BY U.S. Atomic Energy Commission

2.0421, SO2 WASHOUT
M. WOLF, Battelle Memorial Institute, *Richland, Washington* 99352

Assess the gross effectiveness of natural precipitation to remove SO2 from power plant plumes, by a chemical analysis of precipitation collected at ground level under the Keystone Power Plant plume (Project LAPPES).

Determine through laboratory experiments the extent of desorption of SO2, collected in precipitation elements, into the atmosphere 'outside' the plume, and how desorption effect contributes to ground level depletion of SO2 concentration.

Model the effects of natural precipitation to remove power plant plume effluents.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

2.0422, EFFECT OF TEMPERATURE ON BACTERIA
A.J. ROSS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle, Washington* 98115

Heated effluent water from nuclear power plants may be used to raise catfish on the Columbia River. The effect of heated water on fish pathogenic bacteria is unknown. Isolates from a variety of species will be tested for survival at 60 degrees F,70 degrees F,80 degrees F, 90 degrees F, and 100 degrees F.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0423, ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS
G.C. ANDERSON, Univ. of Washington, Graduate School, *Seattle, Washington* 98105

Studies of phytoplankton production are being continued in Puget Sound. The investigation, since 1964, has provided quantitative information on annual phytoplankton production and mean standing crop in two areas of the Sound.

The research proposed herein is to elucidate the reasons for the very large blooms off Seattle when maximum values of 6-7 g C/square meter are photosynthesized per day. Weekly, daily and diurnal sampling will be carried out during periods of high phytoplankton production along with measurements of hydrographic conditions, light and nutrients. Particular attention will be given to the effect of stability, as affected by tides and winds, on the timing of phytoplankton blooms. Measurements will be made of the chemical composition of the crop as well as growth rates of dominant species.

Experimental work involving studies of phytoplankton blooms in enclosed columns of water in situ will be carried out. In this manner, the effects of advection will be eliminated. Culture studies will be conducted with some of the herbivorous copepods.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0424, STUDIES OF THE CONCENTRATIONS OF UNREPORTED LONG-LIVED RADIONUCLIDES IN BIOTA AND OCEAN SEDIMENTS AT BIKINI AND ENIWETOK ATOLLS
T.H. BEASLEY, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105 (AT(45-1)2225)

The occurrence of long-lived radionuclides produced by the testing of nuclear devices at Eniwstok and Bikini Atolls will be investigated. Knowledge of the presence or absence of these radionuclides is of importance for several reasons: 1) scientists of many disciplines currently use long-lived naturally occurring radionuclides for studying meteorological, oceanographic and geochronological processes. The production of these same radionuclides by weapons testing can seriously alter conclusions based on measured contractions that are assumed to be naturally derived; 2) the identification of radionuclides, previously unidentified as the product of nuclear devices, would be valuable to researchers concerned with the use of nuclear devices as a means of excavating canals and harbors; 3) the radiological environment which the beta of this area experience would be better defined. The techniques of multidimensional gamma-ray spectrometry will be used to identify and measure gamma-emmitting radionuclides, while low background beta counting and appropriate chemical techniques will be used to identify radionuclides whose only decay mode is beta partical emission.

SUPPORTED BY U.S. Atomic Energy Commission

2.0425, LEAD IN AQUATIC ENVIRONMENTS
T.M. BEASLEY, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105

The proposed research is aimed at characterizing the role played by biota in the distribution and cycling of lead in aquatic environments. Measurements of stable lead in fresh, estuarine and open ocean water and in selected organisms residing in these waters is underway. The research is designed to point out seasonal effects when lead concentrations in the waters are expected to vary greatly, i.e., periods of high rainfall for all waters and periods of coastal upwelling for marine waters. The proposed project period permits a recording of the lead pollution load of these environments as a result of increased industrialization and urbanization of the Puget sound and Pacific Northwest areas, thereby providing a baseline from which to observe the effectiveness of anti-pollution control measures aimed at reducing environmental levels of automobile exhaust, and other industrial wastes.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0426, CONTROL OF PRODUCTIVITY AND POPULATION CHARACTERISTICS IN AQUATIC COMMUNITIES
W.T. EDMONDSON, Univ. of Washington, Graduate School, *Seattle, Washington* 98105 (AT(45-1))

The object is to analyze the mechanisms that control productivity and population characteristics in aquatic communities. The first stage consists of improving our knowledge of conditions as they exist in natural communities. The basic data consist of measurements of abundance, population structure, rate of activity and relevant environmental features. Much of the work is being carried out in lakes that have been altered in distinctive ways, e.g., the saline lakes in the lower Grand Coulee which have been diluted with fresh water from irrigation project. Other lakes have special features of interest, such as Hall Lake, which used to be meromictic and Mowich Lake, which has no planktonic crustaceans. These field experiments will be backed up by appropriate experiments in the laboratory, as suggested by correlations found in the field data. In addition, appropriate studies of sediment will be made to improve the degree to which the conditions in earlier times can be specified.

Results: A large body of information has already been obtained in previous investigations. Some has been published, and some is in advanced stages of preparation for publication. Much of the information concerns the way the fauna of the saline lakes has changed with more recent dilution, and measurements have been made of the osmotic pressure of blood of invertebrates held in different concentrations of the lake water. A detailed study of plankton productivity and population density has been made in Mowich Lake, and the consequences of the mixing of Hall Lake are being studied. Sediment cores have been taken from the lakes.

SUPPORTED BY U.S. Atomic Energy Commission

2.0427, RADIOCARBON IN THE SEA
A.W. FAIRHALL, Univ. of Washington, Graduate School, *Seattle, Washington* 98105 (AT(45-1))

Samples of sea water are collected and carbon dioxide is extracted onboard ship. Aliquots of the water are returned to the laboratory for total carbon dioxide analysis. The carbon dioxide samples are analyzed for their 14C content. In the upper few hundred meters of the sea, the 14C levels have been significantly perturbed by 14C from nuclear weapons testing in the atmosphere. The samples from the deep sea are presumably natural 14C from the atmosphere to the sea, and from the mixed layer of the sea into the deep sea. The rate of air-sea exchanges of carbon dioxide is expected to be proportional to the square of the average wind speed over the sea surface. In the deep sea, the levels of 14C and total carbon dioxide allow one to assess the rate of deep water advection from regions of deep water formation.

RESULTS: The levels of 14C in the atmosphere are currently about 50% above natural (pre-bomb) levels, and the mixed layer of the sea is about 30% above natural levels. The highest rate of transfer of 14C from the atmosphere to the sea is occurring at southern latitudes. There may be significant transfer of bomb 14C to the deep sea around the margins of Antarctica.

SUPPORTED BY U.S. Atomic Energy Commission

2.0428, INTEGRATED URBAN UTILITY SYSTEMS
B.W. MAR, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

This exploratory interdisciplinary assessment will attempt to define utility system demonstration projects capable of minimizing the impact of urbanization on the environmental quality. The objectives include identification of alternatives and development of sufficient information to justify large scale testing of attractive alternatives. A study of utilizing a city's water supply system as a thermal sink for power plant heat is included as a specific study case to establish methodology for the assessment.

SUPPORTED BY U.S. National Science Foundation

2.0429, NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS
E.B. WELCH, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

A study of the relationship between pertinent environmental factors and the growth of nuisance algae in a highly eutrophic lake is proposed. The relative importance of light intensity, temperature, nitrate nitrogen and phosphate-phosphorus contents, degree of thermal stratification and detention time of the water in determining growth and species succession of the algae will be studied by field observation and statistical treatment of the data. As a potential method of algal control, the effect of nutrient dilution, with low-nutrient water, the presence of lake sediment, and water detention time on growth and species selection will be studied by in situ experiments in plastic bags. The usefulness of monitoring algal productivity in a lake by continuous measurements of dissolved oxygen in the surface water will be evaluated against the light-and dark-bottle method.

This study has particular relevance because of the future potential to evaluate flushing as a method of eutrophication control in Moses Lake.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0430, TOLERANCE AND CYTOLOGICAL RESPONSE OF ALGAE TO MINE WATER
H.D. BENNETT, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

2. WATER QUALITY

Field and laboratory studies are to be conducted to gain further information on the tolerance of algae to mine water and the cytologic effects of mine water on the algae. This is to obtain information on what specific factors of mine water affect the occurrence, establishment, and abundance of algae in mine water, and to determine adaptations of algae that permit or do not permit tolerance to pollution.

Studies are to be made with collections from natural habitats, from field cultures, and cultures in the laboratory. The study will make use of algae known to be tolerant, algae not known to be tolerant, acid mine water, non-acid mine water, and non-polluted water. Physical and chemical factors of the water to be determined will include the major contaminants known to be characteristic of mine water. The cytological characteristics will be studied with the aid of the bright field, phase, and the electron microscope.

The laboratory and field data will be processed to permit drawing of conclusions, based on this and related work, that will help clarify algae-mine water relationships, and to point toward continuing research needed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0431, GEOCHEMICAL BEHAVIOR OF IRON AND MANGANESE IN A RESERVOIR (LAKE LYNN, WEST VIRGINIA) FED BY STREAMS CONTAINING ACID MINE DRAINAGE

R.G. CORBETT, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

Total Program - We proposed to study the geochemical behavior of iron and manganese in a dynamic system involving the impoundment of waters polluted by acid mine drainage. The natural model chosen is Lake Lynn, West Virginia, which has formed behind a dam constructed in 1929. The quality of water and abundance of fauna in the reservoir have deteriorated according to available data. An understanding of the behavior of iron and manganese in this environment should benefit many workers in water resources. The phases of research are ordered such that the project may progress as long as results appear fruitful.

Phase I - Areal Variation in Iron and Manganese Content of Sediments of Lake Lynn. From 150-200 samples of sediment from lake Lynn will be collected and analysed mechanically for particle size and spectrochemically for iron content and manganese content. Any variations present will suggest the course of future phases. Concurrently, the literature will be reviewed for information pertinent to the entire study.

Subsequent researches may involve mineral species in the sediments chemical stratification and seasonal variation thereof of iron and manganese in the impounded water and pore water of the sediment, co- precipitation of other elements with iron and manganese, and a chemical budget involving influx, precipitation, and escape at the reservoir outlet of iron and manganese.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0432, MICROBIOLOGY OF ACID DRAINAGE FROM COAL MINES

W.N. MILLAR, West Va. University, Graduate School, *Morgantown, West Virginia* 26506

In recent years considerable research effort has been directed towards studying the physiology of iron-oxidizing thiobacilli. These autotrophic bacteria (members of the Thiobacillus and Ferrobacillus genera) are responsible for producing much of the acidity found in coal mine drainage. However, little or no practical knowledge has yet been obtained which can be applied to control the activities of these organisms in their natural habitats. This problem of acid coal mine drainage will be investigated from an ecological point of view. The hypothesis adopted is that heterotrophic microbial populations are present in acid drainage and grow at the expense of organic compounds (e.g., pyruvic acid) released by the thiobacilli. If this hypothesis is correct, the removal of these toxic waste products by the heterotrophs must allow greater growth and acid production by the thiobacilli than if the waste products accumulated. Control of the heterotrophic populations in coal mine drainages might result in the partial control of the acid producing thiobacilli in such systems.

The initial objective of the research is to isolate indigenous heterotrophic bacterial and fungal populations from acid coal mine drainage, and to determine their ecological relationships with the iron- oxidizing thiobacilli.

Strains of 'Bdellovibrio bacteriovorus' will be examined for the biological control of the iron-oxidizing thiobacilli. The results from these studies will be used to evaluate 'Bdellovibrio' as an agent for the abatement or control of acid production in coal mines.

SUPPORTED BY U.S. National Science Foundation

2.0433, MINING OPERATIONS FOR THE REDUCTION OF HARMFUL DRAINAGE FROM UNDERGROUND COAL MINES

E.B. WILSON, West Va. University, School of Mines, *Morgantown, West Virginia* 26506

The work is designed to establish those technically and economically optimal underground coal mine operating and planning practices which are or which can be employed as means of preventing or substantially reducing the generation and efflux of harmful (high iron and/or high acid) drainage water. In addition to a 'state of the art' publication describing and analyzing published information, a thorough study of current mining practices will be accomplished. This study will seek to reveal what can be done during the mining process to prevent water pollution and will be conducted by on-site interviews with mine production and engineering personnel. Observation of these procedures and the collection of water samples for analysis will verify their effectiveness and utility. Conclusions will be based on combinations of procedures and will be applied with consideration for mining method and mining conditions. The project will be conducted from February 1970 to July 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0434, ACID MINE DRAINAGE MICROBIOLOGICAL STUDIES

H.A. WILSON, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

The proposed studies will be concerned with: 1. The isolation and identification of the heterotrophic acid tolerant bacteria in sewage polluted acid mine drainage streams. These isolates will be compared with those isolated in sewage polluted 'normal' (non-acid) streams; 2. the isolation of yeasts and true fungi from sewage polluted acid mine drainage streams. These also will be compared with isolates from non- acid streams; and to determine the role yeasts may play in sewage decomposition under the acid conditions; 3. to determine the amino acids and carbohydrates in sewage (by chromatography) and to compare their decomposition rates under 'normal' (non-acid) conditions with their decomposition rates in acid mine water environments.

Yeasts become the predominating microorganisms in sewage-acid mine water mixtures under laboratory conditions and these microorganisms also occur in streams with those characteristics. It is not known just what their role is. Two species of yeasts have been encountered in all of the work in our laboratories on studies of sewage decomposition in an acid mine water environment; however, little work was done to determine the role they played.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0435, EVALUATION OF WETLAND IMPOUNDMENTS ON STATE-OWNED WILDLIFE AREAS

A.F. LINDE, State Dept. of Nat. Resources, *Madison, Wisconsin* 53701

1. Provide a continuing record of changes occurring in submergent and emergent vegetation on study impoundments as a result of time and applied management techniques. 2. Attempt to relate water chemistry to impoundment productivity, applied management practices, impoundment aging, and determine desirable chemical ranges for wetlands in the various regions of the state. 3. Record the amount of sedimentation occurring as an impoundment ages and determine its relationship to impoundment productivity and the magnitude of its effects on decreasing

water depth. 4. Record wildlife use on each study area, for purposes of determining wildlife response to applied management, and to document the amount and type of public use on the area as it reflects recreational values. 5. Test new techniques and develop existing techniques on a variety of study areas where their application would have value.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0436, PLANT-AVAILABLE PHOSPHORUS STATUS OF LAKES
D.E. ARMSTRONG, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

The proposed research plan involves evaluation of the role of phosphorus in eutrophication through an understanding of the factors controlling the amount of phosphorus available to algae and higher plants in lake waters. The approach will be as follows: 1. Standardize methods for the fractionation and quantitative determination of the major forms of phosphorus in lakes, including soluble inorganic, soluble organic, microbial algal and higher plant and sediment phosphorus. Forms of organic phosphorus and the total organic and inorganic phosphorus in the seston and sediments will also be investigated. 2. Determination of the relative rates of fixation of plant-available phosphorus in lake waters by microorganisms, sediments and higher plants as affected by environmental conditions, employing P32-labeled phosphorus compounds. 3. Establish relationships between the forms and amounts of fixed phosphorus in lakes and the actual and potential amounts of phosphorus available for aquatic plant uptake.

Experiments will involve simulated lake environments in the laboratory and analyses of samples taken from lakes at different stages of eutrophication.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0437, ROLE OF PHOSPHORUS-SEDIMENT INTERACTIONS IN EUTROPHICATION
D.E. ARMSTRONG, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The purpose of this project is to determine the relationships between sediment properties and the rate of P uptake or release as a function of limnological conditions. Initial emphasis was placed on the nature and mode of retention of sediment phosphorus. Future investigations will emphasize the factors and mechanisms controlling P uptake and release.

Sediments of diverse properties have been investigated to determine the sediment properties and other factors controlling P uptake and release by sediments. Total P ranged from 560 to 7000 ppm; 30 to 90% of the total P was inorganic P. Inorganic P was mainly non-occluded, exchangeable and associated largely with amorphous Fe in both the non- calcareous and calcareous sediments. Methods for total organic P determination were evaluated; forms and mobility of organic P are under investigation. Retention of added inorganic P was generally greater for non-calcareous than for calcareous sediments and related to levels of native total and inorganic P in the sediments. Amorphous Fe played a major role in P retention. Future work will emphasize P desorption, exchangeability and biological availability. The project was initiated in September, 1968 and is expected to be completed in July, 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0438, MERCURY TRANSFORMATIONS IN RIVER BOTTOM SEDIMENTS
G.M. BOUSH, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The ultimate objectives are to obtain pure cultures of microorganisms capable of growth in environments high in divalent mercury ions; (b) determine the role of microorganisms in the transformations of mercury from inorganic to organic form; (c) determine the role of mercury tolerant microbes in the accumulations of mercury from contaminated effluent; (d) study the mechanism involved in the movement of mercury within aquatic food chains; and (e) attempt to clarify the mercury chemical form or forms present in various environments.

Efforts will be made to study the roles of microorganisms in affecting the fate of inorganic mercuric ion by using the aquatic microorganisms isolated from Wisconsin waters. The rates and conditions to form methyl mercuric compounds should be closely studied. The most important metabolic products from both phenyl mercury and from mercuric ions formed as a result of microbial action will be studied. Uptake, concentration, accumulation and transfer processes of such metabolic products by various ecosystems will be investigated. The water-sediment conditions which favor microbial activities to convert phenyl mercury and mercuric ions to more toxic methyl mercury and other forms which might facilitate biotransfer-accumulation will be investigated.

SUPPORTED BY Wisconsin State Government - Madison

2.0439, METABOLISM OF FIXED NITROGEN BY PLANTS AND BACTERIA
R.H. BURRIS, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The Mo-Fe protein and the Fe protein which acting together fix nitrogen are being isolated and purified from Clostridium pasteurianum and Azotobacter vinelandii. The physical chemical properties of the proteins and the kinetics of their enzymatic activities are under study. The ferredoxin from Bacillus polymyxa has been shown to be functional in nitrogen fixation in this organism and the properties of the ferredoxin are being investigated. Flavoproteins and non-heme iron proteins have been isolated from A. vinelandii and the role of each in electron transport and nitorgen fixation is sought. The ferredoxins from blue- green algae are being compared with ferredoxins from other sources to determine how the blue-green algae fit the evolutionary pattern of this protein. Field experiments are being conducted to establish the role of the nitrogen fixing blue-green algae in eutrophication of fresh water lakes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0440, DETECTION OF LIMITING AND SURPLUS NUTRIENTS IN ALGAE
G.P. FITZGERALD, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

Previous reports have described techniques developed for the detection of limiting or surplus phosphorus in algae. The present work involves the evaluation of a technique for determining if algae were limited by their nitrogen supply. It has been shown that labile carbohydrate reserves tend to build up in algae when they are deprived of sufficient nitrogen for normal growth. It is possible to detect these reserves considerably before the total nitrogen content of the algae starts to decrease. The development and loss of the reserve carbohydrate has been used to follow the development of nitrogen starvation and reversal of starvation by the addition of ammonia or nitrate nitrogen. The significance of these tests to algae in general and to the ecology of nitrogen nutrition in water pollution will be further evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0441, NUTRIENT SOURCES FOR ALGAE AND THEIR CONTROL
G.P. FITZGERALD, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

In order to make logical decisions concerning the nutrients responsible for obnoxious growths of algae we must know the sources of available nutrients. This project has been designed to make use of techniques for the detection of limiting or surplus nutrients, to demonstrate the adaptations algae can make in order to utilize different forms of nutrients, such as polyphosphates, and provide short-term tests which can be conducted under controlled conditions to evaluate such conditions on the availability of certain nutrients. Through the use of these bioassay techniques for nutritional studies of problem-causing algae, it is proposed to study the sources of nutrients available to algae and to evaluate possible means of limiting these available sources.

Effect of Detergent Builder Replacements on Copper Toxicity - Preliminary tests of the effects of NTA, EDTA, HEDTA, and

HEIDA on the algicidal (Microcystis) and algistatic (Chlorella) properties of copper sulfate have indicated that the presence of these products will decrease the toxicity of copper applied to lakes for algae control. This subject will be further evaluated along with a complete literature review of algicide applications in general.

Field Test of the Availability of Phosphorus in Lakes of the Madison Area - By using the acetylene reduction method involving phosphorus limited nitrgen-fixing algae the availability of P will be followed in Madison Lakes at different depths in both the epilimnion and hypolimnion.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0442, THE TREATABILITY OF LEACHATE FROM SANITARY LANDFILLS

R.K. HAM, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

One outcome of the increasing awareness by the public in environmental concern is the attention being given to the contamination of ground and surface waters by leachate from sanitary lanfills. The primary objective of this study is to indicate the usefulness of several methods of leachate treatments by which such contamination may be reduced.

When available, it is likely that the most desirable means of leachate treatment will be simple discharge into a municipal sewer for treatment at the sewage treatment plant. The project includes a study of the implications of such a practice, including determination of the minimum amount of sewage necessary to dilute leachate to avoid disrupting activated sludge or trickling filter processes. In the absence of a sewer, a special treatment process must be used. Basic processes to be investigated for this purpose include lagoons, chemical precipitation, flocculation and sedimentation. Process efficiencies for leachate treatment, and critical characteristics of leachate which may indicate the effectiveness of each of these processes, will be determined for several process configurations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0443, EXPERIMENTAL REVERSAL OF THE LAKE EUTROPHICATION PROCESS

A.D. HASLER, Univ. of Wisconsin, School of Letters, *Madison, Wisconsin* 53706

The proposed research program will attempt to evaluate the hypothesis that artificial acceleration of eutrophication (assuming a fixed, irreducible influx of nutrients) will ultimately result in a decrease in the rate of eutrophication and a temporary increase in production of food and other organic matter.

The majority of experimentation will be done IN SITU, using natural and artificial lake basins (Chippewa and Vilas Counties, Wis.). The acceleration of eutrophication at a predetermined, fixed level of nutrient influx, will be attempted by means of artificial lake circulation and artificial lake warming.

Biological indices of eutrophication, including photosynthetic rates, (14C method), diversity of bacteria and phytoplankton, and rates of zooplankton and fish production will be measured.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0444, A SYSTEMS ANALYSIS OF WATER AND NUTRIENT FLOWS IN THE LAKE WINGRA BASIN

D.D. HUFF, Univ. of Wisconsin, Water Resources Center, *Madison, Wisconsin*

The long-range goal of this interdisciplinary project is development of a capability for computer simulation of the cycling and distribution of eutrophic materials in the environment. The research approach consists of parallel development of nutrient transfer function models and a computer simulation model which combines mathematical representations of hydrologic processes and associated eutrophic- materials cycling.

The major anticipated result of the project will be the use of a simulation model to study probable changes in eutrophic states of lakes which may be attributed to human impact, and to develop methods for control. A second important result is the use of nutrient transfer function models as an aid in determining overall completeness and adequacy of the eutrophication research program.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0445, NITROGEN TRANSFORMATIONS IN LAKE SEDIMENTS

D.R. KEENEY, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The overall objective of the investigation is to elucidate the nitrogen status and transformations in fresh water lake sediments as a means of evaluating the contribution of nitrogen to the relative state and rate of lake eutrophication. This objective is subdivided into the following specific objectives: 1. To determine the types and amounts of nitrogen present in sediment profiles of fresh water lakes as a function of the state of lake eutrophication. 2. To elucidate sediment properties and environmental factors controlling net nitrogen mineralization or immobilization in lake sediments.

The ultimate aims are (a) to provide an index of present and past fertility status of lakes by an examination of the nitrogen status of and transformations in sediments, and (b) to quantitatively define the nitrogen additions to and releases from sediments as a function of lake type, and nutrient input at different times of the year.

The project was initiated on September 1, 1968, and will be completed on June 30, 1973.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0446, MERCURY UPTAKE AND RELEASE BY BOTTOM SEDIMENTS

D.R. KEENEY, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The ultimate objective is to evaluate the uptake and release of mercury by bottom sediments as related to (1) the influence of sediment and water properties; (2) the amounts and persistence of inorganic and organic mercury; and (3) the availability of mercury for biological uptake.

Detailed objectives are to determine the uptake and release of native and added HgO, Hg2 ion, MMC, DMM, PMA and PMH. Sorption- desorption isotherms of sediments from several Wisconsin rivers differing in chemical and physical properties will be obtained. The effect of water composition and redox status of the sediments on uptake and release of Hg compounds will be determined. The exchangeability of native and added Hg will be determined by isotopic (Hg^{203}) techniques.

The forms and distribution of Hg compounds in Hg-polluted and Hg- amended sediments and waters will be determined using the methods currently being developed and evaluated. Amended sediments will be incubated under oxygenated or anoxic conditions at varying temperatures to ascertain the effect of environmental conditions on the rate and extent of Hg transformations. Permanganate traps will be utilized to collect Hg volatilizing from the model systems.

SUPPORTED BY Wisconsin State Government - Madison

2.0447, ROLE OF SULFATE AND MANGANESE OXIDES ON THE RELEASE OF PHOSPHORUS FROM LAKE SEDIMENTS

G.F. LEE, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

A project will be initiated on the role that sulfate and manganese oxides may have in the release of phosphorus from lake sediments. The primary approach will be to add known amounts of sulfate and MNO_2 to freshly collected lake sediments in laboratory leaching tests. The phosphorus concentrations will be monitored during the leaching tests over a period of several weeks to several months. If sulfate and MNO_2 cause an increase in phosphorus release under either aerobic or anaerobic conditions, studies will be conducted to determine the effect of these species concentrations of the kinetics of P release.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0448, SYSTEMS MODELING OF THE AQUEOUS ENVIRONMENTAL CHEMISTRY OF PHOSPHORUS AND NITROGEN IN LAKE MENDOTA
G.F. LEE, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

Objective of this project is to develop a crude mathematical model that will demonstrate the various sources and sinks for nitrogen and phosphorus compounds in Lake Mendota, Madison, Wisconsin. The components of this model will include the amounts of nutrients transported from the watershed, the uptake and release of these nutrients or aquatic organisms within the lake and the lake sediments as well as the removal of these compounds via the outlet and other modes of transport such as insect larva, aquatic weed harvesting and fish removal. Particular attention will be directed toward determining the role of the thermocline in controlling the release of nutrients from the lake sediments during the summer periods of thermostratification. Total mass of N and P compounds present in the lake will be evaluated by periodic sampling of the water in determining the nitrate, ammonia and organic nitrogen, orthophosphate and total phosphorus. One of the primary objectives of this systems modeling project will be to evaluate the relative significance of the various components that influence the amount of nitrogen and phosphorus compounds available for aquatic plant growth within this lake. This type of information will be used to define those areas which need additional attention in order to develop or generalize and refine mathematical models for the aqueous environmental chemistry of nitrogen and phosphorus.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0449, EUTROPHICATION - N CYCLE - NITRIFICATION AND DENITRIFICATION
E. MCCOY, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

This study involves biological nitrification as contributor of nitrate (or ammonia and nitrite) to eutrophication of lakes and streams, the identification of the groups of nitrifiers involved and of their site of activity. Because denitrification may reverse the process it is also being studied as to the bacteria concerned and their potential activity.

Sites representing open water, underlying mud and beach areas on 5 lakes and 4 streams in the Madison area were surveyed in summer 1969 and are now being monitored in spring, summer, and fall 1970. Water samples are generally negative, occasional water samples from bays and backwater inlets are positive - less than 3 ppm as nitrate. Shore samples, particularly under decaying algae or 'Lemna', are strongly positive at 15 ppm to as much as 180 ppm in late summer. Ammonia is always near algal masses, highest value being over 600 ppm. Nitrite is occasionally found without nitrate. Denitrifying bacteria in open water of weedy bays may reach 10,000/ml.

The field study will continue through summer and fall of 1970 and will be followed by laboratory study of the bacteria during academic year 1970-71.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0450, UNSTEADY FLOW OF GROUNDWATER--DISPERSION AND SALT WATER INTRUSION IN NON-HOMOGENEOUS MEDIA
P.L. MONKMEYER, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

In the study of dispersion in non-homogeneous porous media, a general solution for the distribution of a contaminant in one dimensional flow through a layered or continuously graded media has been obtained. For two and three layer systems, the solution has compared very well with experimental data. The solution can be adapted to non- uniform flows. Currently, additional experiments are being carried out to verify the theoretical model.

Subsequently, the work will be extended to salt water intrusion in non-homogeneous, coastal aquifers. This investigation will involve analytical and experimental models of the instantaneous and quasi steady salinity and velocity distributions in confined, layered aquifers. The influences of disperson and pumping and recharging wells will be considered.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0451, EUTROPHICATION OF NATURAL WATERS
G.A. ROHLICH, Univ. of Wisconsin, Water Resources Center, *Madison, Wisconsin*

The research objectives of this multidisciplinary program are to make indepth studies on the eutrophication of natural waters. Among some of the specific objectives are: 1. Determine the cause-and-effect relationship between natural aging of lakes and inadvertent enrichment which leads to short-term changes in water quality in terms of physicochemical and biological factors. 2. Develop methods of forecasting variations in quality of lake waters by the examination of early trends. 3. Contrive methods of management to control optimum quality of lake waters for municipal, industrial, agricultural, and recreational uses and to arrest or reverse eutrophication trends. 4. Examine the interrelationships among several variables pertaining to the process of eutrophication and exclude those which prove to be of doubtful value for continuing interdisciplinary comprehensive studies. 5. Establish a research program that will generate the kinds and amounts of data needed for systems analysis of the total problem by a competent environmental scientist.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0452, MULTIPLICATION OF CLOSTRIDIUM BOTULINUM TYPE E IN THE GREAT LAKES
H. SUGIYAMA, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

Clostridium botulinum type E is present in all four of the Great Lakes studied, but the source of the organism is not fully understood. Contrary to the explanation advanced for foci of concentration of the organism in marine areas, our work suggests type E to be actively multiplying in the lakes.

The proposed research will emphasize Green Bay, which has an exceptionally high level of type E. 1. Seasonal fluctuations in the type E populations at selected locations will be sought to establish cyclic changes in numbers. 2. The depth at which maximum counts of type E exist will be determined with cores of bottom deposits. 3. Combination of vegetation and bottom deposits subjected to alternate freezing and thawing (presumably equivalent to wintering in nature) may support type E growth. 4. Possible relationship between the pollution of the lower Fox River and the frequent samples giving negative control cultures will be studied. 5. Attempts will be made to develop an agar medium on which toxin-producing type E colonies can be readily distinguished.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0453, ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY
H. SUGIYAMA, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

Multiplication of Clostridium botulinum type E in Green Bay may have a seasonal basis. Attempts will be made to see if bottom deposits collected at several locations at frequent intervals will again show a high type E count in the spring followed by decreasing numbers during the summer and fall. Tests will be made to determine if type E will multiply in environmental samples which are repeatedly frozen and thawed in the laboratory.

Studies will be continued on the factors in certain environmental samples which inhibit the growth of type E. Differentiation of toxigenic type E colonies from non-toxigenic 'E-likes' will be attempted. The protoplasts and L-forms of C. botulinum are being studied. Possible multiplication and toxin formation of C. botulinum in vivo will be tested.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S

2.0454, NUTRIENT ENRICHMENT OF RUN-OFF WATERS BY SOILS. ENRICHMENT POTENTIAL OF URBAN SOILS IN THE CITY OF MADISON
J.K. SYERS, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The overall research objective is to evaluate criteria and develop tests for assessing the potential of soils for nutrient enrichment of run-off waters. In phase I, the phosphorus enrichment potential of urban soils in the city of Madison will be investigated. The approach will be as follows: 1. Determine the forms and amounts of inorganic and organic P in selected urban soils in the city of Madison. Soils from existing and future land development sites of high potential erodibility will be emphasized. 2. Determine the release and uptake or organic and inorganic P by the above soils as related to soil properties and run-off conditions. 3. Establish routine tests for predicting the potential of the soils for P-enrichment of run-off waters.

Experiments will involve simulated run-off, stream and lake environments in the laboratory. Extensive use will be made of P32 labeled compounds to evaluate the exchange-ability of adsorbed native and applied inorganic P and biological immobilization and release of P.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0455, EUTROPHIC EVALUATION OF A SMALL MULTI-LAND USE WATERSHED
A.E. ZANONI, Marquette University, School of Engineering, *Milwaukee, Wisconsin* 53233

The proposed project involves the determination of the quantities of nitrogen and phosphorus which originate from various land use activities in a small river watershed tributary to Lake Michigan in the Milwaukee metropolitan area. The watershed in question is the Menomenee River watershed which includes agricultural, residential, industrial, commercial, park and recreation, woodlands and wetlands, and governmental-institutional land uses, and yet encompasses a drainage area of only 135 square miles. Based on the results of preliminary surveys, sampling locations will be located at critical points along the river for discharge measurements and nitrogen and phosphorus analyses. These data will then be used to estimate the nutrient quantities from the various sources in the watershed. The data will also be correlated with hydrological and climatological data to establish the manner in which these watershed factors might influence nutrient quantities from the various sources.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0456, GROUND WATER POLLUTION FROM SANITARY LANDFILLS AND REFUSE DUMP GROUNDS - A CRITICAL LITURATURE REVIEW
A.E. ZANONI, Marquette University, School of Engineering, *Milwaukee, Wisconsin* 53233

The main objective of this study is to review the technical literature and research reports dealing with ground water pollution potential originating from the leachates of sanitary landfills and refuse dump grounds. The intention of this literature review is to determine the seriousness of this problem and on the basis of what is known, make specific recommendations to the Wisconsin Department of Natural Resources regarding the future selection and operation of disposal sites. Also it is anticipated that the review will suggest research programs to obtain needed information in this area.

In addition to technical journals and research reports, a survey will be conducted of the practice employed in this regard in some twenty states in the country. This survey will establish if any research has been done in this area, what regulations are in force regarding the selection and operation of refuse disposal sites, and if any new rules and regulations are being contemplated in the future.

SUPPORTED BY Wisconsin State Government - Madison

2.0457, WISCONSIN RIVER ICE STUDIES
N.P. LASCA, Univ. of Wisconsin, Graduate School, *Milwaukee, Wisconsin*

The objects of this project are: 1.) To determine the effect of river ice on channel development and erosion, 2.) To determine the relationship of pollutants to ice in rivers, 3.) To evaluate ice crystal growth and deformation under progressive stress occurring in ice piling against obstructions.

SUPPORTED BY U.S. National Science Foundation

2.0458, SEDIMENTARY FACIES IN LAKE BUTTE DES MORTS, WISCONSIN
J.W. MCKEE, Univ. of Wisconsin, Graduate School, *Oshkosh, Wisconsin* 54902

Lake Butte des Morts is a shallow, highly eutrophic lake which is undergoing rapid changes--some natural, some caused by man. Because of the importance of this and adjoining lakes to the large number of people who live nearby, management programs are desirable. But many of these should not be attempted until a greater understanding of physical processes in this lake is attained.

Toward this end a series of studies is being planned. This study (the first of the series) will result in a description of the present distribution of sediment types in Lake Butte des Morts. Samples will be taken from short cores, then subjected to standard laboratory procedures for determination of composition and of grain size mineral sediments. Isopleth maps will be constructed to show: 1. Proportion of organic matter or of mineral matter. 2. Mean grain size of sands. 3. Sorting.

A bathymetric chart will be constructed for comparison with previous data in order that the filling rate may be estimated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0459, EFFECTS OF SOUTH SHORE DRAINAGE BASINS AND CLAY EROSION ON THE PHYSICAL AND CHEMICAL LIMNOLOGY OF WESTERN LAKE SUPERIOR.
D.A. BAHNICK, Univ. of Wisconsin, School of Letters, *Superior, Wisconsin* 54880

This project involves a geological and chemical investigation of a sector along the south shore of western Lake Superior. The study area includes portions of Lake Superior which are influenced by stream discharge and erosion of Pleistocene red clay. Water samples will be analyzed for phosphate, nitrate, copper, and conductivity. Bottom sediments will be analyzed for the distribution of particle size. Water samples will be collected in the littorial zone under both turbid and non-turbid water conditions (Turbid conditions indicating the presence of significant amounts of suspended solids).

The data will be analyzed for the effect of river discharge and red clay erosion on water quality. Statistical analyses of sediment samples will be contoured to determine stratigraphic facies relationships of recent lake bottom sedimentation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0460, PHYSICO-CHEMICAL PROCESSES AND IONIC STATES OF MICROCONSTITUENTS IN SEA WATER AND THEIR RELATION TO RADIOECOLOGY OF NORTH ADRIATIC
M. BRANICA, Inst. Rudjer Boskovic, *Zagreb, Yugoslavia*

During the next period the problems will be devoted to the further development of new analytical procedures for the determination of the ionic states of some microconstituents as well as to their physico- chemical characterization in sea water, biota and sediments.

The research effort will be partly centered on the investigation of Kinetics and equilibria between various (ionic, complexed and particulated) species, present in the sea environment, as well as the exchange reaction with the added radionuclides in sea water.

Influence of different conditions in the sea environment on the charge of surfaces of abiotic particles will be also studied.

Techniques used will be mostly various polarographic techniques, electromigration methods and radiometric analysis.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

B. POLLUTION IDENTIFICATION

Measurement, Monitoring, Bioassay, Bioindicators, and Instrumentation. Includes Ecological Baseline Studies, Prediction and Forecasting of Water Pollution Potential.

2.0461, STUDIES ON THE INTERACTIONS OF BACTERIA AND NEMATODES

G.R. WILT, Auburn University, School of Veterinary Medicine, *Auburn, Alabama* 36830

Investigations conducted at Auburn University under OWRR Project A- 006-ALA have resulted in a better understanding of the interactions of aquatic nematodes.

The proposed research will extend from current knowledge with the following objectives: 1) Determine if certain water resources with their indigenous bacterial flora may serve to maintain and increase populations of nematodes known to be important to the welfare of man. 2) Determine what effect bacterial-feeding nematodes have on the bacteriological stabilization of organic matter. 3) Determine further the significance of virus-bacteria-nematode associations. 4) conduct studies on the occurrence and nature of nematocidal activity of aquatic bacteria. 5) Investigate the feasibility of using certain nematodes as rapid and specific indicators of pollution.

This proposed research will not be directed toward public health aspects, but rather towards a much broader base.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0462, AREA DESCRIPTIONS OF ALABAMA'S ESTUARIES

J.H. CRANCE, State Seafoods Division, *Dauphin Island, Alabama* 37528

Objectives: 1. To determine the physical characteristics of the estuarine areas of Alabama including the location, boundaries, acreage, depth, volume, predominant types of vegetation, discharge of streams, principal hydrological properties, special benthic features, human population, major economic features and discharge of effluents into each estuary. To publish an atlas of results.

Procedures: Existing reports, maps and other data of various agencies will be reviewed and analyzed and pertinent information will be compiled. Data not available will be obtained by field surveys. An atlas of the physical characteristics of Alabama's estuaries will be prepared in accordance with procedures adopted by the Technical Coordinating Committee of the Gulf States Marine Fisheries Commission.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0463, VIROLOGICAL METHODS RESEARCH IN WATERS

W.F. HILL, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Dauphin Island, Alabama* 36528

This project is concerned with developing and evaluating the systems requirements for isolating virus from large quantities of virus- contaminated water. This includes, but is not limited to, waters used for drinking, recreation, reclamation, and food production. The major problem reduces to the inadequacy of available methodology to sample, isolate, and concentrate viruses occurring at low multiplicity levels in waters. Methods providing for at least a 1,000-fold concentration of virus are needed at the outset to satisfy a reasonable sensitivity level. At the outset, a sequential methods approach will be implemented. This approach will encompass the adaptation of membrane filtration to sampling and recovery of viruses from large volumes of environmental waters. Concentration of low multiplicities of recovered virus from eluates will involve evaluation of a number of procedures such as hydroextraction, polyelectrolyte and/or aluminum salt flocculation, and ultracentrifugation. Initially, the sequential methods technic will be applied to estuarine waters under laboratory conditions using a 'model' (poliovirus 1) enteric virus. This project was started in July 1969 and is continuing.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0464, BACTERIAL SURVEY OF MARINE BOTTOM SILT

B.E. HUNTLEY, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Dauphin Island, Alabama* 36528

Objectives of the project are to determine if the environmental conditions in the marine silt of Mobile Bay are conducive to bacterial growth with emphasis on the coliform indicator group of organisms. Information obtained from the study will be used to evaluate the validity of current standards which use the coliform bacterial group as reference for fecal pollution. Bottom 'silt' will be collected from selected sampling sites for (1) use in culture media at the laboratory to determine if it will support bacterial growth and (2) will be analyzed for its bacterial content. Sampling sites have been established in (1) areas permanently closed to the harvesting of shellfish because of pollution and (2) areas subject to seasonal closure during periods of increased river flow into the Bay. Physical parameters of the bay water and 'silt' at the sites are being monitored to determine if seasonal variations in the environment are a factor affecting bacterial growth. The project started in August 1969 and is continuing.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0465, CHEMICAL INDICATORS FOR FECAL POLLUTION

F.C. KOPFLER, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Dauphin Island, Alabama* 36528

The objective of this project is to evaluate the feasibility of using the end products of human and animal metabolism found in feces as chemical indicators of pollution. The ultimate goal is that the detection of certain metabolites will permit recognition of fecal pollution when enumeration of fecal indicator bacteria cannot be relied upon to do so.

This year the evaluation of coprostanol will be continued. Water from various sources will be examined for lipids which may interfere with the determination of coprostanol; clean-up techniques for these extracts will be refined or devised if necessary. The persistence of coprostanol in water under selected conditions will be investigated. The concentration of coprostanol will be compared with levels of indicator bacteria in sewage and selected natural waters.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0466, CHEMICAL POLLUTANTS IN THE ESTUARINE ENVIRONMENT

F.C. KOPFLER, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Dauphin Island, Alabama* 36528

The objectives of the project are (1) to determine the identity of organic pollutants in raw and finished waters; (2) to develop or refine methods of analysis for chemical pollutants; (3) to determine the significance of inorganic, natural or synthetic organic chemicals in various waters and (4) to determine the relationship of chemical pollutant concentrations in shellfish to the chemical state and amount of the substance present in the environment.

This year the accumulation rate and total accumulation of mercury by groups of oysters each exposed to a different chemical form of mercury in a flow-through aquarium will be investigated. Initially inorganic mercury, methyl mercuric chloride and phenyl mercuric acetate will be used.

The relationship between the elevated zinc burden in oysters and the apparently normal concentration of zinc in the overlying water at a particular location in Mobile Bay will be studied.

Silica-gel and flurosil column chromatographic clean-up techniques for pesticide extracts of water will be evaluated and compared as time permits.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0467, VIROLOGICAL METHODS RESEARCH IN WATERS
W.F. HILL, U.S. Environ. Protection Agcy., Gulf Coast Water Hygiene Lab., *Dauphin Island, Alabama* 36528

This project is concerned with developing and evaluating the systems requirements for isolating virus from large quantities of virus-contaminated water. The major problem reduces to the inadequacy of available methodology to concentrate and recover viruses occurring at low-multiplicity levels in waters used for drinking, recreation, reclamation, and food production. Methods providing for at least a 1,000-fold concentration and 50 to 100 percent recovery of virus are needed to satisfy a reasonable sensitivity and efficiency level. At the outset, a sequential methods approach was implemented. This approach encompasses the adaptation of the membrane-adsorption technique as the primary procedure for concentrating and recovering viruses from large-volumes (100-gallon quantities) of surface waters and finished water. Further concentration of low-multiplicities of recovered virus from filter eluates will involve evaluation of a number of secondary procedures such as two-phase separation, polyelectrolyte-adsorption, and continuous-flow zonal ultracentrifugation, to name a few. The sequential methods approach will continue to be applied to estuarine waters and tap water under laboratory-controlled conditions using a 'model' enteric virus (poliovirus type 1, LSc2ab). By combining the membrane-adsorption technique with aqueous polymer two-phase separation, volume reductions of 126,000 to 1 have been observed with up to 67% of the input-virus being recovered. The prototype-system has shown a capability for detecting virus occurring at multiplicities as low as 1 to 2 PFU per 5 gal from both fresh and estuarine waters.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0468, BIOLOGICAL PROPERTIES OF SEWAGE LAGOONS AT TUSKEGEE, ALABAMA
K.S. CHAHAL, Tuskegee Institute, School of Agriculture, *Tuskegee Institute, Alabama* 36088

This study will determine the efficiency of sewage lagoons and the effect of microorganisms and their byproducts on the quality of water in receiving streams. Samples of raw sewage and lagoon effluent will be analyzed for total solids, BOD, dehydrogenase activity, total microbial count, and relative proportions of different kinds of microorganisms during different seasons of the year. Microbial byproducts will be extracted from cultures of microorganisms isolated from samples. The biological activity of the byproducts will be tested using mammalian tissue culture technique. Parameters for bioassey will be cytochemical changes, synthesis of protein and nucleic acids, and total cell count. Identification of compounds will be by IR and UV spectrophotometry, gas, paper, and thin layer chromatographic methods.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0469, AQUATIC-BIOTIC COMMUNITY STRUCTURE AS AN INDICATOR OF POLLUTION
D.T. ROGERS, Univ. of Alabama, School of Arts, *University, Alabama* 35486

The species diversity of benthic macroinvertebrate communities will be investigated in several small streams which are affected by strip mine drainage. Iron, silica, copper and pH will be measured in the water from which the invertebrate samples are taken. A statistical analysis will be used to determine which of the water quality criteria have the greatest affect on the macroinvertebrate community structure as described by the formula d equals minue E p sub i log sub 2 p sub i where p sub i is the ratio of the individuals in species 'i' to the total individuals in the community. This study will cover a twelve month cycle.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0470, BASELINE WATER QUALITY STUDY OF THE ALASKAN ARCTIC ESTUARINE ENVIRONMENT
V. ALEXANDER, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The almost unknown environments of the shallow estuaries and barrier island complexes, the tundra lakes, and the rivers and streams of the Alaskan Arctic are suddenly being stressed by the influx of thousands of people engaged in construction, drilling, transportation, and exploration in support of the vast new oil strikes. The impact of this activity on the arctic aquatic ecosystems cannot be assessed without a basic knowledge of the existing virgin environment. It is therefore proposed that a year-round, baseline study of the water quality parameters and biota in the shallow arctic estuaries, lakes, rivers, and streams be undertaken immediately.

Specific tasks to be accomplished will involve detailed work in the Colville River area and comparative work all along the Alaskan arctic coast with special interest to be given to areas where immediate pollution problems exist. The detailed work will involve the physical circulation and flushing in the shallow arctic estuaries, the nature and movements of sediments, the ice movements in the estuaries and rivers with an eye to the effect of ice on the transport of pollutants, the chemistry and biology of primary productivity, and a survey of the biota of the fresh marine aquatic environments of the Alaskan Arctic.

This project will be part of a logistically combined, well planned coherent effort with the University of Alaska's Sea Grant effort in the Alaskan Arctic. 1 May 1970 is the starting date of the project and it is expected to run through 30 April 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0471, ORGANIC COMPOUNDS IN ALASKA PERMAFROST GROUNDWATER
N.J. BIRKHOLZ, Univ. of Alaska, Inst. of Water Resources, *College, Alaska* 99735

Detection and identification of trace organic compounds in well waters associated with the interior Alaska permafrost regime are being studied using gas and thin layer chromatography and spectra. Surface waters and soil samples are being similarly investigated to the extent that they can clarify the origin of organics at deeper levels. Changes in trace organics will be studied during development of a well.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0472, THE LIMNOLOGY OF TWO DISSIMILAR SUB-ARCTIC STREAMS AND IMPLICATIONS OF RESOURCE DEVELOPMENTS
D. NYQUIST, Univ. of Alaska, Inst. of Water Resources, *College, Alaska* 99735

Many Alaskan rivers and streams are fed by surface and runoff carrying large quantities of suspended sediments, cold water tempratures, and, in many cases, significant ice cover. The river and stream to be studied in this project, Chatanika and Goldstream, not only have the above characteristics, but in addition, associated within the area, is one of the main population centers of Alaska.

The Institute of Water Resources has a basic need for the development of baseline data on a comparatively unpolluted stream system in order that it fulfill its studies of providing adequate advice in water resource management for large areas in the arctic and sub-arctic of Alaska with respect to their development by man.

The objectives of this project will be to: 1. Establish a record of the current flora and fauna before changes due to development by man can occur. 2. Compile a qualitative and quantitative standard against which future populations can be compared. 3. Assess the source and the amount of present nutrients which are being contributed to the streams. 4. To investigate the effect the present addition of nutrients is having on the community productivity.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0473, NAVY ENVIRONMENTS - ARCTIC SEA ICE ORGANISMS
R.A. HORNER, Univ. of Alaska, Institute of Marine Sciences, *Douglas, Alaska* 99824 (N00014-67-A-0317-0003)

Technical Objective: This work relates to improvement of Navy capabilities in marine vehicle and system operation in the arctic. Enhanced performance of surface and subsurface vehicles, systems and weapons will accrue through better understanding of the Navy environment in relation to the quantity, distribution and acoustic, optical, or fouling affects of marine biological populations. In addition, information relative to ecology, pollution, and environmental control of the arctic marine environment will be obtained.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0474, THE QUALITY OF ARIZONA WATERS WITH PARTICULAR REFERENCE TO FLUORIDES
W.H. FULLER, Univ. of Arizona, School of Agriculture, *Tucson, Arizona* 85721

Work on this project to date has consisted of compiling analyses of waters from the Tanque Verde area, east of Tucson. The analyses are arranged according to the legal description of each well included in this study.

Wells in Township 13 S, Ranges 15 and 16 E; Township 14 S, Ranges 15 and 16, and 17 E; Township 15 S, Ranges 15, 16, and 17 E.

Work on this project has not proceeded to the point where conclusions may be drawn or the results plotted on a map.

SUPPORTED BY University of Arizona

2.0475, RADIOCARBON AS A TRACER IN GROUND WATER PROBLEMS
A. LONG, Univ. of Arizona, Graduate School, *Tucson, Arizona* 85721

The radiocarbon content of ground and surface waters is being used as a tracer to study surface and ground water movement. The data are being related to such ground water problems as the rate of laminar flow through aquifers, their permeability, the source, time and rate of charge, radioactive contamination in water supplies, and the waste disposal problem.

The increase in the carbon-14 content of the atmosphere, biosphere and hydrosphere due to nuclear technology is also being monitored.

SUPPORTED BY Arizona State Government

2.0476, PLAQUING AND FLUORESCENT ANTIBODY METHODS FOR DETECTION AND IDENTIFICATION OF ENTEROVIRUSES
P.P. LUDOVICI, Univ. of Arizona, Water Resources Research Ctr., *Tucson, Arizona* 85721

The proposed study is aimed at developing practical plaquing techniques for the direct detection and separation of enteroviruses from natural wastewaters. Emphasis will be placed on the use of primary and established cell lines and differential overlay media.

Fluorescent antibody procedures will be employed to devise a more rapid technique for the identification of these plaque-forming enteroviruses from natural wastewaters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0477, MATHEMATICAL MODEL OF MICRONUTRIENTS AND BIOLOGICAL PATTERNS IN LAKE MEAD
H.K. QASHU, Univ. of Arizona, Water Resources Research Ctr., *Tucson, Arizona* 85721

Progressive increases in concentration of dissolved solids in the Colorado River water from Lake Powell to Imperial Dam seem to alter plankton dynamics and biological productivity of the river. Also, changes in biological productivity and micronutrients concentrations occur within the same reservoir. Development of a digital simulation model to predict micronutrients concentrations and biological productivity is necessary for diagnosing changes in plankton.

The objectives of the study are: (1) to determine trace metal balance at different locations in Lake Mead, (2) to measure biological productivity and conduct plankton population counts at each sampling location, (3) to derive functions relating biological productivity to trace metal concentrations, suspended sediments and some physical variables (temperature, light, solar radiation), and (4) to develop a mathematical model for predicting spatial and temporal changes in biological productivity, plankton dynamics and trace elements concentrations.

Relationships of biological variables (phytoplankton, zooplankton, and biological productivity) to the chemical and physical variables of the aquatic system will be derived using statistical procedures and time series analysis methods. A digital simulation model will be developed with capabilities which allow coupling to a salinity model for the river and reservoir system(s).

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0478, A CONTINUOUS COAGULATION EFFICIENCY MONITOR FOR WATER AND WASTE SYSTEMS
G. BROWER, Univ. of Arkansas, Water Resources Research Ctr., *Fayetteville, Arkansas* 72701

Coagulation of water and waste is very important to water resources. The mechanism of coagulation is one of the primary means of water purification. There is a need for an instrument that would check a water or waste system and determine the optimum coagulant dosage to be added. Currently, no such instrument exists. This proposal outlines the development of an instrument that the water or waste may be placed in and the optimum coagulant dosage will be read out. The instrument will be proven under actual field conditions. Cost economics of the instrument, savings in materials, and increased water quality will be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0479, A EUTROPHICATION MODEL OF THE WHITE RIVER BASIN ABOVE BEAVER RESERVOIR IN NORTHWEST ARKANSAS
R.A. GEARHEART, Univ. of Arkansas, Water Resources Research Ctr., *Fayetteville, Arkansas* 72701

This research will attempt to evaluate the various nutrient contributors to a reservoir in Northwest Arkansas, namely Beaver Reservoir. The purpose is to predict by use of a mathematical model the rate at which this relatively new reservoir will accumulate nutrients. This involves identifying and quantifying on a time-series basis those elements which accelerate eutrophication. The three most common elements known to affect aquatic productivity are carbon, nitrogen, and phosphorus. The major contributors of nutrients to receiving waters are: sewage effluent, urban runoff, agriculture practices, and recreational activities, - all of which can be isolated and monitored in this particular system.

The implementation of this research is as follows: 1) A preliminary examination and isolation of nutrients contributors. 2) Location of sample points based on preliminary examination. 3) Establishment of a sampling schedule which will yield the greatest information with the smallest error. 4) Collect necessary data for input into mathematical model. 5) Construct and computerize mathematical model with acquired data. 6) Predict further eutrophication rates with mathematical model.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0480, MINERAL ANALYSIS OF WATER
W.E. SABBE, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00536)

OBJECTIVE: Provide a facility whereby rural residents of Arkansas can have their domestic waters analyzed for those minerals which tend to render it objectional for general

household use. Accumulate and disseminate data on the chemical content of Arkansas' ground waters.

APPROACH: Water samples forwarded to the laboratory via the County agent will be analyzed for hardness, pH, total dissolved salts and iron. The report, which is returned to the farmer via the County Agent, will describe the water quality and recommend type of water conditioning equipment needed (if any) to improve water quality.

PROGRESS: For the 1969 calendar year 1637 domestic and 145 irrigation water samples were analyzed for various mineral content. This compares with 878 and 171 for 1968 and 809 and 118 for 1967. An additional 203 special tests were performed. Manganese in domestic water was determined on samples submitted in 1968 and 1969. Forty-eight percent of the samples had Mn in excess of the maximum level established for Public Health Standards while thirty-four percent contain Mn levels above which domestic users complain about difficulties in washing and cooking. Therefore the determination of Mn will be a routine test beginning in 1970 and domestic users will receive the necessary recommendations for its removal from their water.

SUPPORTED BY Arkansas State Government

2.0481, DIGITAL SYSTEMS FOR ON-SITE DATA COLLECTION FOR WATER QUALITY ANALYSIS
M.K. TESTERMAN, Univ. of Arkansas, Graduate School, *Little Rock, Arkansas* 72005

The proposed work is concerned with the development of an electronic digital system for on-site data collection in water resources research and control programs. System design objectives include (1) data recordings directly readable by computer input devices, (2) a selectable number of measurement channels within a design maximum, (3) system operation either independent or in synchronism with other equipment of the same type, (4) provisions for interfacing with telemetry packages or data modems for transmission over communication networks (e.g. Bell System Dataphone).

The work would involve establishing data acquisition requirements and sources of error, data system requirements and performance constraints, and system equipment design.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0482, RIVER MURRAY SALINITY SURVEY IN SOUTH AUSTRALIA
UNKNOWN, Australian Dept. of Engin., *Adelaide, South Australia, Australia*

Origin and objective of project: Quality control of water by establishing a series of observers along the Murray and a laboratory for water analysis (Bolivar sewage treatment works).

SUPPORTED BY Australian Government

2.0483, COMPARISON OF MULTIPLE TUBE & MEMBRANE FILTER TECHNIQUES FOR COUNTS OF COLIFORM, FAECAL COLI & ENTEROCOCCI IN TROPICAL WATERS
UNKNOWN, Northern Territory Admin., *Darwin, Northern Territory, Australia*

Comparison studies published are mainly in temperate zones. Establishment of comparisons for tropical waters with their differing flora were required to confirm suitability of tests for routine count studies.

Progress: Completed.

SUPPORTED BY Australian Government

2.0484, VIABILITY OF INDICATOR BACTERIA, COLIFORM, FAECAL COLI & ENTEROCOCCI IN VARIOUS TROPICAL WATERS OF THE NORTHERN TERRITORY INCLUDING SEAWATER
UNKNOWN, Northern Territory Admin., *Darwin, Northern Territory, Australia*

To determine persistence of bacterial contamination in the waters of the Northern Territory to aid assessment of routine counts and pollution investigations.

Progress: 80% complete.

SUPPORTED BY Australian Government

2.0485, POLLUTION OF BOTANY SAND BEDS
G.R. WALLIS, New South Wales Dept. of Mines, *Sydney, New South Wales, Australia*

Origin and Objective of Project: To study the extreme pollution of a major water reservoir.

Progress to Date: Identification of pollutants broadly completed but sources in doubt.

SUPPORTED BY Australian National University

2.0486, TASTES AND ODORS IN WATER SUPPLIES
D.I. JENKINS, Univ. of California, School of Engineering, *Berkeley, California* 94720

The proposed research is a continuation and broadening of current work concerned with the identification and resolution of the source and nature of odorous compounds in natural waters. Emphasis is on the study of aquatic organisms as one of the major contributors to the problem of taste and odor in waters.

Conventionally the major odor categories include medicinal (phenolic-type compounds), fishy (nitrogen and sulfur-containing compounds), sulfidal and terpenoidal. Papers have been or are in the process of being written on the latter two categories: The sulfidal work involved odors (in descriptive terms) of rotton eggs, skunk, spoiled cabbage, etc., which are associated with simple mercaptons, sulfides and disulfides; the terpenoidal work involves odors (in descriptive terms) of earthy, woody, musty, floral, etc., and includes a variety of essential oils.

The earthy-smelling compounds isolated from blue-green algae and from various actinomycetes are not only the most widespread but also the most troublesome because extremely minute quantities render waters impotable. For this reason emphasis is being directed toward the resolution of the earthy-smelling compounds coupled with the determination of their metabolic production for control aspects.

In addition to developing biological growth units and sampling techniques, microanalytical techniques have been used and developed involving gas chromatography, infrared spectroscopy, mass spectrometry and PMR.

Cooperation with the local water purveyor has enabled an exchange of samples and information on actual reservoir waters.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0487, PROVISIONAL ALGAL ASSAY PROCEDURES
E.A. PEARSON, Univ. of California, School of Engineering, *Berkeley, California* 94720

Deterioration of surface water quality through eutrophication (increasing levels of nutrients resulting in increasing algal growth), has led to research to determine which factors are responsible for eutrophicatign or increased plant productivity. This project is concerned with the development of bioassay techniques for determining nutrient levels and for providing theoretical bases for relating bioassay results to the natural environment. The theory of algal growth is based on kinetic relationships between growth rate and concentration of the growth rate limiting nutrient. Such relationships should allow rational extrapolation of laboratory assay results to natural environments to permit estimation of the factor that limits growth and the concentration at which it becomes limiting. Two bioassay techniques, batch and continuous (chemostat) culture, are being compared and evaluated with respect to accuracy precision and convenience. The assays are performed under conditions of continuous light (400 f.c.), constant temperature (24 degrees C), and with unialgal test species. The results will be compared with results obtained by similar research studies at other laboratories, to permit selection of the most appropriate bioassay techniques for further evaluation under field conditions. This project commenced December 1, 1968 and will be terminated on January 31, 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0488, THE SIGNIFICANCE AND CONTROL OF WASTEWATER FLOATABLES IN COASTAL WATERS
R.E. SELLECK, Univ. of California, School of Engineering, *Berkeley, California* 94720

The major objective of the study is to develop and evaluate quantitative methods for sampling and characterizing floatable materials of wastewater origin in the marine environment. These methods will be used to determine the pollutional significance of floatables and to suggest means of monitoring and control.

Floatables are described as either surface films or particulates. Surface films will be sampled quantitatively using screens of suitable materials and characterized by chemical, chromatographic and infrared techniques. Coliform concentrations will also be determined. Particulates will be collected by surface skimming, quantitated by weight and size distribution, and examined by microscopy. Floatables of natural origin will be distinguished from those of wastewater origin by comparing the characteristics of materials from a 'clean' control area with those of materials taken directly from wastewater and from the vicinities of marine outfalls. Mechanisms of sea slick formation and shoreward transport in coastal regions will be examined in situ to determine the flux of floatable materials between the sea and the shore, using tagged floatable materials.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0489, ENVIRONMENTAL BIOLOGY OF TOMALES BAY
E.H. SMITH, Univ. of the Pacific, School of Arts, *Dillon Beach, California* 94929

The principal objective of the research is to learn how marine communities change in time under natural and artificial conditions. It must be stressed that the research now in progress has passed the faunal check list stage and moved into the investigation of individual organisms of groups or organisms and their relationship to the environment in which they are found. Such knowledge is required in order to evaluate and control the effect of man on the marine environment. Tomales Bay is one of the last unpolluted bays on the West Coast of the United States. The establishment of the Point Reyes National Seashore is expected to increase the artificial disturbance of the shallow water marine communities to an appreciable extent. It should be possible to observe the reciprocal effects between the increasing human population and the marine communities by maintaining a program monitoring the ecosystem. Data on physical and chemical parameters will be used to assess the relationship between the environment of individual organisms to the general environment of the region. This information can be used to reconstruct the pathways by which stress is applied to the community. Studies of functional morphology and environmental physiology will help to show how marine species react to changing conditions. The data acquired in these studies can be used to predict the impact of man on the marine environment elsewhere and to the ultimate feedback to human welfare.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0490, A METHOD FOR ASSESSING THE EXTENT OF POLLUTION FROM STORMWATER RUNOFF FROM AN URBAN AREA
D.L. FEUERSTEIN, Aerojet General Corporation, *El Monte, California* 91734

The program will prepare designs of and develop a cost effectiveness evaluation procedure for a number of alternative solutions to storm and combined sewer problems extant at the City of Sacramento, Calif. The program will utilize a systems approach and will be designed to provide a solution to the problem at Sacramento that will have applicability to sewerage systems throughout the nation with similar characteristics. The program will: (1) provide hydrologic bases and waste water compositions for the design of seven candidate systems; (2) develop preliminary plans for each alternative system to assess the costs; (3) estimate construction, operation, and maintenance costs of each system; (4) collate and evaluate data from field investigations so as to provide a maximum national utility; (5) and provide recommendations in the form of a ranking of alternative systems in terms of cost and adverse or beneficial effects on the community.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0491, INSHORE FISHERIES HABITAT EVALUATION AND MONITORING
A.R. STRACHAN, State Dept. of Fish & Game, *Long Beach, California* 90802

This broad-based study will provide necessary guidelines for the protection and enhancement of nearshore areas with respect to the rapidly increasing activities of man, thereby aiding the Department in achieving its four stated objectives. Specifically, the major objectives of this Habitat Evaluation and Monitoring Program will be: (1) to document the present status of the nearshore marine animals and plants of California, their habitat, and needs in order to establish a basis for sound management policies relating to these living resources; and (2) to monitor, evaluate, and document changes to the biota, the environment, or both, as a direct or indirect result of man's activities, and to recommend action that will remedy situations that are found to be deleterious to the best interests of all concerned.

A general reconnaissance will be made of selected areas of the coast from the intertidal to 100-foot depths. The team of skilled biologists-divers will survey and map the geography of this subtidal zone. Notes, photographs, and reference bearings will be made. The small boats required in these operations will follow the divers as they survey the submarine topography, and will be used in taking bearings on terrestrial landmarks so the areas may be revisited.

These biologist-divers will also work on the backlog of contract surveys the Department has been requested to undertake, and conduct such immediate surveys (fire fighting surveys) that may be required of the Department during the fiscal year.

SUPPORTED BY California State Government - Sacramento

2.0492, HYBRID COMPUTER SIMULATION OF GROUND-WATER BASINS
W.J. KARPLUS, Univ. of California, School of Engineering, *Los Angeles, California* 90024

The purpose of the on-going research is three-fold: the primary objective is to establish the feasibility of employing a specialized hybrid (analog-digital) computing technique for the treatment of important mathematical and physical problems arising in ground-water pollution control. To this end a computational method developed at the University of California, Los Angeles has been implemented by constructing a special network specifically applicable to ground water problems. The resulting model is being applied to several ground-water problems existing in southern California. A second more general purpose of the research is to develop the technical skills required for a long-range attack on ground-water pollution problems. A subsidiary objective of the program is to provide a training ground for doctoral and master's engineering students so as to assure a supply of technical specialists adequately trained in the physics of ground-water control and in computer technology.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0493, ULTRAVIOLET ABSORPTION IN COASTAL WATERS
R.B. TIBBY, Univ. of Southern California, Allan Hancock Foundation, *Los Angeles, California* 90007

The proposed work revolves around the basic hypothesis that UV absorbance is a quantitative measure of the extent and dilution of a marine sewage field and that it is directly related to organic load and may be a better index to organic load than BOD.

Improved methods developed during the past year for determining dissolved, particulate and total carbon, and for separating the contributions of organic and inorganic constituents of the waste field and of the background waters, now will be applied in situ and in conjunction with the routine monitoring programs of

selected waste disposal agencies in Southern California whose discharge is subject to primary, secondary, or tertiary treatment.

The procedures also may provide information on the rates of biodegradation in the marine environment.

Present studies on the productivity of phytoplankton and benthic algae by oxygen evolution and isotopic carbon uptake will be continued, and will be correlated with the release of extracellular metabolites as determined by UV absorbance.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0494, INDUSTRIAL WATER POLLUTION CONTROL PROBLEMS

J.L. MACKIN, Stanford Research Institute, *Menlo Park, California* 94025

The general objectives of the current research are to identify and specify water pollution control problems in selected industries and to devise potential solutions to these problems. The longer term goal is to pool Institute resources and capabilities for assisting industrial and other clients in investigating the nature and control of water pollution problems arising from a wide spectrum of sources.

SUPPORTED BY Stanford Research Institute - Menlo Park

2.0495, AN ENVIRONMENTAL MONITORING PROGRAM FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN BAY

L.W. WEISBECKER, Stanford Research Institute, *Menlo Park, California* 94025

The monitoring program was developed as a comprehensive resource management information system, which would allow management policy for the resource to be based upon environmental consideratons.

Based on the present limited understanding of the resource, its uses, and their conditions and effects, the following minimum information needs were developed: 1. Continuous or weekly determination of 26 in-channel water quality and biological parameters for some 28 locations throughout the Delta, Suisum Bay, and San Pablo Bay. 2. Quarterly aerial surveillance photographic coverage of the Suisan Marsh be determine distribution and trends of marsh grasses as these affect suitability of the Marsh for waterfowl habitat. 3. Twice yearly aerial surveillance photographic coverage of the entire Delta to determine resource demand and use characteristics and to obtain an updated description of the Delta and an overall synoptic assessment of water quality conditions. 4. Continuous monitoring of all municipal, industrial, and agricultural waste water flow rates together with frequent sampling and determination of chemical, physical, and biological parameters that are related to receiving water quality. 5. Data related to resource demand and use from any available source on a continuing and current basis.

In addition an information handling system was specified that incorporates the functions of data processing, information storage and retrieval, modeling of the resorce, and a program that predicts the effects of resource use.

Recommendations were made for implementing and continually updating the program. Program costs were developed.

SUPPORTED BY California State Government - Sacramento

2.0496, ORGANIC SUBSTANCES IN WATER

D.F. GOERLITZ, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

Wide and complex varieties of organic substances are present in water and the number of the organic pollutants reaching water supplies is rapidly increasing. Knowledge of the extent, character, and composition of organic substances in water has lagged significantly behind that of the mineral components.

The work involves largely the development of methodology for the separation, identification, and measurement of organic substances in water. The initial work has been concerned with natural organic substances in water. The processes being developed basically involve extraction, vacuum evaporation, chromatography, and infrared spectroscopy.

The development of highly sensitive techniques for the separation, identification, and measurement of pesticides in water will be continued. Recovery studies will be continued and extended to cover additional pesticides to those already investigated. Efforts will also be directed toward the development of an electron capture gas chromatographic procedure for the analysis of chlorinated phenoxy acid herbicides and their derivatives in water.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0497, ARCTIC ENGINEERING GEOLOGY (NASA)

G.W. GREENE, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

States to which project pertains: Alaska.

Photographic and thermal infrared remote sensing surveys can provide valuable information concerning permafrost related engineering problems and can assist the engineering geologist in site selection and route planning in Arctic Alaska to demonstrate infrared techniques in the field, three test sites, each approximately 50 miles long and one mile wide, have been designated along the proposed oil pipeline route. These sites are typical of much of the terrain traversed by the pipeline.

During 1970 approximately 80% of the planned surveys were made. Adverse weather prevented completion of the field work. It is expected that the remaining field work will be done in 1971. One or more reports will be written also during 1971.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0498, SEISMOLOGICAL STUDIES - SANTA BARBARA

R.M. HAMILTON, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

The present network should reveal which structures in the Santa Barbara area are seismically active at the present time. With the addition of critical channel-floor stations, it should provide sufficient precision in hypocenter determinations to reveal which, if any, of the faults through the channel oilspill area are moving. Such precision in hypocenter determination will be required if water flooding for increased oil recovery is to be carried out safely.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0499, DEVELOPMENT OF REMOTE-SENSING TECHNIQUES TO DETERMINE WATER QUALITY

G. GOODWIN, U.S. Natl. Aero. & Space Adm., Ames Research Center, *Moffett Field, California* 94035

The purpose is to develop remote sensing techniques which can be used to study the productivity, toxicity and turbidity of water bodies. The studies will provide a data base from which to evaluate local and global effects on marine ecology due to man-made and natural pollutants. Applications will include rapid determination of photosynthesis-induced productivity over large regions of the oceans, surveys of water quality following pollution abatement action, determination of presence and extent of a surface film as a toxic agent and barrier to oxygen transpiration, and delineation of tidal intrusions, currents, and water body boundaries. Airborne measurements will be performed to evaluate instrumentation such as a recently developed differential radiometer system (DRS) for operational use in determining chlorophyll, turbidity and surface films through unique reflectance or polarization characteristics. Laboratory studies will be conducted, for example, of thin films on the surface of water utilizing ellipsometry (polarization spectroscopy) techniques. Modification of these techniques to the remote identification of complex pollutant films on the surface of real bodies of water will be investigated. The investigator shown above is the Project Monitor whose telephone is 415-961-1111.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0500, ENVIRONMENTAL PROTECTION PROGRAM

R.N. STORER, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Technical Objective: To obtain, and organize pertinent information and data on current standards that apply to CONUS Naval facilities and to develop information on pollution control tests. Instrumentation and sensors for pollution ashore and in harbor and for non-ordnance deep water dumping. This will provide initial input to YF38.554.002. Data base for Navy pollution control to begin 1 July 1971.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0501, DEVELOPMENT OF NUCLEAR ANALYTICAL TECHNIQUES FOR OIL SLICK IDENTIFICATION

H.R. LUKENS, General Dynamics Corporation, *San Diego, California* 92112 (AT(04-3)-167)

The overall objective of the oil slick program is to develop nuclear and analytical techniques for oil slick identification. The first phase determined the feasibility of characterizing and identifying oil slicks by analysis of trace elements using Neutron Activation Analysis techniques.

The primary reason for this investigation is to provide the law enforcement agencies at various levels of Government the tools with which to enforce water pollution caused by releasing oil of any type from any source.

The work to be undertaken under Phase II is to characterize oils relevant to coastal waterways. The chief tasks are to obtain and analyze by Neutron Activation Analysis (NAA) a statistically satisfactory sampling of crude and residual oils that are as immediately related to the coastal-waterway pollution problem as possible, to subject the resulting data to statistical analysis, and to formulate probability statements that can be useful in coastal oil-slick identification work. The work will include an investigation of the suitability of samples from beached oil-slicks for identification purposes, and will include due consideration of the relative importance of oil seepages to the problem. Also, a practice test of a nuclear identification technique will be performed.

SUPPORTED BY U.S. Atomic Energy Commission

2.0502, GEOSECS - ACQUISITION AND CONSTRUCTION OF SHIPBOARD ANALYTICAL EQUIPMENT AND HYDROGRAPHIC AND SAMPLING SYSTEMS

A.E. BAINBRIDGE, Univ. of California, Graduate School, *San Diego, California* 92038

Considering the ocean as a source of food, a disposal area for nuclear and industrial waste products, and a controlling factor in the earth's climatic regime, our ultimate use of the sea is critically dependent on a detailed understanding of processes presently understood in only the vaguest and most qualitative way. These are the stirring and mixing processes in the deep sea, the interchange of material between deep and surface water, and the variation of organic productivity throughout the ocean, and the exchange of water and gases with the atmosphere. The GEOSECS program will measure in detail the oceanic constituents along Arctic to Antarctic sections at all depths, to provide, for the first time, a set of physical and chemical parameters measured on the same water samples. These data will provide the input for quantitative studies of oceanic mixing and organic productivity, and, at the same tme, serve as a baseline for the levels of pollutants and of fission and waste products being added to the sea. The Scripps Institution is responsible for supplying the shipboard computer, the salinity-depth temperature profiling system, hydrographic equipment, the shipboard gas chromatographic and titration systems, bottom water temperture and radon profiling system, Si32 collection equipment, rare gas and He3/He4 ratio equipment, and for the atmospheric, stable isotope, inorganic carbon, and dissolved gas analytical programs.

SUPPORTED BY U.S. National Science Foundation

2.0503, GEOSECS - OPERATIONS STAFF

A.E. BAINBRIDGE, Univ. of California, Graduate School, *San Diego, California* 92038

Considering the ocean as a source of food, a disposal area for nuclear and industrial waste products, and a controlling factor in the earth's climatic regime, our ultimate use of the sea is critically dependent on a detailed understanding of processes presently understood in only the vaguest and most qualitative way. The interchange of material between deep and surface water, the variation of organic productivity throughout the ocean, and the exchange of water and gases with the atmosphere. The GEOSECS program will measure in detail the oceanic constituents along Arctic to Antarctic sections at all depths, to provide, for the first time, a set of physical and chemical parameters measured on the same water samples. These data will provide the input for quantitative studies of oceanic mixing and organic productivity, and, at the same time, serve as a base-line for the levels of pollutants and of fission and waste products being added to the sea. The Scripps Operations Group is responsible for coordination of the analytical and sampling operations; the design, construction, and installation of shipboard sampling and analytical facilities; and measurement coupling with real-time shipboard computer system.

SUPPORTED BY U.S. National Science Foundation

2.0504, DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN AND BEHAVIOR OF TRACE ELEMENTS IN THE OCEAN AND ORGANISMS (ABBREV)

T.R. FOLSOM, Univ. of California, Graduate School, *San Diego, California* 92038 (AT(04-3)34,Proj.)

Objectives: Following up our recent discovery of (127 year) Ag- 108m in certain 1964 marine biological samples toward better knowledge of albacore movements, turnover rates for metals, and stability of certain subsurface strata

Background: Recently Ag-108m was discovered in marine organisms we had analyzed in 1964 for Ag-110m. This dated a water mass used by the albacore and suggested the silver turnover rates for other organisms.

Procedures: Liver tissues analyzed with two-dimensional and summing spectrometers.

Continuation: Follow up by assaying for Ag-108m more old 1964 samples containing Ag-110m. Collect 1970 biological specimens, including albacore, for possible silver dating through recent Chinese tests. Continue procedure developments for Cs, Ag and Co using tissue samples.

Results: Exceptional concentrations of Cs in muscles of large fish has been demonstrated. Unexpected uniformity of natural cesium in the marine environment has been demonstrated. The usefulness of two silver nuclides for dating fallout movements has been discovered.

SUPPORTED BY U.S. Atomic Energy Commission

2.0505, MEASUREMENTS OF BOMB-PRODUCED RADIOCARBON IN THE SURFACE AND SUB-SURFACE WATER OF THE PACIFIC OCEAN

H.E. SUESS, Univ. of California, Graduate School, *San Diego, California* 92038 (AT(04-3)34,)

Measurements of bomb-produced radiocarbon in the surface water of the oceans is a long-range project intended to give information on the CO2 exchange through the air-sea interface, and on mixing phenomena in the upper layer of the ocean. In connection with this project the Scripps Institution of Oceanography has collected water samples over the past 13 years, and the La Jolla Radiocarbon Laboratory has carried out the respective determinations. Since 1957 the radiocarbon laboratory at the Scripps Institution of Oceanography has included in its research a fairly representative number of measurements of bomb-produced carbon-14 in surface water of the Pacific and Indian Oceans.

SUPPORTED BY U.S. Atomic Energy Commission

2.0506, THE DEGREE OF FECAL POLLUTION IN THE WATER OF REGIONS OF THE EASTERN DISTRICTS, BY A NEW COMBINED CHEMICAL-MICROBIOLOGICAL METHOD

L. TAN, Univ. De Sherbrooke, *Sherbrooke, Quebec, Canada*

Project (1) undertakes to develop combined methods, both practical and effective, for the detection of fecal pollution in water, using coprostanol and coprostanone as chemical tracers. Both of these are specific compounds in the intestinal system of

mammals. The chemical method is based on chromatographic analysis, both in thin layers and in the gaseous phase, while the microbiological analysis is based on the classical method of counting coliforms. Project (2) is a logical extension of (1). The three factories at Magog, East Windsor and East- Angue contribute visibly to pollution of the St. Francois and consequently of the St. Laurent. Nevertheless, the nature and extent of this industrial pollution are not well known. We propose to study this pollution, which risks injury to the health of the population. We wish to analyze by the methods of complexometry or atomic absorption all toxic elements, such as mercury and lead.

SUPPORTED BY Canadian Government - Ottawa

2.0507, TAXONOMY AND BIOLOGY OF SLUDGE WORMS
R.O. BRINKHURST, Univ. of Toronto, *Toronto, Ontario, Canada*

A study of the systematics of Sludge Worms and their biology and ecology, with special reference to their use as indicators of pollution in fresh and brackish water.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0508, OCEAN CIRCULATION
K. BRYAN, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (001146)

Technical Objective: To develop a comprehensive theory of the large-scale circulation of the ocean. The successful incorporation of the theory in the form of numerical models will be useful for pollution studies of large water bodies, long-range forecasting of sea-surface temperature, and joint air-sea model studies of the sensitivity of the earth's climate to large-scale atmospheric pollution.

Approach: Professional man years equal 5.0. The time-dependent models of the ocean will be studied in detail with a view of using them to pedict surface temperature. Tracer studies will be carried out to develop a tool for studying the uptake of excess CO2 by the ocean. Diagnostic studies with observed data will be carried out to determine more accurate formulas of turbulent mixing.

Progress: Hydrographic data has been assembled and interpolated on to a regular grid in preparation for diagnostic model studies of the Atlantic Ocean. Calculations have been extended, and a final write-up completed for a study of the Antarctic circumpolar current. Preliminary calculations have been made with a model of the World Ocean.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0509, STRUCTURE & MOTIONS - ATLANTIC
D.V. HANSON, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (011689)

To increase understanding of the physical, chemical and dynamical properties of coastal and ocean waters off the southeast coast of the U.S. to facilitate ESSA marine services in regard to tides and tidal currents, and transport of chemical constituents, heat, and pollutants by oceanic and coastal currents.

The principal study concerns the source of the Gulf Stream and the dynamics of circulation in the Gulf of Mexico. The major feature of this circulation will be studied by means of serial measurements of chemical and physical variables from the research vessels, Lagrangian current measurements using radar-transponder equipped drogue buoys, and surface temperatures sensed from earth satellites. Deep sea tide gauges and near bottom current meters will be used to test a theory of tides in the Gulf of Mexico proposed by Zetler and Hansen. Detailed attention will be directed to the influence of the Gulf Stream on the nearshore and estuarine environments.

Papers have been published on transport fluctuation and Lagrangian current observations in the Florida Current, and Gulf of Mexico tides. Studies of Lagrangian current measurements in the Gulf Stream south of Cape Hatteras, Gulf Stream meandering east of Cape Hatteras, evaluation of satellite data for observing varying positions of the Gulf Stream, coherence of large scale currents, and oceanographic conditions in the vicinity of Cay Sal Bank have been complete and submitted for publication. Data from two cruises in the Fall of 1969 await detailed analysis, but already provide information on the time scale of major circulation features in the Gulf of Mexico on which to base plans for future observations.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0510, WATER QUALITY ASSESSMENT AND POLLUTION CONTROL
S.S. SCHULTZ, U.S. Air Force, Frank J. Seiler Res. Lab., *Colorado Springs, Colorado* 80840

Technical Objective: AF function - environmental support of base operations (water quality/pollution control). Deficiency - USAF installations must implement a program of water quality monitoring to legally document their water pollution abatement programs in compliance with governmental water quality criteria as directed by AFR 161-22, Environmental Pollution Control. No model program exists to pattern such a comprehensive effort. Research - development of a water pollution abatement and monitoring program for the USAFA which will also be appropriate to USAF installations. How research contributes - a model water monitoring program will be developed which will include sampling networks, instrumentation, testing procedures and interpretation methods for determining the physical, chemical, and biological properties of water resources as part of the total environment pollution abatement and monitoring program. The objective of this research is to do the necessary research on methods and techniques and to develop a Water Quality Assessment and Pollution Control Program for the USAF Academy which will also be an appropriate model program for wide application in USAF pollution control programs. In addition, some specific problems in the USAF non-potable irrigation system will be investigated and their solution will have universal application of environmental pollution control such as: control of eutrophication in surface reservoirs, isolation and elimination of offensive odors in spray irrigation systems using treated sewage effluents, and ground water quality assessment and management. The model water quality monitoring program which should result from this research will provide a basis for legally documenting water pollution abatement programs as directed by AFR-161-22. It also will provide guidance on the manpower requirements and training essential for a continuing program for measuring, evaluating and controlling water pollutants of concern to the Air Force.

SUPPORTED BY U.S. Dept. of Defense - Air Force

2.0511, HYDRO- AND BIO-GEOCHEMISTRY OF HEAVY METALS
T.T. CHAO, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: Nationwide.

The principal objectives of this project are to elucidate the occurrence, distribution, and interactions of heavy metal elements in a water-sediment and soil plant system so that hydro- and bio-geochemical techniques may be developed for mineral exploration. The long-range work plans include the following: (1) Develop new methods for determining micro-quantities of certain heavy metal elements for exploration purposes; (2) establish the range of concentration and forms of occurrence of heavy metal elements in solution, in association with suspended materials, and in stream-bed sediments in a water system in mineralized and non-mineralized areas, (3) determine the response of these metals to environmental changes such as geological formation, ore deposits, water chemistry, chemical composition and mineralogy of stream-bed sediments, etc.; (4) study mechanisms of retention of a given metal element with different components of stream sediments; and (5) determine soil plant relationships in terms of heavy metal content in an area of known ore deposits.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0512, RIVER BASIN STUDY
D.A. HOFFMAN, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Studies are needed to determine basinwide influences upon water quality. Data on selected water quality parameters from a series of reservoirs and streams within a given basin are needed to follow changes occurring in water quality. Specific programs will be developed to measure these parameters, evaluate new field instruments and techniques, devise better methods of analyzing the data, and determine the most effective ways for its use. Investigation of the basin-wide factors will be made on river basins selected for important features and functional characteristics.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0513, PREDICTING NITRATE CONTENT OF AGRICULTURAL DRAIN WATER
J.T. MALETIC, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Conceptual model systems involving lysimeters and greenhouse work will be utilized to determine chemical reactions and movement of nitrogen from various sources. Soils of different origin and mineral composition will be used. Data from the model systems, plus data on nitrogen uptake of various irrigated crops secured from a search of the literature, will be used to develop a computer program for predicting the nitrogen transformations taking place in soil-water system under variations of time, moisture content of the soil, temperature, oxygen in soil air, source of nitrogen, or other factors. The computer program will be tested for reliability from data secured in a companion research contract at the University of California. The computer program will be applied in deriving estimates of the nitrogen content of drainage effluent from the San Luis Unit, Central Valley Project, California.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0514, ANALYTICAL METHODS - WATER CHEMISTRY
M.W. SKOUGSTAD, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

Analytical methods and techniques for many constituents that are found in water, such as aluminum, the halogenides, zinc, nitrate, nitrite, selenium, and detergents and other pollutants, frequently require modifications and refinements before they can be adopted specifically for water analysis. Improvements in all analytical procedures, including special instruments and techniques, are necessary to meet the requirements of expanding research efforts in the field of water chemistry.

The work consists of evaluating the potential of a technique and refining it to the minute concentrations significant in water chemistry. Fundamental chemical methods are studied as well as methods employing specialized equipment and instrumentation, such as X-ray and emission spectroscopy, electrometric, flame photometric and chromatographic instruments.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0515, PHYSICAL CHEMISTRY OF RADIOELEMENTS - RADIOMETRIC METHODS OF ANALYSIS
L.L. THATCHER, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

The objective of this project is to improve existing analytical methods and develop new analytical methods for the determination of trace concentrations of natural and synthetic radionuclides in water. Also, to make preliminary studies of determinations of trace concentrations of stable elements by activation analysis. Analytical techniques such as alpha and gamma spectrometry are used extensively. Frequently used chemical processes include ion exchange, solvent extraction, coprecipitation, and electrodeposition.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0516, TECHNIQUES AND INSTRUMENTATION - MONITORING LABORATORY
P.R. TRAMUTT, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The principal purpose of this research is to develop and/or test new methods, techniques, and instrumentation that collect, analyze, and record water quality parameters for engineering and research needs.

The monitoring laboratory study will be directed toward developing a field laboratory kit that can be used by regional personnel for monitoring water quality data where only a limited number of parameters are to be measured. Also, part of this program will be the selection of analytical methods for use as acceptable standards for comparing our work with others.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0517, FIELD RESEARCH LABORATORY (MOBILE LABORATORY)
P.R. TRAMUTT, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

This study will develop a mobile field laboratory that can be taken to the research site. The laboratory will be self-sufficient and capable of performing analyses for the usual chemical and biological parameters. Capability will also be provided for minor modification in order to handle analyses for unique and unusual parameters. The mobile laboratory is now being equipped with analytical instrumentation and equipment. The mobile laboratory will be put into full field operational use in water quality and ecology research studies after completion of shakedown trips. Provisions will be made to test the laboratory's usefulness for supporting other studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0518, RESEARCH TRACE METHODS
F.N. WARD, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

Develop and study interferences in new methods of trace analysis that have potential use in applied mineral prospecting. Continuation of selective-ion electrode study to evaluate usefulness of such electrodes in following applications: 1. Iodide for iodine in igneous rocks to test feasibility of using iodine content as 'pathfinder' element. 2. Sulfide for indirect determination of mercury in water. 3. Fluoride for application of direct addition method for fluorine in soils, rocks, and water. 4. Copper for use of direct addition method for copper in water.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0519, DATA ACQUISITION SYSTEMS IN WATER QUALITY MANAGEMENT
L.R. FREEMAN, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

This project will delineate the general objectives of a State Water Pollution Control Program and identify the types and quantity of information needed to accomplish these objectives. A survey of the state of the art of three water quality data gathering techniques (sampling/wet chemistry; electronic sensors; aerial surveillance) will be carried out to establish the capabilities, reliability and cost of each technique. A procedure will be developed for designing a state water quality monitoring program which is responsive to the state program objectives, and utilizes the best combination of the three data gathering techniques, subject to budget constraints. A water quality monitoring system will be designed for the State of Colorado to demonstrate the procedure.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0520, WATER QUALITY MANAGEMENT DECISIONS IN COLORADO
G.V. SKOGERBOE, Colorado State University, Environmental Resources Center, *Fort Collins, Colorado* 80521

The purpose of this work is to study the operation of the Colorado Water Quality program in order to develop a constructive critique which will assist in future program development. To accomplish this, the following objectives will be pursued: 1. Evaluate Colorado's present monitoring system for surveillance of stream standards with respect to both present and potential sources of pollution. 2. Evaluate the capability of present institutional programs to anticipate potential pollution problems and for

providing information necessary in decision- making regarding water quality management. 3. Evaluate present and projected institutional processes for pollution enforcement in Colorado, along with alternative methods for attaining conformance with stream standards.

Reliance will be placed upon case studies involving decisions by the Colorado Water Pollution Control Commission, together with policy statements and procedures established by that agency. Interviews will be conducted with parties involved in the selected cases to obtain attitudes with a variety of sources throughout the State, to assist in evaluating the present institutional processes for making adequate decisions, and to assist in evaluating the effectiveness of present enforcement techniques.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0521, A SYSTEM FOR GEOLOGIC EVALUATION OF POLLUTION POTENTIAL AT MOUNTAIN DWELLING SITES

J.P. WALTZ, Colorado State University, Environmental Resources Center, *Fort Collins, Colorado* 80521

The proposed research is to develop a hydrogeologic classification system for mountainous terrain. The classification system is to be designed for use in evaluating pollution potential at dwelling sites in the mountains.

Streams and wells in the mountains are susceptible to contamination because sewage disposal systems are usually privately owned and may be poorly situated or constructed. In addition, contaminated surface water can usually percolate directly into the ground via exposures of fractured or jointed rock. Also, direction and rate of ground water motion in a fractured medium are difficult to determine.

The procedure proposed for this research is to collect quantitative measures of topographic, geologic, and hydrologic variables. These data are to be used in a discriminant function analysis. The data will be in two groups: group I will contain information from sites where contamination has been documented and a source of pollution can be identified; group II will contain information from sites where no contamination can be detected, but where a pollution source is present.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0522, APPLIED ECOLOGICAL STUDY OF SPRING CREEK, FORT COLLINS, COLORADO

C.G. WILBER, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00032)

OBJECTIVE: Study body of water adjacent to different types of land use areas. Information concerning the effect of different land use on natural water. Information for better advice on the application of ecological rules to land use planning.

APPROACH: Oxygen & temperature profile of stream recorded simultaneously from the source to the mouth at different times of the year. Study of pollution indicators such as tubificid worms will be made from some indication of the biological condition of the stream. The areas drained by the stream will be mapped and classified according to use. A study of the types and amount of invertebrates in different areas of the stream. Record the types and extent of solid waste dumped into the stream in different areas.

PROGRESS:

SUPPORTED BY Colorado State Government

2.0523, AN ECOLOGICAL STUDY OF THE LOWER HOUSATONIC RIVER - PHASE I - SURVEY OF THE CHEMICAL ASPECTS OF THE RIVER

J.J. POLYHOWICH, Univ. of Bridgeport, Graduate School. *Bridgeport, Connecticut* 06602

The lower twelve miles of the Housatonic River will be sampled at six stations for both ecologically important and pollutant substances. Each week, a total of seventy two samples will be assayed for nitrates, nitrite, total phosphate, silica, oxygen, chloride, alkalinity, chromium, copper, iron, zinc, cyanide, detergents and hydrogen sulfide. In addition, turbidity, Seechi, BOC, and temperature measurements will be made at each station. The resultant data will be used to characterize this estuary with regard to its circulation patterns and the levels of the various polluting substances. This study is being conducted during the summer and early fall of 1970.

SUPPORTED BY Connecticut State Government

2.0524, SURFACE WATER TEMPERATURE OF THE CONNECTICUT RIVER

R.A. JONES, State Board of Fish. & Game, *Hartford, Connecticut* 06115

Objectives: 1. To profile on a seasonal basis the surface temperature of the Connecticut River from Wilder, Vermont to its mouth at Saybrook, Connecticut. 2. To detail surface water temperatures of certain areas of the Connecticut River which may influence the restoration of anadromous fish. Surface temerature isotherms will be plotted in areas of heated effluents, other heat sources and temperature depressing tributaries.

Procedures: Temperature determinations will be obtained with a Barnes Model PRT-5 infrared radiation thermometer and recording equipment mounted on S-46 helicopter owned and operated by the State of Connecticut, Department of Aeronautics.

Over-flights will be made at altitudes of 100 feet or less on a monthly basis from April through November. One day each month up-river flights will be made from Saybrook, Connecticut to the vicinity of Wilder, Vermont. During these flights, the river to Hartford will be crisscrossed using marine navigation aids and man-made structures as reference points. Above Hartford the flight will be essential mid-river using man-made objects and topographic features as reference points.

After a review of the average temperature profile at the completion of the up-river flight, a detailed survey will be made at points of temperature rise and depression; such as heat effluents, impoundments and tributaries during the return flight. Certain major tributaries will be surveyed to provide data to correlate with main stem temperature patterns.

Data will be plotted as an average temperature profile along the length of the study area against river miles and man-made features. Detail survey data will be plotted as isotherms in the areas of interest. Completed temperature information will be utilized as base data for future analysis as regards recommendations to regulatory agencies on location and allowances for heat producing industries. Data will also be used to provide information on the cause and magnitude of thermal loading from various sources such as steam electric plants, manufacturing operations and solar energy in areas of impoundments and shallows related to hydroelectric operations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0525, DEVELOPMENT OF INSTRUMENTAL TECHNIQUES FOR THE ANALYSIS OF TRACE ORGANIC CONSTITUENTS IN WATER

R.P. COLLINS, Univ. of Connecticut, Graduate School, *Storrs, Connecticut* 06268

The proposed research plan involves the development of more effective methods for isolating, concentrating, identifying and measuring trace organic constituents in public water supplies. Improved and highly refined instrumentation is needed for this purpose because of the ever increasing amounts of highly complex organic constituents which are being introduced into water supplies and for which, at the present time, no techniques exist for their detection or measurement.

Laboratory investigations would test the usefulness of the following analytical procedures: a. Coupled gas-chromatography and mass spectroscopy. b. On-column trapping procedures. c. Coupled gas chromatography and rapid scan infrared spectroscopy. d. Thin-layer chromatography. e. DEAE column chromatography for isolating and concentrating high molecular weight organic constituents.

Upon completion of the laboratory phase the analytical procedures developed would be used in sampling Connecticut rivers and reservoirs in which difficulties from industrial effluents and/or objectionable tastes and odors had been experienced.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0526, CHARACTERIZATION OF TASTE AND ODORS IN WATER SUPPLIES
R.P. COLLINS, Univ. of Connecticut, Graduate School, *Storrs, Connecticut* 06268

This project is concerned with the identification of compounds which induce taste and odor in public water supplies. The project is concerned primarily with the characterization and isolation of taste and odor substances produced by microorganisms. The compounds are isolated from either pure culture filtrates or natural habitats. The odorous constituents are isolated by gas-liquid chromatography and identification is made by combined gas chromatography and mass spectroscopy as well as by infrared, nuclear magnetic resonance spectroscopy.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0527, CHARACTERIZATION OF TASTE AND ODORS IN WATER SUPPLIES
R.P. COLLINS, Univ. of Connecticut, School of Liberal Arts, *Storrs, Connecticut* 06268

This project is concerned with the identification of compounds which induce taste and odor in public water supplies. The project is concerned primarily with the characterization and isolation of taste and odor substances produced by microorganisms. The compounds are isolated from either pure culture filtrates or natural habitats. The odorous constituents are isolated by gas-liquid chromatography and identification is made by combined gas chromatography and mass spectroscopy as well as by infrared, nuclear magnetic resonance spectroscopy.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0528, ANALYTIC AND PROCESS CLASSIFICATION OF EFFLUENTS (ORGANIC NITROGEN IN ACTIVATED CARBON EFFLUENTS)
T. HELFGOTT, Univ. of Connecticut, School of Engineering, *Storrs, Connecticut* 06268

This research involves testing of effluents to classify the residual organics in terms of chemical analyses and process behavior. The residual organics, as measured by total organic carbon content, in the effluents of activated carbon treatment have been found to contain cationic organics. This implies the presence of nitrogen in an amino acid or quaternary form. These residual organics maintain cationic characteristics even at high pH above the isoelectric point of most amino acids except for a few basic amino acids. This information has been found by use of a modified electrodialysis/electrophoresis technique. Tests in this research are to confirm directly that the residual organics in activated carbon effluents contain organic nitrogen. Plans involve collection of sewage effluent, treatment with activated carbon, concentration and fractionation of the residual organics by gravitational electrodialysis and the analysis of the nitrogen of the concentrated fractions.

Part of this research activity involves the use of a total nitrogen analyser and the development of this instrument to distinguish organic and inorganic nitrogen.

The significance of this information is that only after the refractory components of waters are detailed can the most effective and efficient treatments be practiced and the ecological and public health considerations be known.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0529, BEHAVIOR OF STREAM INSECTS
S.W. HITCHCOCK, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONH00308)

OBJECTIVE: Gain knowledge of the behavior of representative species of stream insects, especially as related to changing conditions in the stream. Study migration and dispersal of immature stream insects. This has particular importance in gaining information on repopulation of streams denuded by drought or pollution.

APPROACH: Methods of measuring movement upstream will be developed and comparisons made between a permanent stream and an intermittent stream. An attempt made to correlate with laboratory studies of upstream movement.

PROGRESS: Routine sampling continued to measure recovery in the streams following drought. This work is completed and awaits tabulation, summary, and preparation for publication. Because of three years of drought, the original plan as outlined could not be followed, but information was gained on survival in these streams. In the stream dry to its source, apart from those insects normal to an intermittent stream, recovery in numbers and genera proceeded upstream. In the stream that was dry for only part of its length, recovery moved downstream. Those insects with short life cycles and able to survive in intermittent streams suffered less predation than those in permanent streams. This is due to the drought-induced destruction of insect predators which require a year or more of larval life.

SUPPORTED BY U.S. Dept. of Agriculture

2.0530, VARIABILITY IN DIATOM MORPHOLOGY AND WATER POLLUTION
F.R. TRAINOR, Univ. of Connecticut, School of Liberal Arts, *Storrs, Connecticut* 06268

The purpose of the present investigation is twofold: (1) to study the morphological and growth responses of freshwater diatoms to changes in the physical and chemical environment using the culture technique, and (2) to study morphological variability in laboratory cultures of diatoms incubated in natural waters. If we can demonstrate in controlled laboratory experiments as well as in cultures incubated under 'natural' conditions morphological responses of an organism to changes in environment, we would expect certain morphological types to be indicators of the chemistry of the water. Among the environmental components which will be investigated are: levels of inorganic nutrients, levels of available CO2, presence of certain organic substances, pH, temperature, and light.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0531, A MULTI-PHASIC COMPONENT STUDY TO PREDICT STORM WATER POLLUTION FROM URBAN AREAS
P.R. WALTERS, Avco Economic Systems Corp., *Washington, District of Columbia* 20006 (C-1743)

Storm water surface runoff not only may cause local damage by flooding, but also by polluting the receiving streams. Improved techniques are needed to predict the quality as well as quantity of storm water runoff in an urban area for application to planning and better control of pollution, evaluation of requirements for hydromechanical structures as well as the design of treatment systems.

The proposed research will develop methodology for predicting urban area water pollution. Parametric models will determine pollution levels from land activity and environmental factors. This will afford an area- wide spectra analysis of pollution.

The model system will enable analysis and assessment of pollution conditions, benefits, and cost of alternative remedial measures to include conveyance and treatment as well as management practices to control pollution. Also included is a demonstration of the methodology in selected metropolitan areas to validate its feasibility and practicability as a tool for planning, management and control of urban area storm water pollution. It is anticipated that the project will be started in September 1969 and will be completed in September 1970.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0532, VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY
R.R. COLWELL, Georgetown University, School of Arts, *Washington, District of Columbia* 20007

This project will continue an investigation of the incidence and pathogenicity of the bacterial pathogen 'Vibrio parahaemolyticus' in marine and estuarine animals, with particular emphasis on the Chesapeake Bay blue crab, 'Callinectes

sapidus'. The animals, sediment and water will be sampled periodically and any resulting bacteria will be identified. Information on the natural flora of estuarine and marine invertebrate animals will be collected in a format suitable for computer analysis so as to provide a basis for understanding the interaction amongst the micro-organisms constituting the commensal flora. The pathogenicity of any 'Vibrio parahaemolyticus' isolates for crabs, shrimp and mice will be determined.

SUPPORTED BY U.S. National Science Foundation

2.0533, POLLUTION CONTROL IN THE MARITIME ENVIRONMENT

G.C. NICHOLS, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

To identify the magnitude and other characteristics of marine- related water pollution, such as sources and causes of pollution, types of pollutants, quantities and locations of spills, in the New York harbor area. To determine additional data which should be incorporated in future incident reports. To develop correlations between significant components of the water pollution problem and determine probabilities of occurrence of potential spills. If time and data permit, to develop methodology for estimating potential risk (or expected loss) resulting from accidental spills of one or more pollutants deemed to be of major significance. To examine the type of data available in pollution incident reports filed with the Coast Guard, the Corps of Engineers, the FWQA, the Port of New York Authority, the American Petroleum Institute, and other sources for the period January 1967-June 1969. To establish a format for coding the data contained in these reports. To collate the data gathered from the various sources to eliminate double-counting and identify the dimensions of the water pollution problem in the area. To analyze the data obtained according to source and causes of pollution, types and quantities of pollutants, geographical location of spills, and other important factors, and develop a few significant cross- tabulations. To evaluate the quality of the data currently available and indicate deficiencies in these data. If time and money permit, to explore the feasibility of forecasting future accidental spills.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

2.0534, GEOCHRONOLOGY, C-14 METHOD

M. RUBIN, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

States to which project pertains: all.

The dating by C-14 of samples pertaining to changing climates will continue, pursuant to the primary objectives of the project. Emphasis will be made on dating tectonic movements, to determine rate of movements on global plates. Construction of sea level curves from all over the world will be continued. Some dating of ground water for general problems in movement is contemplated. Magnetic dipole oscillations during the Wisconsinan glaciation will be measured from any rapid-deposited sediment unit. Pollution studies on rivers and oceans will be undertaken to determine contribution of 'dead' and 'modern' carbon to the total carbon carried in solution and in particulate form.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0535, ULTRAVIOLET STUDIES (SOLAR-STIMULATED FLUORESCENCE)

G.E. STOERTZ, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

States to which project pertains: Not applicable for areal data; testing was over California and Arizona.

Instruments and techniques are sought for remotely detecting substances that fluoresce when irradiated by sunlight. A prototype Fraunhofer line discriminator (FLD) operating at the amber sodium-D2 line (5890 angstroms) has been converted to operate at the blue hydrogen-F line (4861 A). Conversion to the deep red hydrogen-C line (6563 A) is commencing.

The sodium-D2 FLD proved useful as an airborne or shipboard fluorometer over water, measuring substances that fluoresce amber, such as rhodamine dyes. Rhodamine WT was monitored in concentrations below 5 ppb in clear river water, moderately turbid marine coastal water, and highly turbid estuaries.

Airborne tests over water were conducted over San Francisco Bay, San Pablo Bay, the Bonita Channel west of Golden Gate, and the Colorado River near Needles, California. Airborne tests over land were conducted over southeastern California and west-central Arizona.

Ultimate objectives are to develop capability to monitor pulp- and papermill effluents by the fluorescence of lignin sulfonates, the distribution of phytoplankton by chlorophyll fluorescence, and to monitor other pollutants such as oil spills, detergents, or chemical wastes.

Objectives include development and testing of airborne instruments and survey techniques, of accessory laboratory apparatus and techniques, and of data-compilation procedures to permit either qualitative or quantitative applications of remote fluorescence analysis.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0536, STANDARD MONITORING SECTIONS A-6 AND A-7 CRUISE AND AIGIST 1970 NERVE GAS DUMP SITE SURVEY

W.T. ADAMS, U.S. Dept. of Transportation, Coast Guard, *Washington, District of Columbia* 20591

On 12 November 1970 the USCGC ROCKAWAY (WAGO 377), CDR William T. ADAMS, Commanding, will depart Governors Island, New York to occupy Coast Guard Monitoring Sections A-6 and A-7 and to survey the August 1970 Army nerve gas dump site. A concurrent monitoring of Section A-5 will be conducted by the USCGC (WHEC 39) upon returning from Ocean Station ECHO.

Standard Monitoring Sections A-5, A-6 and A-7 cross the Gulf Stream and are occupied several times each year by the Coast Guard in an attempt to define the seasonal variations of this current system. The Salinity-Temperature-Depth (STD) sensor will be used to gather oceanographic data along the sections. STD casts by the CGC ROCKAWAY will be supplemented with Nansen casts to near bottom periodically.

The nerve gas dump site survey will be made about 20 - 21 November 1970. The data gathered during this cruise, coupled with the deep water data gathered during the actual dump period by the USCGC MENDOTA (WHEC 69), should provide insight into the possible distribution of the selected parameters related to nerve gas, its degradation products and its effect on the marine environment in the area of the dump site. During both the occupation of stations on the Sections A-6 and A-7 and the dump site, data will be gathered to show the vertical distribution of temperature, salinity, oxygen, fluoride, nitrates, phosphates, silicates and ammonia.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

2.0537, WESTERN BEAUFORT SEA ECOLOGICAL CRUISE (WEBSEC 9-70)

T.L. ROBERGE, U.S. Dept. of Transportation, Oceanographic Unit, *Washington, District of Columbia*

On 23 September 1970, the USCGC GLACIER (WAGB 4), Capt T. L. Roberge commanding, will depart Point Barrow, Alaska, to conduct a cooperative baseline assessment of the biological, chemical, geological and physical variables of the marine ecosystem in the coastal waters of the Western Beaufort Sea (Cape Halkett to Barter Island). Particular emphasis will be placed on the area near Prudhoe Bay. The duration of the survey will be approximately one month.

The Western Beaufort Sea, adjacent to the North Slope oil field, is an area in which the likelihood of future pollution is great. All too frequently, investigations of the impact of pollution on the marine ecosystems are conducted without any quantitative knowledge of the ecosystems in their unpolluted state. The lack of such knowledge seriously limits the analysis and interpretation of data taken after pollution has begun. It is imperative that a quantitative assessment of the variables of the ecosystem be undertaken as soon as possible.

At least two cruises must be conducted to obtain an estimate of normal seasonal variation in the ecosystem. One cruise will be conducted this autumn at the end of the open water season and another at the beginning of the open water season (mid-July 1971).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

2.0538, COMPLETION OF AN ECOLOGICAL SURVEY CRUISE IN THE SOUTHEASTERN CHUKCHI SEA

T.L. ROBERGE, U.S. Dept. of Transportation, Coast Guard, *Washington, District of Columbia* 20591

From 23 September to 18 October 1970, the USCGC GLACIER (WAGB 4), Capt. R. T. Roberge Commanding, conducted a cooperative ecological cruise in the Southeastern Chukchi Sea. The objective of this cruise was to conduct an assessment od chemical, physical, biological, and geological conditions in the marine environment as baselines for comparison with future conditions in the event of pollution. Because of the relatively advanced state of development of the North Slope oil field, the principal area of interest was the western Beaufort Sea. The eastern Chukchi Sea, not yet the site of development, was an alternative area. The presence of extensive pack ice in the vicinity of Point Barrow precluded sampling operations in the Beaufort Sea: accordingly the cruise was conducted in the Cape Lisburne-Icy Cape area of the southeastern Chukchi Sea.

The following scientific organizations participated in the cruise: U. S. Coast Guard Oceanographic Unit, Washington, D.C; U. S. Geological Survey, Menlo Park, California; U. S. National Marine Fisheries Service (formerly BCF) Laboratory, Auke Bay, Alaska; U. S. Bureau of Sports Fisheries and Wildlife, Anchorage, Alaska; Smithsonian Institution, Washington, D. C. and the Institute of Marine Science, University of Alaska, College, Alaska.

Ninety-two stations were occupied during the cruise yielding the following data or samples: 47 Nansen bottle casts for temperature, salinity, and nutrients; 136 NBT Drops; 14 Niskin bottle casts for geochemical water samples and nutrients; 28 Current meter lowings for 130 hours; Surface meteorological observations on station; 60 Vertical zooplankton tows; 81 Mid-water trawls; 33 Box cores; 12 Metal-free gravity cores; 71 Grab samples of bottom sediments; 4 Piston cores; 3 Isotopic oxygen water samples; 4 Microplankton tows; 14 Beach profiles; 2 Airborne particulate samples; 68 Transmissometer lowerings; 42 Bottom camera lowerings; 100 Hours of bird and mammal survey; 66 Birds collected; 7 Mammal species identified.

All data will be published, with a description of sampling methods and a preliminary interpretation, in the USCG Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

2.0539, HYDROLOGY, USDI

M. DEUTSCH, U.S. Natl. Aero. & Space Adm., *Washington, District of Columbia*

The hydrologic problems have been divided into 4 study classes: (1) inland hydrologic features, (2) quantities and physical properties of snow and ice (3) estuarine and coastal hydrologic features and (4) water quality parameters. The purpose of the hydrology program is to develop an automated data collection, processing, analysis and distribution network utilizing both remote sensor (air and space) and ground control data. A real-time network of ground monitor stations will be selected from about 50,000 data collection stations presently maintained by the USGS water resources division in cooperation with all 50 states, and numerous federal, interstate and local agencies. The investigator shown above is the Project Monitor whose telephone is 202-382-4423.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0540, NATURAL AND CULTURAL RESOURCE MANAGEMENT

A.B. PARK, U.S. Natl. Aero. & Space Adm., *Washington, District of Columbia*

Department of Interior Bureaus are progressing on feasibility studies of the application of earth resources satellite data and associated space technology to operational functions of the department. These studies are in eight broad task areas each consisting of several discrete projects: 1. Land classification for reclamation planning and management, including water logged irrigation land, tropical land irrigation classification, arid land weather modification, water and land resources for classification of arid irrigation lands, weed control for irrigation management, water quality flow for irrigation, intense rainstorms and water management development of system for utilizing ERTS data for reclamation, soil engineering, and improved snow survey. 2. Land use classifications and resource inventories for multi-bureau requirements including application of space systems to public land inventories, public timber and spruce beetle control, resource inventory of Papago Indian Reservation, use of ERTS data by computer for Indian affairs, and cadastral surveys of public lands. 3. Oil leaks and slicks, including applications of NASA's fraunhofer line discriminator to oil and water pollution problems. 4. Ecology of Wetlands and Uplands Wildlife Habitat Areas, including use of ERTS data for wildlife refugee management, and the use of space imagery and technology for game areas and coastal zone fish and crustacean breeding areas ecology studies. 5. Inventory, preservation, management of national parks using space technology, and including archaeological site development. The investigator shown above is the Project Monitor whose telephone is 202-133-6523.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0541, SPACECRAFT OCEANOGRAPHY PROJECT

A.B. PARK, U.S. Natl. Aero. & Space Adm., *Washington, District of Columbia*

Since 1965, the Naval Oceanographic Office and the National Aeronautics and Space Administration have been conducting, through a formal working agreement, a research program to define feasible ocean measurements from space platforms. Broad consideration of applicable remote sensors to measure ocean features has resulted in a concentrated effort to define the oceanographic goals for the next several years with regard to space systems. Basically, this project has narrowed funding requirements for research to define sensor, observational and data requirements for a satellite bearing the following systems: (A) MOCS- Multichannel ocean color system, (B) Time-thermal infrared mapping system, (C) AWODs-all weather ocean dynamics system. These sensor systems will obtain data on all ocean features evaluated to date the remote sensing from space. This project also recognizes the value of the data collection system (DCS) which has been successfully used for interrogating surface platforms, as a complimentary system to remote sensing. Research for justifying and specifying the sensor systems, observational requirements and data handling techniques for the above systems is divided into five categories: (1) Ocean color via visible region sensors. (2) Sea temperature or thermal charting via infrared (and microwave) sensors. (3) Ocean dynamics-primarily with microwave sensors with secondary visible and infrared vision sensors. (4) Specific ocean applications such as sea ice, shoals, food-from-the-sea, pollution and coastal (processes) ecosystems. and (5) Management. A coherent program for developing requirements in all these areas has been presented to the National Aeronautics and Space Administration (NASA). This is the only national effort of its kind in oceanography as not similar programs exists in the Department of Defense, the National Aeronautics and Space Administration or elsewhere. The investigator shown above is the Project Monitor whose telephone is 202-963-6523.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0542, TAXONOMY AND ECOLOGY OF INSHORE MARINE MICROBIOTA

J.B. LACKEY, Unknown Inst. Or Indiv. Grant, *Florida*

This envisages publication of an illustrated account, with keys, of inshore marine and brackish water protozoa and microscopic algae, both planktonic and benthic. Their commonness or rareness, cosmopolitan or restrictive distribution will be covered by ecology, especially with reference to pollution, nutrient richness and water poor in nutrients. Regions covered to date are

the Atlantic Coast, Florida to Woods Hole, Massachusetts; the Florida Gulf Coast, the California Coast, the Island of Oahu and Guanabara Bay, Brazil.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0543, ST. JOHNS RIVER FISHERY PROJECT

H.L. MOODY, State Div. of Game & Fish, *Eustis, Florida* 32726

The purpose of this study is to monitor fish populations of the entire St. Johns River for fishery conservation purposes.

The rapid rate of human population growth in this section of Florida has produced and is continuing to cause limological and terrestrial changes, through public works and other activities, which has adverse effects on the fishery of the river. The aim of this study is to define these changes more precisely in order that deteriorations of the fishery may be arrested or prevented.

Fish population samples are taken with various standard fishing gear and by different methods, including chemicals, to determine successive changes in the populations and their species composition which may be related to natural environmental factors, water pollution, or to artificial changes in the habitat. Studies of sportfisherman success, harvest rates and fishing pressure are also made.

SUPPORTED BY Florida State Government - Tallahassee

2.0544, MEASUREMENT OF ELEMENTS DEPOSITED FROM ATMOSPHERE

C.L. DANTZMAN, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-RC-01382)

OBJECTIVE: Determine the amount of chlorine, fluorine, iodine, and sulfur brought down from the atmosphere in rainfall.

APPROACH: Rainfall will be caught in stainless steel rain gauges and collected in acid-leached jugs. The jugs will be changed monthly and analyzed for the elements in question.

PROGRESS: Water sampling of nine streams and six bodies of water within a radius of 50 miles of the Range Cattle Station began in January 1969 and continued at one-month intervals. Rainwater collecting from five sampling stations continued. All water samples were analyzed for Al, Ca, Cl, Cu, F, Fe, I, K, Mg, Mn, P, Na, Zn, and soluble salts. Quantities of the elements were found to vary during the year for all sampling stations including streams, lakes, and rainwater.

SUPPORTED BY Florida State Government - Tallahassee

2.0545, STUDIES ON THE METHANOGENIC BACTERIA IN SLUDGE

P.H. SMITH, Univ. of Florida, School of Agriculture, *Gainesville, Florida* 32601

Experiments are being conducted to describe the methanogenic microflora in sludge. A large number of pure cultures of methanogenic bacteria have been isolated and their characteristics determined.

Experiments are being conducted to determine quantitatively the roles of fatty acids in the digestion process.

A culture collection of methanogenic bacteria has been established containing all extant cultures of methanogenic bacteria. The cultures are available to interested investigators through the American Type Culture Collection.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0546, ENZYME SYSTEMS OF ESTUARINE ORGANISMS

D.L. COPPAGE, U.S. Environ. Protection Agcy., Office of Res. & Monitoring, *Gulf Breeze, Florida* 32561

Two of the major classes of pesticides - the organic phosphates and the carbamates - are toxic to animals because they inhibit the enzyme acetylcholinesterase (AChE), which is essential to normal nerve impulse transmission. By assaying the AChE activity in nerve tissue of aquatic animals, pollution of the estuarine environment by these chemicals can be detected before deaths occur and at levels far below those which can be detected by present analytical techniques.

We will establish normal enzyme levels for selected vertebrate and invertebrate species, and conduct periodic sampling and assay. Lowered enzyme activity in one or more species will be indicative of pollution. We will also expose various fishes and invertebrates to commonly used pesticides to study degree of AChE inhibition and time necessary for recovery. An investigation of the effects of lowered enzyme levels on estuarine fauna will be conducted.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0547, WATER QUALITY AND FUNGI-NEMATODE-SEAGRASS-RELATIONSHIPS

J.W. FELL, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

Environmental conditions in Biscayne Bay are being altered rapidly through continued urbanization and industrialization. However, studies on the existing food web and sources of productivity, adequate to provide a baseline for planned development and use of this natural resource, have not been made. Initial observations suggest that the mangroves lining the shores and the macro-algae and sea grasses of the shallow bay bottom produce such large quantities of detritus that they constitute the major source of productivity. It also appears likely that this material is made available in a form utilizable by the invertebrates and fishes principally through fungal degradation. The fungi in turn may be grazed by nematodes and other small invertebrates co-habiting the detrital sediments. The specific roles of fungi and nematodes however, are not known and it is important to examine these organisms in the natural environment and to determine the effects of environmental variables on this food chain sequence. Anticipated environmental changes are likely to include large quantities of heated water, industrial and human wastes and the destruction of fringing mangroves by bulkheading.

The following aspects will be studied: 1) distribution of human pathogenic yeasts and their potential use as pollution indicators; 2) effects of thermal effluents on fungal and nematode populations; 3) role of fungi and nematodes in estuarine productivity, specifically in the mangrove system.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0548, GEOSECS RADIOCARBON AND TRITIUM MEASUREMENTS

H.G. OSTLUND, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

Considering the ocean as a source of food, a disposal area for nuclear and industrial waste products, and a controlling factor in the earth's climatic regime, our ultimate use of the sea is critically dependent on a detailed understanding of processes presently understood in only the vaguest and most qualitative way. These are the stirring and mixing processes in the deep sea, the interchange of material between deep and surface water, the variation of organic productivity throughout the ocean, and the exchange of water and gases with the atmosphere. The GEOSECS program will measure in detail the oceanic constituents along Arctic to Antarctic sections at all depths, to provide, for the first time, a set of physical and chemical parameters measured on the same water samples. These data will provide the input for quantitative studies of oceanic mixing and organic productivity, and, at the same time, serve as a base-line for the levels of pollutants and of fission and waste products being added to the sea. Ostlund will concentrate on C14. If measurements are made with higher precision than currently available, C14 holds the greatest wealth of information as the most important oceanic radio tracer, because it is involved in both the inorganic-organic carbon cycle and the general circulation problem. Ostlund requires considerable support to environmentally condition facilities to assure highly precise (plus or minus 4 per mil) and reliable results.

SUPPORTED BY U.S. National Science Foundation

2.0549, UPPER ST. JOHNS WATER QUALITY, FLORIDA

D.A. GOOLSBY, U.S. Dept. of the Interior, Geological Survey, *Tallahassee, Florida* 32304

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with State and local agencies in Florida and the Corps of Engineers.

Purpose: To determine the types and sources of contaminants in waters of the upper St. Johns River basin as an aid in evaluation of water management proposals.

Methods: Seasonal sampling, with concurrent measurement of discharge, is proposed for about 20 sites in the basin and specific conductivity profiles along main stream and tributaries run to determine sources of contamination. Field and laboratory determinations will be made and besides the customary determinations of common minerals will include dissolved oxygen, pH, nutrients, pesticides and trace elements.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0550, REMOTE SENSING, EVERGLADES AREA, FLORIDA
M.C. KOLIPINSKI, U.S. Dept. of the Interior, Geological Survey, *Tallahassee, Florida* 32304

Purpose: To determine the relations between water conditions and biological populations in the Everglades by interpretation of airborne data and to develop new applications in natural resources research for data from remote sensors.

Methods: Spectral reflectance measurements of floral communities and water will be obtained using an airborne 18-channel optical- mechanical scanner. The data will be accumulated in a form that will allow use of a computer to identify and map the distribution and amount of selected communities. Remote sensing data will be examined for potential in: detecting plankton blooms, locating alligator holes, and estimating populations of large animals.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0551, PRODUCTIVITY AND MINERAL CYCLING ON NATURAL AND MANIPULATED ECOSYSTEMS
D.A. CROSSLEY, Univ. of Georgia, School of Agriculture, *Athens, Georgia* 30601

Major objective of this research involves an intensive study of water quality, productivity and nutrient cycling on natural and manipulated ecosystems at U. S. Forest Service Coweeta Hydrologic Laboratory. Initial research will concern annual and seasonal input- output of water and nutrients of four watersheds. Dissolved and particulate materials reaching the weir ponds will be sampled regularly. Feasibility of several sample alternatives will be examined for measuring particulate losses. Emphases will be placed on the successional weed stand, 6 year coppice stand and 13 year pine catchment areas.

SUPPORTED BY U.S. National Science Foundation

2.0552, ENTERIC BACTERIAL DEGRADATION OF STREAM DETRITUS
C.W. HENDRICKS, Univ. of Georgia, Graduate School, *Athens, Georgia* 30601

At the present time many of our clean fresh water lakes and streams are receiving pollutant materials from various agricultural, industrial and municipal sources. It is currently believed that if the dilution rate is sufficiently small, little permanent damage results to the body of water in question. However, many of these materials can serve as substrate for the growth and multiplication of organisms which are presently indicators of fecal pollution and can cause disease. The major objective of this proposal is to conduct basic research on mechanisms by which enteric bacteria, including pathogens, can survive in the aquatic environment. Particular attention is now being given to the understanding of the growth - promoting activity of various substrates which are either indigenous to the aquatic environment or are artifically introduced and to describe the conditions which will influence the rate of turnover of both bacterial populations and substrates. Techniques which allow for the direct measurement of oxygen uptake of metabolizing bacteria are now being employed to yield data concerning those natural substrates which can support the growth of enteric bacteria. Our preliminary results appear to be sufficient to being the continuous culture experiments which should give us infc mation about growth yields on these substrates. Once specific information has been obtained concerning the utilization of this material, we would be in a better position to understand the roles of both the aquatic environment and the bacteria in a polluted stream. Such data could also aid in the classification of rivers and streams and form a foundation for the construction of model systems which might be able to predict the theoretical pollution limits of a given body of water. It is conceivable that this type of knowledge could yield useful data on how presently contaminated bodies of water can be reclaimed.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0553, FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION
C.M. HIMEL, Univ. of Georgia, School of Arts, *Athens, Georgia* 30332

The major objective of this research is the study of the application of designed fluorescent probe molecules with cholinesterase enzymes in the detection of insecticides at low levels in water.

Fluorescent probe molecules which are equilibrium inhibitors of the anionic site of Ch.E. have been synthesized. 1-(5-Dimethylaminoaphthalene-1-sulfonamide) 3-N, N dimethylaminopropane and its aliphatic quaternary derivative act as active-site-directed, equilibrium fluorescent probes at the anionic site of Ch.E. The presence of the probe molecule at the active site interferes with the binding of certain phosphate type and chlorinated hydrocarbon type insecticides. The degree of interference is reflected in the fluorescence spectral response of the probe-enzyme complex.

Sensitivity of the analytical method is determined by the relative concentrations of the enzyme and the fluorescent probe. It is also related to the equilibrium constants for the dissociation of the probe- enzyme complex and the insecticide-enzyme complex. Indicated sensitivity is in the range of 10 to minus the 8th power or less at present.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0554, TRACE ELEMENT ANALYSIS BY DIRECT DETERMINATION ON ION EXCHANGE RESINS
D.E. LEYDEN, Univ. of Georgia, School of Arts, *Athens, Georgia* 30332

The objective of this research will be to develop sensitive and accurate procedures for the analysis of akaline earth, transition metal and heavy metal ions in aqueous solutions. This method of analysis involves the use of selective ion exchange resins and subsequent determinaton of the retained ions by direct analysis of the resins by X- ray spectrography. Application of the method will be made to many diverse subject areas including analytical chemistry, water pollution, oceanography, trace element geochemistry and geochemical prospecting. The method has been successfully applied to the analysis of barium in water and in aqueous NaCl solutions containing from 10 to minus super 4 to 10 minus super 8 moles. Preliminary studies have shown the feasibility of applying this method to other alkaline earth elements and to the transition metals copper and zinc. Research will be concentrated on the development of procedures for further applications of commercial resins and to test and to develop other specific ion exchange resins to meet particular analytical problems. Methods for analyzing solids will be developed as well as for solutions.

SUPPORTED BY U.S. National Science Foundation

2.0555, DETERMINATION OF DEGRADED DYES AND AUXILIARY CHEMICALS IN EFFLUENTS FROM TEXTILE DYEING PROCESSES
R.K. FLEGE, Georgia Inst. of Technology, Water Resources Center, *Atlanta, Georgia* 30332

Work will be directed toward the development of methods for identification and quantitative measurement of dyes and chemical auxiliaries, in raw and treated textile mill effluents.

Chromatographic and indirect spectrophotometric methods of analysis will be investigated. Methods developed will be extended to cover residues, from those dyes and chemicals, originating from reactions in the dyebaths or waste treatment processes.

Dyeing formulae will be made up from widely used dyes and auxiliary chemicals. Analytical methods will be developed for identification of those known dyes and chemicals.

Effluents from commercial dyeing processes, that make use of chemicals in the model formula, both before and after conventional waste treatment, will then be analyzed in an attempt to determine the degradation product of those dyes and chemicals resulting from waste treatment processes.

Processing formulae using known dyes and auxiliary chemicals will be subjected to laboratory waste treatment techniques, simulating those used for treatment of domestic waste in conventional treatment plants and lagoons. Effluents from these experiments will be analyzed for presence of original dyes and auxiliaries and their forecasted degradation products.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0556, PREDICTION MODELS FOR WATER QUALITY PARAMETERS

W.W. HINES, Georgia Inst. of Technology, Water Resources Center, *Atlanta, Georgia* 30332

This proposal is the second phase of a project entitled 'Prediction Models for Water Quality Parameters.' Phase II will build on the results of Phase I work. Phase II objectives are, first, to quantify the feedback and control mechanisms that exist in the total water quality system of a basin or region (the qualitative feedback network is developed as a part of Phase I); and, second, combining the quality parameter interaction (between dissolved oxygen and temperature) model from Phase I, which describes stream quality resulting from various uses and waste discharges, with the feedback control system mentioned above, general system behavior under different policies will be studied.

The need for Phase II has become clearer as Phase I has progressed. Considerable work has been done and is now in progress on various components of the total water quality system; e.g., the research being performed in Phase I on the prediction of the stream quality component. It is known that social, economic, and political conditions and attitudes influence the amount of waste discharge to streams, and the water quality standards result from needs and desires of the various public and private sectors, etc. Therefore, in order to put water quality planning and management on a more rational and more socially equitable basis, the various water quality system components must be embedded in a comprehensive system which is capable of relating the actions and decision of each segment to those of the others. This approach will be of assistance in setting water quality standards that can be reasonably attained, since the total system response can be studied and changes made in the proposed standards prior to putting them into effect.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0557, APPLICATION OF MODERN ELECTROANALYTICAL TECHNIQUES TO THE ANALYSIS OF HEAVY METALS IN WATER

P.E. STURROCK, Georgia Inst. of Technology, Water Resources Center, *Atlanta, Georgia* 30332

The proposed research plan involves laboratory and field investigations directed at determining the suitability of modern electroanalytical techniques for the analysis of water for trace contaminations by heavy metals. The approach will be to determine the sensitivity limits, accuracy and interferences for a number of metal ions using solutions of known concentrations prepared in the laboratory. Then the procedures and techniques developed will be tested on samples obtained from various points along the Chattahoochee River to see if point to point and day to day fluctuations of heavy metal concentrations can be observed.

Laboratory investigations will employ the following methods: 1. Square-wave polarography. 2. Phase-selective A.C. polarography. 3. Derivative chronopotentiometry.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0558, HYDROLOGY OF COASTAL AREA IN THE VICINITY OF RICEBORO, GEORGIA

J.R. GEORGE, U.S. Dept. of the Interior, Geological Survey, *Atlanta, Georgia* 30309

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Georgia.

Purpose: To determine the hydraulic and chemical characteristics of surface waters in the North Newport River Drainage Basin and the piezometric surface and quality of water in the principal artesian aquifer in the vicinity of Riceboro prior to the beginning of operations of a large industry as well as after the plant is in operation.

Methods: The tidal behavior of the Newport River estuary will be studied and the amount of interchange between salt and fresh water, the time of travel through the estuary, and the dispersion patterns will be determined. Discharge measurements will be made. Chemical analyses will be made on water samples collected periodically and water quality monitors will be installed. Wind direction and velocity component data will be recorded at one station. Continuous water level recorders will be installed on four wells. Electric and gamma-radiation logs will be made of selected wells within 30 miles of Riceboro to determine the amount of casing and depth of the well and aid in interpretation of the geology and identification of the aquifer. Aquifer tests will be made at the plant site after completion of the plant wells.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0559, DISSOLVED OXYGEN AND OXYGEN DEMAND IN A SALT MARSH BORDERED ESTUARY

D. FRANKENBERG, Univ. of Georgia, Marine Institute, *Sapelo Island, Georgia* 31327

The project supported with this grant describes and analyzes dissolved oxygen an oxygen demand distributions, with respect to time and space, in a small unpolluted, estuary bordered by a salt marsh, the Duplin River of Sapelo Island, Georgia. The relationships between the distributions of dissolved oxygen and oxygen demand and the distributions of physical, chemical and biological parameters in the estuary are tested statistically through multivariate analysis in order to generate mathematical and computer simulation models of dissolved oxygen and oxygen demand phenomena. The predictive value of these models is tested by their application to the Dulpin River and to larger, more complex estuarine systems nearby. In addition, the results of this research will provide important base lines from which the effects of stresses imposed on a salt-marsh estuary by unusual processes (those which alter oxygen concentrations) can be measured.

SUPPORTED BY U.S. National Science Foundation

2.0560, A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC

D.W. MENZEL, Skidaway Inst. of Oceanograph., *Savannah, Georgia* 31406

This project to identify the major problems of man's contamination of the oceans will be carried out in two parts: (1) Samples of the ocean environment including zooplankton, fishes (migratory and non-migratory), benthic organisms sediments, sea water, surface slicks, and airborne material will be analyzed for pollutants (heavy metals, transition metals, pesticides, and petroleum derived hydrocarbons). (2) Following completion of the above program, a study group will be convened in Woods Hole to discuss the results and to interpret them. The final product will be the planning document for a full-scale research program in the Environmental Quality of the North Atlantic Ocean. Skidaway Institute of Oceanography will have primary responsibility for analysis of benthic organisms, zooplankton and sediments for heavy metal concentration. The Institute will play a leading role in the Part II Study. Dr. Menzel will be responsible for the overall management of the program.

SUPPORTED BY U.S. National Science Foundation

2.0561, COMMERCIAL OYSTER FISHERY DEVELOPMENT INVESTIGATION
H.M. SAKUDA, State Div. of Fish & Game, *Honolulu, Hawaii* 96813

The objectives of this phase are to: 1) Continue experimental commercial oyster growing operations and assist private growers in improving production; 2) Determine the effects of adding chemical fertilizers to the growing waters in respect to oyster production; 3) Continue monitoring of the oyster growing waters to establish the sanitary quality of various potential cultural sites; 4) Conduct marketing studies to determine consumer demand; 5) Conduct relaying and short-term depuration studies in commerical quantity and determine durations required to cleanse oysters so that a standard relaying and depuration period can be established for Hawaiian waters.

The work will be conducted mainly in West Loch, Pearl Harbor and at the Molii Fishpond under a cooperative agreement with the pond operator.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0562, EVAPOTRANSPIRATION BY SUGAR CANE
P.C. EKERN, Univ. of Hawaii, Water Resources Research Ctr., *Honolulu, Hawaii* 96822

Field data from the installation of a large semi-contained hydraulic lysimeter within a major irrigated sugar cane region at the Kunia substation of the Hawaiian Sugar Planters' Association will be given laboratory analysis for correlation of the measured rate of consumptive use with pan evaporation and other soil and meteorological parameters suitable for prediction of irrigation interval scheduling.

Other activities: Calibration of this instrument as a primary standard for the measurement of evaporation from water, Latosol, and successive growth stages of sprinkler irrigated sugar cane; assessment of the patterns of moisture movement within the lysimeter and measurement of the heat budget within the soil; calibration of the neutron probe for tropical soils; and collection of seepage waters for detection of the rate of movement of nitrates and other constituents through the profile into the ground water.

Methods used: A 6 m square, 2 m deep container with walls of fiber glass reinforced resin, supported on an hydraulic scale of nylon reinforced irrigation hose will comprise the lysimeter. Batteries of resistance blocks, tensiometers, and access tubes for neutron probe will be arrayed for in situ record of soil moisture status. A similar array of thermistor units will record temperature gradients within the lysimeter soil. Porous ceramic tubes will be used to maintain soil water suction equivalent to 100 cm of water at the bottom of the soil column. Percolate waters withdrawn through this system will be preserved for qualitative analysis. Correlative studies will be made of the long period (24 hour) water use rates with pan evaporation and other predictive parameters. Short period (hourly rates) will be assessed as reflected in cane growth, particularly in the presence of temporary mid- day wilt.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0563, BACTERIOLOGICAL STUDY OF THE POLLUTION OF KANEOHE BAY, OAHU
K.R. GUNDERSEN, Univ. of Hawaii, Water Resources Research Ctr., *Honolulu, Hawaii* 96822

A comprehensive study of coliform distribution and other indicator bacteria of sewage origin will be made of the water in Kaneohe Bay, Oahu, Hawaii including hydrological and meteorological observations.

Six sites near sewage outfalls and in the Bay will be sampled at two water depths and of the bottom deposit. Sewage just prior to disposal will also be sampled. All liquid samples will be collected at least weekly and with aseptic technique. Liquid bottom samples will be analyzed for coliforms 35 degrees C, thermostable 45 degrees C, enterococci 35 degrees C and total count 25 degrees C. Prior to sampling, air and water temperatures, wind direction and speed, cloudiness, rainfall, water turbidity will be measured.

This study is expected to provide the much needed data for determining the degree of sewage treatment required and for a planned study of the bacterial involvement in the transformations of inorganic nitrogen and sulfur compounds in the Bay.

SUPPORTED BY University of Hawaii

2.0564, GEOSECS - ISOTOPIC MEASUREMENTS (C13/C12O18/O16DH) IN DISSOLVED INORGANIC CARBON, ATMOSPHERIC CO2 & H2O VAPOR & DISSOLVED O2 (ABBREV)
P.M. KROOPNICK, Univ. of Hawaii, School of Arts, *Honolulu, Hawaii* 96822

Considering the ocean as a source of food, a disposal area for nuclear and industrial waste products, and a controlling factor in the earth's climatic regime, our ultimate use of the sea is critically dependent on a detailed understanding of processes presently understood in only the vaguest and most qualitative way. These are the stirring and mixing processes in the deep sea, the interchange of material between deep and surface water, the variation of organic productivity throughout the ocean and the exchange of water and gases with the atmosphere. The GEOSECS program will measure in detail the oceanic constituents along Arctic to Antarctic sections at all depths, to provide, for the first time, a set of physical and chemical parameters measured on the same water samples. These data will provide the input for quantitative studies of oceanic mixing and organic productivity, and, at the same time, serve as a base-line for the levels of pollutants and of fission and waste products being added to the sea. This proposal covers the construction of (1) sea-going systems for extraction of dissolved O2 and CO2 from sea water for isotopic analysis, (2) shipboard systems for collection of atmospheric CO2, N2O, and water vapor, and (3) laboratory system for conversion of dissolved O2 stripped from sea water to CO2 for mass spectrometric analysis. Isotopic analyses and N2O measurements will be done in collaboration with the Isotope Laboratory at Scripps Institution of Oceanography.

SUPPORTED BY U.S. National Science Foundation

2.0565, POLLUTION OF COASTAL WATERS
L.S. LAU, Univ. of Hawaii, School of Engineering, *Honolulu, Hawaii* 96822

Coastal waters undoubtedly constitute one of the most important natural resources in Hawaii. In spite of the importance of existing and potential pollution of the coastal waters, knowledge of the extent of such pollution and its effects in these waters in Hawaii is extremely meager. The objective of the proposed investigation is to plan an overall program of research on the pollution of Hawaiian coastal waters, intended to provide a satisfactory knowledge base for a sound water quality control program. The provision of knowledge might be approached by a combination of several possible routes: pollution survey, ecological surveys, waste discharge case studies, and single pollutant studies. The pollution effects would be subjected to economic analyses and appraisal of esthetic effects, and implications in controls and institutional management. The general procedure would be organization of an interdisciplinary steering committee of university faculty, a renowned water pollution expert as executive secretary and additional out-of-state specialists as short-term consultants. Through continuing studies and/or workshops, review will be made of pollution patterns, parameters, pollution effects, waste discharges, transport mechanisms, fates, and the adequacy of present water quality standards. Liaison will be maintained with other state programs and other Sea Grant programs especially coastal zone management.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0566, IDENTIFICATION OF IRRIGATION RETURN WATER IN THE SUBSURFACE
R.H. YOUNG, Univ. of Hawaii, Water Resources Research Ctr., *Honolulu, Hawaii* 96822

The proposed project will summarize in a comprehensive report the physical and chemical characteristics of return irrigation

water derived from areas of tropical agriculture. Sampling will be continued from the Kalauao and Kahuku areas of Oahu and from the isthmus and West Maui ground water areas. Both composites and profile samples will be obtained from complete analyses including determinations of pH, chloride, sulfate, nitrate, phosphate, silica, hardness, bromide, iodide, fluoride, and boron. Basic data collection will necessitate sampling of rainwater, surface run-off, bulk-fallout and spring water. Some tritium studies for flow-tracing and age-dating will be utilized. The total water quality information will be correlated with fertilization and irrigation practices and land use patterns to ascertain man's contribution to the basal water, to identify patterns of ground water flow, rock weathering, chemical erosion, and for formulation of water quality standards and/or water management practices.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0567, INVESTIGATION OF MICROLAYER COLLECTION FOR POLLUTION MEASUREMENT

G.W. HARVEY, Oceanic Institute, *Waimanalo, Hawaii* 96795

Objective: To determine the effectiveness of the microlayer collector with its associated analytical methods for sampling, detecting and tracing pollutants at the air-water interface in Hawaiian waters.

Large (18-liter) samples will be collected simultaneously from the 60-micron and the 10-centimeter levels along suspected gradients of pollution in Kaneohe Bay, Oahu, with controls from the very clean oceanic water outside the Bay. Samples will be held for not more than one hour so that degradation will be minimized.

The high concentrations of organic material in the surface microlayer have suggested it as a site for detecting and monitoring pollutants. Our past work has shown unexpectedly large quantities of bacteria, algae, protozoa and other organic and inorganic particles in this region, with possible and specific relationships to marine pollution. At least five possible indicator organisms have been found in the 60-micron layer.

Fluorometry, atomic absorption and conventional spectrophotometry will be employed for chemical analyses, supplemented by some standard methods for oil residues. High resolution and interference contrast microscopy with special chambers, will be used for most of the particle analysis.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0568, ANALYSIS OF IMPURITIES AND THEIR REMOVAL FROM REACTOR COOLING WATER

E. SZABO, Central Res. Inst. of Physics, *Budapest, Hungary*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0569, DETERMINATION OF THE DISTRIBUTION OF RADIONUCLIDES DISCHARGED TO THE GROUND AT THE NRTS, IDAHO

J.T. BARRACLOUGH, U.S. Dept. of the Interior, Geological Survey, *Idaho Falls, Idaho*

Program is a continuation of that conducted in previous years. The observation of migration of the radioactive isotopes contained in the aqueous wastes has been a primary part of the program. Underground movement has not yet reached a steady state and observations will continue until steady state is reached. The program consists of observation of radionuclide migration and is determined from empirical analysis of data on aquifer discharge effects observed as water level fluctuations in wells to tracer studies using both natural and introduced elements to determine both vertical and horizontal movement, determination of head differentials between aquifers and single wells and between wells and bore hole geophysical logging.

SUPPORTED BY U.S. Atomic Energy Commission

2.0570, EFFECTS OF URBANIZATION ON GROUND-WATER SUPPLIES, BOISE AREA, IDAHO

N.P. DION, U.S. Dept. of the Interior, Geological Survey, *Idaho Falls, Idaho*

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Idaho.

Purpose: To provide a detailed description of the ground water resources of the Boise-Nampa area in southwestern Idaho and to assess the effect of urbanization on this source of water supply.

Methods: The hydrology of the shallow aquifers extending to depths of about 200 feet will be evaluated on the basis of their occurrence and the availability, source, movement, and quality of the water they contain. This will be accomplished by (1) collecting construction, water-level and chemical quality data and driller's logs for selected wells, (2) constructing geohydrologic diagrams showing the lateral and vertical extent and lithology of hydrologic units, (3) using hydrographs and piezometric maps to show short-term water level fluctuations, long term trends, areas of recharge and discharge, and the elevation and configuration of the water table, (4) collecting water samples for chemical analyses to show the distribution of various chemical types of water.

The effects of urbanization will be assessed by seeking to establish the nature and location of changes, if any, in groundwater recharge, movement, discharge, and quality using current and historical data. Extensive use will be made of aerial photos taken in 1953 and in 1969 to determine changes in land-use and water-use patterns.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0571, ECOLOGICAL FACTORS INFLUENCING FREE-LIVING NITROGEN-FIXING ORGANISMS IN CERTAIN NORTHERN SOILS

G.R. ANDERSON, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00214)

OBJECTIVE: Determine whether or how Azotobacter propagate in the main streams and irrigation systems of southern Idaho. Identification and classification of Azotobacter from plot and soil studies. Determine if Azotobacter can serve as an indicator of the toxicity of fluorine effluents.

APPROACH: The ecology of these organisms in Portneuf soils and related irrigation waters will be studied. The effect of nutrients and climatological factors on Azotobacter in native waters will be followed through population changes. Unusual Azotobacter in native waters will be followed through population changes. Unusual Azotobacter isolates from natural and artificially induced populations will be identified. The particular effect of fluorides on Azotobacter strains will be measured in soil, water, and laboratory cultures, using a fumigation chamber.

PROGRESS: Field soils of Palouse and Moscow silt loam were thoroughly mixed with Beijerinkia, moistened and reburied in plastic bags in the field. A population increase of three log values was noted in all glucose (.5%) amended soils. These populations figures were obtainable only as a result of dilution plating on acid nitrogen free, acid nitrogen free with 50 ppm Fungizone and Martin's alkaline nitrogen free media. Inhibited growth on soil plates at low dilution was routine. Studies of old field plots in Moscow silt loam revealed the absence of Beijerinkia regardless of soil preparation. Azotobacter populations increases of 10 were noted without inoculum and with a minimal natural population. Plot counts of Beijerinckia from distilled water dilution bottles revealed the apparent increase in Beijerinckia in distilled H(2)O over a period of three months or more. Air inoculation of Southern Idaho soils by Nitrogen fixers was measured. Nitrogen-fixers. Pseudomonas, Cladosporium and other unidentified organisms, were recovered from the impinger. No Azotobacter were found indicating that Azotobacter are not usually transported from soil to soil through the air.

SUPPORTED BY U.S. Dept. of Agriculture

2.0572, AN INVESTIGATION OF FACTORS RELATIVE TO GROUND-WATER RECHARGE IN IDAHO

R.E. WILLIAMS, Univ. of Idaho, Graduate School, *Moscow, Idaho* 83843

Location of those communities in Idaho producing appreciable volumes of wastewater has been determined in an earlier investigation by these researchers. The objective of the immediate

study is the examination of several hydrogeologic environments which in the future may be affected by wastewater disposal and recharge. Information on soils, groundwater, natural recharge, and geology will be obtained for several localities. Analysis of these data will facilitate recommendations concerning recharge and irrigation and the effect of these two processes on surface and ground-water environments.

At least one waste disposal operation will be examined in detail. The role played by the soil and rock as a renovating agent for wastewater will be examined at the locality of the disposal project.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0573, AN INVESTIGATION OF FACTORS INFLUENCING WATER QUALITY IN SOUTH FORK, COEUR D'ALENE RIVER

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The quality of the South Fork of the Coeur d'Alene River, Idaho, reportedly has been degraded by various users. However, little study of the river, its quality or the sources of its pollution has been undertaken. This study is designed to define the pollutants, determine their concentrations, their sources, and to recommend corrective measures.

SUPPORTED BY Idaho State Government

2.0574, CONTAMINATION OF DRINKING WATER AS A POSSIBLE FACTOR IN RETARDATION OF GROWTH OF SUCKLING CF1/AN1 MICE

M.P. FINKEL, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-38)

A test is being run to determine whether drinking water was responsible for a disease that appeared suddenly in the CF1/An1 breeding colony 7-8 years ago. The colony had been in excellent condition before several lactating mice died, and soon after that many suckling mice were undersize, apparently because they were not getting enough milk. Mice that survived to weaning age often were able to grow subsequently to normal size, and when they were bred, their reproductive performance was not different from that of mice not so severly retarded early in life. Infection seemed not to be the cause, and change of diet and bedding material had no effect. After several years autoclaved demineralized drinking water was substituted for autoclaved tap water, and growth of suckling mice has almost returned to normal. To test the hypothesis that a pollutant in the laboratory tap water becomes toxic to lactating mice upon autoclaving, breeding pairs of mice are being maintained on autoclaved demineralized water, autoclaved tap water, or fresh tap water. The experiment will be carried for 3-4 generations. Reproductive performance is being measured by number of litters and number of offspring produced, number weaned, and weight at weaning.

Results: Most of the original breeding pairs have produced one or two litters, and several second generation mice have reached reproductive age. There are not enough data at this time, however, to indicate whether drinking water was responsible for the disease manifested by failure of suckling mice to grow normally.

SUPPORTED BY U.S. Atomic Energy Commission

2.0575, ELECTROCHEMICAL METHODS FOR THE DETERMINATION OF TRACE AMOUNTS OF PHOSPHATE IN NATURAL WATER

J.A. COX, Southern Illinois University, School of Technology, *Carbondale, Illinois* 62901

The electrochemical techniques of stationary electrode polargraphy and cathodic stripping voltammetry are being investigated as possible means of trace analysis of phosphate.

The former method requires the formation of an electrochemically reducible phosphate complex; initial work will involve phosphomolybdic acid. The latter technique requires reversible deposition of phosphate as an insoluble salt on an electrode. Copper will be initially employed since a film is known to be formed on this metal in phosphate solution.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0576, BIOLOGICAL SURVEY OF STREAMS OF COLES COUNTY, ILLINOIS

L. DURHAM, Eastern Illinois University, Graduate School, *Charleston, Illinois* 61920

This study is designed as a systematic survey of the fish, macroinvertebrate and plankton populations of the streams in Coles County in east-central Illinois. It is intended to provide a basis for comparison studies of the future, in particular, following the construction of a flood-control reservoir which is in the land acquisition stages. The stations sampled have been carefully designated and mapped to allow exact duplication of areas sampled in the future. Thus the effects of such reservoir construction and function on stream populations may be observed. Data being collected include certain aspects of water quality including standard tests for D.O., temperature, pH, hardness, alkalinity, NO3, NO2, SO4 and PO4. BOD's and coliforms are being determined periodically. Examination of these data should also provide information concerning possible sources of pollution to the reservoir. Discovery and identification of such sources may allow remedial measures to be carried out before the reservoir reaches the filling stages. This project was initiated in June, 1967 and will be terminated in June, 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0577, DETECTION OF OIL CONTAMINATION IN SEA WATER

G.L. JOHNSON, I I T Research Institute, *Chicago, Illinois* 60616

An instrument is being constructed and tested for continuously monitoring the concentration of suspended persistent oil and oily residues in fresh or salt water in the range 100 to 1000 plus or minus 10 ppm. Infrared absorption spectrometry is employed. The third harmonic of the methylene group at 1.21 Mu is employed because the small hydrocarbon absorption coefficient here makes optical density independent of particle size, and because the small water absorption coefficient here permits a water thickness sufficient for a flowing sheath of clean water. The sheath prevents contact between oil and optical windows. A lead sulfide sensor observes alternately at the absorbing wavelength and the mean of a pair of low absorption flanking wavelengths, to discriminate against non-spectrally selective or broadly selective interference, i.e. displacement of absorbing water by transparent solutes or particulates, scattering losses, and variation in source color temperature. A second sensor observing an out-of-phase signal provides common-mode rejection of noise due to non-oily (transparent) particulates, and cross-talk from a duplexed I sub o signal.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

2.0578, A PRELIMINARY INVESTIGATION OF THE ROLE OF SEDIMENTS IN EUTROPHICATION

M.L. SILVER, Univ. of Illinois, School of Engineering, *Chicago, Illinois* 60680

The objective of this research is to perform a feasibility study that will aid in determining the amount and type of association between sediments and the phosphate nutrients responsible for the acceleration of eutrophication in rivers and lakes. Aquatic sediments may act as stable phosphate reservoirs under certain conditions; however, natural or man made disturbance that destroys this equilibrium may release unacceptably large quantities of nutrients back into the water.

The first phase of the investigation will determine, from the literature, the present state of knowledge concerning where phosphates occur in sediments, what are the quantities held, how the phosphates are held, and what mechanisms exist for dislodging phosphates from sediments. A second phase of the research will perform laboratory tests to define the manner in which phosphates are retained in sediments under conditions encountered in aquatic environments. In addition, the feasibility of using techniques such as X-ray diffraction and P sub 32 tracer techniques to measure various interaction mechanisms will be determined. The development of techniques for determining

where and why this nutrient is held or released should provide techniques for the future study of the fates of similar pollutants.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0579, SAND AND GRAVEL AQUIFERS OF NORTHEASTERN ILLINOIS

J.E. HACKETT, State Geol. Survey, *Urbana, Illinois* 61801

The region under investigation consists of Lake, McHenry, Cook, DuPage, Kane, and Will counties, and makes up the greater Chicago metropolitan area. Subsurface data and surficial mapping have been the basis for identifying and mapping surficial, interbedded and basal sand and gravel aquifers. The mapped aquifers are at least 15 feet thick. Surficial aquifers are overlain by 10 feet or less of fine grained sediments. Interbedded aquifers are overlain by more than 10 feet of fine grained sediments and are underlain by 10 feet or more of fine grained sediments above the top of the bedrock. Basal aquifers are underlain by less than 10 feet of fine grained sediments above the top of the bedrock. The mapping criteria lead to a delineation of the more favorable areas for large ground-water developments from sand and gravel. Mapping of the position of the aquifers relative to land surface facilitates understanding of hydrologic conditions and consideration of possibilities for artificial recharge and ground-water pollution.

SUPPORTED BY Illinois State Government - Springfield

2.0580, METHODS IN SPECTROGRAPHIC ANALYSIS OF SOILS & PLANTS FOR MINOR ELEMENTS

S.W. MELSTED, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-15-0361)

OBJECTIVE: Improve and adapt methods of spectrographic analyses to polluted drainage waters, study methods of soil and plant samples preparation to permit use of emission spectrograph, x-ray fluorescence and atomic absorption techniques and continue cooperative evaluations of spectrographic methods, prepare large standard plant material samples for cooperative analysis and referee work.

APPROACH: Methods of chelation and chemical separation to remove interferring contaminants will be studied. Possibility of pelletizing soil and plant borate and metaborate fusions for x-ray fluorescence and subsequent dissolving for spectrographic and atomic absorption will be investigated. Large ten-pound samples will be dried, ground and thoroughly mixed for cooperative analysis and selection for future use in calibrating methods and referee work.

PROGRESS: The spectrographic analyses of soils fused with sodium metaborate and then dissolved in nitric acid shows considerable promise for combining x-ray fluorescence and emission spectrographic analyses with a single sample preparation technique. The use of nitric acid, rather than hydrochloric acid, to acidify polluted water samples while being concentrated for spectrographic analysis improved the accuracy of such analyses. Present procedures are not entirely satisfactory for waters high in lead and chromium. The method for spectrographically determining Ca, Mg, K and Al in ammonium fluoride (P-1) soil extracts is reasonably satisfactory. A method for the analyses of horseradish was also worked out.

SUPPORTED BY U.S. Dept. of Agriculture

2.0581, THE SEPARATION AND IDENTIFICATION OF TRACE ORGANICS OF INDUSTRIAL ORIGIN IN NATURAL WATERS

V.L. SNOEYINK, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

The proposed research involves the use of concentration techniques followed by gas chromatographic separation and spectrometric characterization and analysis of certain organic pollutants of industrial origin. The pollutants to be examined are these aromatic polycyclic and heterocyclic compounds not naturally found in the environment.

Various concentration techniques such as freeze concentration, solvent extraction, and adsorption will be used to obtain a sample suitable for separation by gas chromatography or other chromatographic techniques. The separated fractions will then be identified by mass spectrometry, infrared spectrophotometry, or other applicable spectrometric methods.

These laboratory techniques will be developed using a synthetic water containing concentrations of selected compounds typical of those found in industrial effluents and waste streams. The most successful techniques will then be used to detect and trace pollutants in a natural water system.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0582, HYDROLOGY AND WATER QUALITY OF SURFACE MINING FOR COAL IN PIKE COUNTY, INDIANA

D.G. FREY, Indiana University, Water Resources Research Ctr., *Bloomington, Indiana* 47401

The project area is in southwestern Indiana, in the area where Coals No. 4 and 5 have been strip-mined for many years.

Two automatic recording steam gaging stations have been established, and partial flow measurements will be taken at 6-8 sites; water quality samples will be taken at these and perhaps 50 other locations, particularly in the South Fork Patoka River.

The project was begun in September 1964, and a report (Indiana University Water Resources Research Center Report of Investigations No. 1, 1965) was published; the project was expanded to include a detailed study of quantity and quality of water in the Busseron Creek Watershed of Sullivan County (Report of Investigations No. 2 is due in September, 1968), and to include reconnaissance investigations in fringe areas. The current project will continue the reconnaissance in a few of the fringe areas.

SUPPORTED BY Indiana University - Bloomington

2.0583, WATER POLLUTION STUDY OF THE WABASH RIVER

J.M. BELL, Purdue University, School of Engineering, *Lafayette, Indiana* 47907

Studies were initiated to develop a comprehensive surveillance program on the quality of the Wabash River between Lafayette and Covington, Indiana. Data is collected at a critical time of the day throughout the summer months of low flow.

An attempt is being made to obtain a mathematical model(s) which may be used to predict the response of the dissolved oxygen concentration in the river to the waste discharges resulting from municipalities, industries, and agriculture sources in the Greater Lafayette Area.

SUPPORTED BY Purdue University - Lafayette, Ind.

2.0584, ECOLOGIC IMPACT OF HUMAN ACTIVITIES ON WATER RESOURCE ENVIRONMENTS

V.R. FERRIS, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907

The goal of the proposed research is to develop methods for sampling and analyzing nematode populations from water resource areas of known contrasting conditions, in order to establish baselines and indices by which this group of aquatic organisms may be used as a tool for quantifying ecological change. Benthic and shoreline samples will be taken from specified areas where the streams are used to dispose of waste materials. Detailed ecological data will be recorded, including physical and chemical characteristics of soil and water in the areas. Permanent mounts of nematodes recovered will be prepared. Nematode populations will be analyzed, and curves constructed to express community structure in the various sites studied. Importance values will be calculated for each species based on frequency and density values and on a metabolic factor for each species. Matrices will be constructed to show coefficients of similarity and dissimilarity for each of the sampling sites and diversity indices calculated. Ordination constellations will be constructed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0585, PREIMPOUNDMENT STUDY OF WATER QUALITY, SAYLORVILLE RESERVOIR DES MOINES RIVER, IOWA

E.R. BAUMANN, Iowa State University, School of Engineering, *Ames, Iowa* 50010

Several large reservoirs are under construction in Iowa by the U.S. Army, Corps of Engineers. Water quality in reservoirs in the northern plains states is of increasing concern, especially in view of potential downstream water uses, water quality requirements, and reservoir recreation demands. A three-year preimpoundment study was initiated in 1967 to measure selected water quality parameters in the area of Saylorville Reservoir. This reservoir is located on the Des Moines River north of Des Moines, Iowa and extends 50 miles upstream to Boone, Iowa.

Measurements and samples are being taken weekly at five stations in the reservoir area under natural river conditions prior to completion of the dam. A continuous water quality monitoring station will be located at one station to provide continuous records. Parameters of water quality included in the study are: temperature, turbidity, pH, chemical oxygen demand, biological oxygen demand, dissolved oxygen, carbon dioxide, chlorophyll, phosphates and all forms of nitrogen. Additional parameters are analyzed periodically and diurnal studies also performed.

The study is being made to determine the type and nature of the aquatic environment which exists under natural river conditions and provide data which can be used later in comparison with post-impoundment conditions.

SUPPORTED BY Iowa State University

2.0586, MOLECULAR AND APPLIED ASPECTS OF MICROBIAL ENZYMOLOGY AND ECOLOGY

P.A. HARTMAN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01763)

OBJECTIVE: Investigate: the use of enterococci as indicators of fecal pollution of water and foods. The genetics, regulation, production, purification, properties, and applications of bacterial amylases.

APPROACH: Physiological and gas chromatographic data of possible use in differentiation of enterococci will be examined and attempts made to develop improved media and methods for isolation and enumeration of enterococci; these will be used to study the ecology of enterococci. Amylase isoenzymes will be isolated and compared with other bacterial amylases, the genetics, regulation and excretion of amylases will be examined; and applications sought.

PROGRESS: (a) Enterococci - 29 streptococci (including 17 enterococci) were exposed to 30 different tests; 11 tests were evaluated further using fresh isolates; 9 tests were found that might have value in differentiating plant from animal types. Preliminary gas chromatographic fatty acid analyses also were made. (b) Amylases - Mutants of B. subtilis blocked in cell-wall synthesis have been isolated; from these we hope to obtain doubly-blocked mutants that can be used to study mechanisms of amylase excretion. Expected linkage of amylase (amy) genes of B. subtilis to Group IV markers was not realized; linkage to markers within the other 3 groups have been studied superficially and will be studied in greater detail. Mutations in control or level of amylase production also have been isolated and partially characterized. Slide electrophoresis of our amylases is being perfected. (c) Immune reactions in insects - Tenebrio and Galleria larvae were used to examine immune responses in invertebrates. Tenebrio did not exhibit a response to MS-2 phage or Ps. aeruginosa bacterins. The phage did not immunize Galleria; the bacterin was toxic to some Galleria lines. Mechanisms of toxicity were examined. (d) A new immunological template model is being developed. The model, in its present form, accomodates existing data more readily than does any model heretofore proposed.

SUPPORTED BY Iowa State Government - Des Moines

2.0587, QUALITY OF TILE EFFLUENT

H.P. JOHNSON, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01805)

OBJECTIVE: Determine plant nutrients content (N,P,K) of effluent from tile outlet terraces and from subsurface drainage systems under row crop. Investigate the mechanics of NO(3) movement in water-saturated and -unsaturated soil by miscible displacement experiments.

APPROACH: Field work, Part one: Sample soil and water discharged from tile outlet terraced area under fertilized corn or beans. Analyze water and soil for N, P and K and compute nutrient losses involved. Part two: Sample effluent from subsurface drainage system under row crop. Analyze for N, P and K and compute total nutrient losses from effluent. Laboratory work: add saturated phosphorus solutions to soil columns; plot concentration of phosphorus in effluent with time and compare with rate of addition of phosphorus. Study distribution of phosphorus in columns after completion of experiment.

PROGRESS: A Hach Chemical Company method for testing for phosphorous has been tested. In this method the phosphorous determination depends on transmittance of light through a phosphorous solution to a photocell. It was therefore found important to filter particles from the leaching water before phosphorous tests were run. The method was used to determine phosphorous leached from laboratory soil columns of topsoil. Concentrations ranged from about 0.05 to 1.00 microgram of elemental phosphorous per milliliter of water. Surface water running from the plow layer through large root holes and cracks in soil to tile drains might be expected to reach these concentrations. In soil without large channels, it is believed that the phosphorous almost totally absorbed before reaching the tile. Two automatic tile effluent samples have been obtained. Plans are proceeding for measuring nutrients discharged with tile effluent. The effluent from tile outlet terraces was collected and analyzed (Coop with ARS) for N, P and K. A thesis which defines the effect of diking and straightening a stream (Boyer River) was completed. Flood peaks have been increased about three times and duration of overbank flow from three to five times. Tile and surface drainage experiments were continued.

SUPPORTED BY U.S. Dept. of Agriculture

2.0588, DEMONSTRATING THE ELECTROLYSIS BOD MEASURING METHOD

J.C. YOUNG, Iowa State University, School of Engineering, *Ames, Iowa* 50010

The electrolysis BOD system provides a method of continuously and automatically recording the oxygen uptake of polluted waters. In principle, the system is an automatically adjusting respirometer in which the pressure adjustment is made by replenishing the depleted oxygen supply with oxygen produced by electrolysis of the water in a weak electrolyte solution. The proposed research involves placing electrolysis BOD systems in a number of wastewater treatment plants within the State of Iowa where they will be operated by plant personnel. The systems will be used to measure the BOD at various points within the plants. The principle objectives of the study are 1) to demonstrate the advantages of the electrolysis system when used for actual plant operation purposes, and 2) to obtain BOD data from several types of treatment plants. The data will in turn be used to evaluate the performance of the individual types of plants and to investigate the possibility of using oxygen uptake rate as a parameter in designing such plants.

Results obtained in the first year of the project indicate that the electrolysis system is extremely valuable for studying the biodegradability of industrial wastes since the system can be operated for weeks or months without depleting the oxygen supply within the reaction vessel. One of the most significant findings is that the first-order reaction rate coefficient for domestic wastewaters is two to three times higher than reported from dilution BOD methods.

2. WATER QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0589, COLIBACTERIOPHAGES AS VIRUS INDICATORS IN WATER AND WASTEWATER
Y. KOTT, Technion, *Haifa, Israel*

Due to the potential danger of transmission of enteroviral diseases by the water route, and in some instances, the low reliability of the coliform index, a more suitable indicator is required in water quality control. E. coli bacteriophages are proposed to be used as the new indicator.

The proposed phases of investigation are: a. To establish a phage enterovirus ratio, applicable to any water body. b. To use this new indicator for developing criteria for the colibacteriophages pollution index.

The bacteriophages have been chosen because of their fecal origin, specificity of attachment to bacteria, short generation time, high multiplication rate and resistance to chemical agents.

The current directions of research are: 1. Isolation of E. coli bacteriophages. - In order to be able to identify the E. coli strains of bacteria, more than 70 colibacteriophages have been isolated and tested on a few hundred E. coli strains isolated from water. 2. A number of specific Aerobacter aerogenes bacteriophages have been isolated and identified. The electron micrographs showed their heads and tails to be of various sizes and lengths. 3. With the aid of these colibacteriophages a test has been devised in which a given sample of water was filtered through a Membrane Filter, exposed to specific colibacteriophages and subsequently incubated on a differential medium. Results were recorded after 18-24 hours and field tests are planned. 4. The recovery of coliphages filtered through Membrane Filter was 100 per cent when the filter was pre-treated with serum. Field samples also showed good results.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0590, PARTITION COEFFICIENTS FOR FE, MN, CO, NI, ZN, CU, BETWEEN RIVER WATER AND SUSPENDED LOAD
E.E. ANGINO, Univ. of Kansas, School of Engineering, *Lawrence, Kansas* 66044

The study of selected heavy metal (Fe, Mn, Ni, Co, Cu, Zn) partition coefficients between the suspended and dissolved load of streams and the relation to the mineralogical make-up of the suspended load will be investigated. The trace element chemistry will also provide background and seasonal values for the streams in question. Such data is needed if we are ever to be able to establish water quality standards for the metals in question. It is hoped that this study can shed some light on the effect of the suspended load on the water quality and chemistry of the dissolved load of streams under natural conditions. Each sample from the stations and river systems mentioned in the proposal will also be studied for the chemical parameters noted, mineralogic make-up and their relation to the geology of the terrain over which the streams flow.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0591, APPLICATION OF ELECTRON SPIN RESONANCE IN WATER POLLUTION STUDIES
E.E. ANGINO, Univ. of Kansas, State Geological Survey, *Lawrence, Kansas* 66044

Many of the problems involved in water pollution are affected by the non-equilibrium systems prevailing in natural systems. To know what some of the heavy metal species present in aqueous solution is of interest. Theoretically, Electron Spin Resonance is a possible tool for studies of this type. However, it has not been evaluated for this application. Starting with Fe, Mn, Cu, and Cr solutions of different pH and species, the change in oxidation state will be followed by use of ESR recordings.

Significant changes in the ESR patterns for each species (as a function of pH) should provide a means of monitoring similar chemical changes in natural water systems. This possibility will be checked against samples from known water pollution systems (urban such as urban drainage ditches, rivers, reservoirs, etc.). Positive results could lead to use of ESR in continuous monitoring systems for water pollution.

SUPPORTED BY Kansas State Government - Topeka

2.0592, THE EFFECT OF URBANIZATION ON SMALL DRAINAGE BASINS
P.L. HILPMAN, Univ. of Kansas, State Geological Survey, *Lawrence, Kansas* 66044

To investigate the physical and biological changes in small drainage basins brought about by the transition from rural to urban land use.

The initial phase of the project will consist of a complete survey of the geological, zoological and botanical conditions of a small (4- square-mile) rural drainage basin adjacent to a rapidly expanding urban area. After completion of the survey the drainage basin will be re- evaluated on an annual basis over a 4- to 5-year period in an attempt to correlate changes noted with increasing urban influence. Meteorological and hydrological data will be recorded continually throughout the study period. Subprograms of the project include: (1) effects of urbanization on quality and quantity of runoff; (2) usefulness of farm ponds as indicators of antecedent climatological conditions in drainage basin studies; (3) the effect of modifications of vegetation, slope and soil on runoff; (4) the influence of directional storms on hydrographs in small drainage basins; (5) assets and liabilities of upland waste-disposal sites and their relationships to surface and subsurface water quality; (6) the usefulness of analog and digital modeling techniques in predicting the effects of urbanization on drainage-basin performance; (7) the usefulness of remote-sensing devices in drainage-basin studies; and (8) the value of drainage-basin analyses in land-use planning.

SUPPORTED BY Kansas State Government - Topeka

2.0593, MULTISPECTRAL CAMERA CLUSTER
R.K. MOORE, Univ. of Kansas, Ctr. for Res., *Lawrence, Kansas* 66044

A four-camera multispectral cluster using 70 mm Hasselblad cameras is being acquired for use in earth observations research at the University of Kansas. The camera cluster will be mounted on the University aircraft and will be available for various projects. Availability of the IDECS (Image Discrimination and Enhancement Combination System) developed under NASA and DOD sponsorship will permit studies of automated analysis of the multispectral photos resulting from the camera cluster. Use of the instrument is expected in on-going projects involving studies of crop identification and stress, range lands, urban land use, transportation networks, hydrology and water pollution, ecology of natural plant communities and archaeology.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0594, WATER QUALITY MODELING AND PREDICTION
E.S. LEE, Kansas State University, School of Engineering, *Manhattan, Kansas* 66502

The primary objective of this research is to apply the recently developed modeling and prediction techniques such as the quasilinearization technique, invariant imbedding, and nonlinear filtering and estimation to establish realistic mathematical models. It will be shown that by the use of these modeling techniques, computational requirements can be reduced and certain experimental difficulties in obtaining the data can be eliminated.

Another objective of this study is to develop and improve the above mentioned techniques for water quality modeling. Since all the modeling techniques to be used are fairly new, further developments and improvements which are especially suited for water quality modeling will be made.

The modeling and parameter estimation of (1) the amount of pollutants in a water stream or river with and without longitudinal dispersion, (2) the estimation of rate constants in waste treatment systems, and (3) dynamic modeling will be studied. Only plug flow situation will be studied in the dynamic modeling.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0595, INTERACTIONS OF MERCURY WITH AQUATIC AND EDAPHIC ENVIRONMENTS

G.M. PAULSEN, Kansas State University, School of Agriculture, *Manhattan, Kansas* 66502

Physicochemical and biological interactions between mercury and its environment are determined to predict pollution, distribution, and effect of mercury on aquatic colloids, alluvium, and flora. Physicochemical constants measured using 203 Hg-labeled methylmercury chloride and mercuric chloride, aquatic colloids, and three aquatic alluvium types include distribution, diffusion, and activity coefficients; cation exchange capacity; and retention and elution by leaching columns. Effects of varied mercury concentration and colloidal and alluvial pH will also be measured. Using Lemna app. as representative aquatic flora, effects of methylmercury chloride and mercuric chloride on mercury adsorption and accumulation, growth, photosynthesis, and aquatic oxygen concentrations will be determined. Treatment variables for Lemna are autotrophic and heterotrophic conditions, three mercury concentrations, three aquatic temperatures and, under autotrophic conditions, two light intensities.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0596, THE ECOLOGY OF DRAKE'S CREEK, KENTUCKY

R.D. HOYT, Western Kentucky University, School of Science, *Bowling Green, Kentucky* 42101

General objectives: 1. The training of individuals (graduate students) in the procedures of aquatic biological research, data analysis, and interpretation. 2. The establishment of 'baseline' limnological characteristics of regional aquatic environments as the basis for their management under increasing pressures of industrialization and urbanization in the future.

Scientific objectives: 1. A general survey of the flora and fauna establishing qualitative aspects of the communities as they presently exist. 2. The identification and subsequent study of ecological problems involving specific components of the flora and fauna.

SUPPORTED BY Lenk Manufacturing Co. - Franklin, Ky.

2.0597, INFLUENCE OF THE EFFLUENT FROM A CONCENTRATED INDUSTRIAL COMPLEX ON A LARGE RIVER - EFFECTS ON INDICATOR ORGANISMS

H.M. HANCOCK, State Dept. of Fish & Wl. Rso., *Frankfort, Kentucky* 40601

Objectives. To determine what happens to indicator organisms held in control and affected areas.

Procedures. Artificial substrates will be placed in various places in the river. Sample bottom material and test organisms (corbicula and insect larvae) will be placed in the one cu. foot openings in 260 lb. cast concrete artificial substrates. They will be kept in place with hardware cloth. The substrates there will be placed in control and influenced areas and left for various intervals. Organisms will be examined for physical appearance, and then some organisms and some muds will be returned to be tested for inorganic and organic constituents as previously described. Newly trapped micro and macro benthos will be determined in the laboratory. Approximately 538 hours for chemical consultation and 435 hours biological consultation will be required for this job.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

2.0598, ANALYSIS OF SOLUTIONS FOR SURFACE-ACTIVE CONSTITUENTS

H.H. BAUER, Univ. of Kentucky, Water Resources Institute, *Lexington, Kentucky* 40506

The behavior of surface-active substances at electrodes will be investigated in order to identify the effects due to the nature of the surfactant, the nature of the electrolytes present, and the relation between these two factors at different concentrations of both types of substances. These studies will be made by the tensammetric method which is well established.

The results will indicate the extent to which such methods can serve for the determination of surfactuants in the presence of the wide variety of other substances that one expects to be present in samples of water that will need to be monitored for possible pollution. In addition, it may become possible to treat adsorption processes on a theoretical basis that includes the effect of the presence of electrolytes at the surface; present theories do not take this effect into account.

The applicability of a new technique of greater sensitivity and precision than the tensammetric method will be explored after the main features of the phenomena occurring have been elucidated by the tensammetric technique.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0599, DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY

E.B. BRADLEY, Univ. of Kentucky, Water Resources Institute, *Lexington, Kentucky* 40506

The proposed research is a study of the application of laser Raman spectroscopy in the detection and identification of molecular water pollutants. The primary advantages in such an approach are (1) laser Raman spectroscopy offers a direct method of detection and identification of molecules in water solution or suspension, and (2) the ability to detect and identify high-molecular-weight pollutants.

Laboratory and field investigations will include the following: (a) preparation of standard samples of various industrial and agricultural molecular water pollutants to which Raman spectroscopy is uniquely applicable, (b) use to standard samples to establish levels of detectability, sensitivity limits, and numbers of compounds in representative polluted water samples from industrial effluents that can feasibly be detected and identified by laser Raman spectroscopy at one time without separation techniques, (c) construction and testing of internal-beam-condensing cells, multiple-entrance cells, and laser- cavity cells, (d) sensititivity enhancement of Raman spectra by beam ratioing, (e) development of a catalog of standardized Raman spectra of a wide variety of water-soluble industrial waste products divided into the following categories: 1. organic pesticides, 2. petroleum products, 3. detergents, 4. inorganics.

The data will be employed to develop practical applications of laser Raman spectroscopy for the extension of analytical techniques of molecular identification outside the normal capability of GLC and mass spectroscopy.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0600, TAXONOMY AND PHYSIOLOGY OF PROTOZOA IN CAVE STREAMS AND POOLS

S.M. GITTLESON, Univ. of Kentucky, Graduate School, *Lexington, Kentucky* 40506

The proposed research involves laboratory and field investigations of taxonomy and physiology of protozoa in cave streams and pools. Preliminary studies in Pine Hill Cave Kentucky indicate that: 1) numerous species of protozoa do occur in significant forms in streams and pools that sink into the cave; 3) many of these protozoa have never been described.

This data suggests that knowledge of the role of protozoa in the ecosystem is important for understanding problems concerning the ecological impact of water development, ground water purity and effects of pollution on groundwater.

Investigations primarily at the Mammoth Cave National Park, Kentucky, will include study of samples from cave streams, pools and surface water related to: 1) identification of protozoa; 2) distribution of protozoa; 3) chemical analysis (ions, gases, total inorganic and organic carbon) and physical analysis (temperature, conductivity, viscosity; specific gravity) of the water; and 4) study of how peculiar conditions of caves - low temperature and absence of light effects type, number, survival, growth and motile behavior of protozoa.

2. WATER QUALITY

SUPPORTED BY University of Kentucky

2.0601, DIGITAL COMPUTER MODELING OF LIMESTONE GROUNDWATER SYSTEMS
J. THRAILKILL, Univ. of Kentucky, Graduate School, *Lexington, Kentucky* 40506

Digital computer techniques to model limestone groundwater basins in two and three dimensions will be developed. Finite difference, finite element, and pipe network flownets will be investigated, and both darcy and turbulent flow cases will be studied. Emphasis will be on evolution of the aquifer in response to geologic controls, including geochemical parameters (state of saturation of recharge to the aquifer). Models will be created for the Mammoth-Cave-Sinkhole Plain aquifer in Kentucky and other ground-water systems.

Application of the models will be to further understanding of the nature and development of limestone aquifers and to furnish predictive information, including well siting and pollution paths, for specific ground-water basins.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0602, WATER RESOURCES OF THE BOWLING GREEN AREA, KENTUCKY
T.W. LAMBERT, U.S. Dept. of the Interior, Geological Survey, *Louisville, Kentucky* 40202

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Kentucky.

Purpose: To provide information on the quantity and quality of the water in the Bowling Green area for use in planning additional industrial development.

Methods: Detailed information on ground-water sources will be collected with particular emphasis on delineating the areas of potentially high yield. The investigation will include a study of the underground flow patterns and potential sources of contamination. Information on water quality of streams and aquifers will be collected and changes in water quality monitored. The relationship between ground water and water in streams is particularly significant because of large base flows and recurrent flooding of large solution channels by high river stages. Partial-record stations will be operated on tributary streams for correlation of record with the gaging and water quality station on Barren River at Bowling Green.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0603, THE IMPACT OF MICROORGANISMS ON OIL
S.P. MEYERS, Louisiana State University, School of Agriculture, *Baton Rouge, Louisiana* 70803

The ability of yeasts and molds to degrade a broad spectrum of organic compounds is well known, as is their ability to withstand considerable biological and abiotic environmental stress. Recent studies have shown the noteworthy hydrocarbonoclastic ability of these organisms. Significant densities of various yeast taxa in the Louisiana marshland with its vast shrimp and fish industry, suggest the need for critical evaluation of the population dynamics of these organisms under a variety of stress and oil spill conditions. Tests are proposed to evaluate hydrocarbon utilization by marine-occurring yeasts and yeast- like fungi in the shrimp-oyster region of Louisiana and to ascertain the response of these organisms to oil intrusion into the marshland rhizosphere. Response of the major bacterial population will be evaluated in terms of the hydrocarbonoclastic yeast concentration. Dominant hydrocarbonoclastic species will be evaluated as possible bioassay organisms of levels of petroleum contamination. Attention will be given to ultimate development of techniques for accelerated biodegradation of oil pollutants in such aquatic habitats.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0604, SEDIMENTOLOGY OF LOUISIANA'S ESTUARIES
W.S. PERRET, State Wildlife & Fish Comm., *New Orleans, Louisiana* 70130

Objectives: (1) To determine the sediment forms of the state estuaries as an index of their respective condition. (2) To determine the degree to which alterations have already affected sediments and to establish a base line for the evaluation of future estuarine modifications, their effect on sediments, and subsequently in the biota. (3) To develop data for the sedimentology of the estuaries of La. to be available for inclusion in an atlas of the Gulf of Mexico estuaries in cooperation with the other states of the Gulf States Marine Fisheries Comm. and the Bureau of Comm. Fisheries.

Procedures: Data will be obtained for textural analysis (sand, silt and clay) and, if feasible, carbonate, carbon and nitrogen content of the sediments in the study areas. Sufficient samples will be collected to present a complete picture of the sediment characteristics of the study areas. Samples will be collected by means of a dredge or grab sampler. All data will be collected, analyzed and prepared in a form which will be available and acceptable for incorporation as a section in an atlas of the estuaries of the Gulf States according to the techniques and procedures recommended by the Estuarine Technical Coordinating Committee of the Gulf States Marine Fisheries Commission.

Part 3 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0605, DISPOSAL OF PAPER MILL EFFLUENT THROUGH IRRIGATION OF BOTTOMLAND HARDWOOD UNDER LOUISIANA CONDITIONS
C.W. WILSON, Louisiana Technological Univ., School of Agriculture, *Ruston, Louisiana* 71270

The objective of the proposed research is to determine the economic and technical feasibility of disposing of paper mill waste through irrigation of hardwood forests under Louisiana conditions.

A system for delivery of the waste water to the forest area to be irrigated will be designed. The probable increase in timber yeild from irrigation will be determined. The waste water, stream conditions, and forest conditions will be studied. From this information, economic and technical feasibility will be determined. The effect of diverting paper mill waste water on water quality of Dugdemona River will be predicted.

The results of this study should be applicable to other waste water supplies in Louisiana.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0606, PHYSICAL AND CHEMICAL CHARACTERISTICS OF MAINE STREAMS AND RIVERS
L. BOND, State Dept. of In. Fish & Game, *Augusta, Maine* 04330

Objectives: To obtain the following information on each stream investigated in order to determine its suitability as a residence nursery or spawning area for fish populations. 1. Volume of flow in cubic feet per second. 2. Length, surveyed, average width, and depth. 3. An evaluation of pools, riffles, and bottom types. 4. An evaluation of natural and man-made obstructions to fish migration. 5. Temperatures at time of survey and other periods when possible. 6. Source, type, and extent of water pollution, and oxygen determinations in critical situations.

Procedure: The brook, stream or river will be surveyed by boat or on foot to determine the extent and character of pools and riffles. Suitability as a spawning and nursery area for salmonid fishes will be determined, on the basis of volume of flow temperature, suitable bottom material, riffles, pools, and other species present.

Obstructions will be surveyed to determine their effect on migration and stream flow. Temperatures will be taken at various points along a stream to determine the effect of spring seepage, tributaries, and impoundments. The source, type and extent of domestic and industrial pollution will be determined. When critical conditions are apparent dissolved oxygen will be determined by the Winkler method.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0607, HYDROGRAPHY OF THE PENOBSCOT RIVER ESTUARY
R.W. HATCH, Univ. of Maine, Graduate School, *Orono, Maine* 04473

A long range program of studies on the ecology of the Penobscot estuary has been established by the Maine Cooperative Fishery Unit. Part I involves a detailed study of the hydrography of 30 miles of estuary from Bangor Dam to Belfast. Salinity, temperature, density and dissolved oxygen have been and will continue to be monitored with the view toward detecting changes in the estuarine environment from anticipated pollution abatement in Penobscot River. This project was initiated July, 1963.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0608, GEOCHEMICAL CYCLES INVOLVING FLORA, LAKE WATERS, AND BOTTOM SEDIMENTS
S.A. NORTON, Univ. of Maine, School of Arts, *Orono, Maine* 04473

The study is investigating variations of silica concentration in time and space in Chalk Pond - near Beddington, Maine. Critical parameters include (1) abundance and diversity of diatoms, (2) sympathetic variations in silica, sodium, potassium, calcium, iron, and aluminum ions, (3) oxidation potential, (4) acidity, (5) temperature, and (6) the mineralogy of the lake-sediment interface.

Relevance of the study to socio-economic problems is contained in the fact that diatoms constitute both a water use problem, in some lakes, and provide, generally, a useful index to conditions in the geochemical and biological cycles within the lake environment.

Suitable transect lines and sampling sites have been established to lake morphometry and field sampling of bottom sediments and water for inorganic determinations commenced in 1969. Changes in the silica regime at the time of fall overturn have been established.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0609, HYDROGRAPHIC AND BIOLOGICAL SURVEY OF MONTSWEAG BAY AND VICINITY
D. DEAN, Univ. of Maine, Ira C. Darling Ctr. for Res., *Walpole, Maine* 04573

An 850,000 KW nuclear-powered electric generating facility is under construction at Bailey Point, Montsweag Bay, Lincoln County, Maine. Initial operation is scheduled for 1 January 1972. The project is designed to establish ecological baselines for the unaltered environment prior to this date, and to assess the effects of thermal alteration thereafter.

Monitored at frequent intervals throughout the year are: temperature, salinity, nutrient levels, phytoplankton, zooplankton, benthic communities, attached algae, and fishes. Stocks of commercially important shellfish and sea worms are assessed quarterly. Sediment distribution, current patterns, and rates of sedimentation are also being studied.

SUPPORTED BY Maine Yankee Atomic Power Company

2.0610, TO DETERMINE THE PROPERTIES OF THE SUSPENDED SEDIMENT POPULATION OF CHESAPEAKE BAY
J.H. MANNING, State Dept. of Ches. Bay Affrs., *Annapolis, Maryland* 21404

The objectives of this study are to determine the properties of the suspended sediment population of the Chesapeake Bay. The area of investigation will extend from the head of the Bay at Turkey Point (and in the mouth of the Susquehanna River) to the mouth of the Bay at the Virginia Capes. The following properties will be determined: (1) the spatial and temporal variations of the concentration of total suspended solids, (2) the spatial and temporal variations of the particle size distributions (both number and volume) of the suspended solids, (3) the percent of the total suspended solids accounted for by organic matter, (4) the mineralogic composition of the inorganic fraction, (5) the relative contributions to the suspended load by river flow, shore erosion, primary productivity, and by the resuspension of bottom sediments, and (6) the fraction of suspended sediment which escapes the Bay.

Samples will be collected monthly from five or more depths at each of 18 to 20 channel stations extending the full length of the Bay. The concentrations will be determined by filtration; the percent organic matter by combustion; the mineralogy by x-ray diffraction; and the size distribution with a Zeiss Particle Size Analyzer and a Mine Safety Appliance Particle Size Analyser. These properties will be used to estimate the relative contribution by the various sources of suspended sediment.

Part 3 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0611, TIME-OF-TRAVEL - PRINCIPAL MARYLAND STREAMS
K.R. TAYLOR, U.S. Dept. of the Interior, Geological Survey, *Baltimore, Maryland* 21204

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Maryland.

Purpose: To provide water users a time-of-travel guide which would tell them when a contaminant would reach their intakes, how long it would persist, and what the levels of concentration would be.

Methods: A fluorescent dye will be introduced into selected streams. The time of arrival of the leading edge, the maximum concentration, and the time of passage will be measured at successive downstream locations. By several such determinations at selected rates of discharge, a relationship between discharge and time-of-travel can be developed for each reach.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0612, AUTOMATED DETERMINATION OF PRIMARY PRODUCTIVITY
G.E. LEVIN, Biospherics Research Inc., *Rockville, Maryland* 20853

The primary productivity project encompasses the development and fabrication of an automated device to determine primary productivity (the rate at which carbon is photosynthetically fixed to start the aquatic food chain) of lakes and sea by the radiocarbon technique. Biological and engineering studies have led to the conceptual design of an instrument which collects a sample of sea water in situ, delivers it to an aliguot of carbon-14 tagged sodium carbonate, incubates the sample under ambient light and temperature conditions, filters and dries the sample, and then measures the metabolically incorporated radioactivity with a GM counter. Some of the proposed applications are: (1) As a monitor to record the productivity before, during and after the addition of heated water effluents into a bay. This should permit direct measurements and provide historical and factual data on the effects of thermal discharges. (2) As an analyzer for destratification studies in a large impoundment where the traveling sampler could move up and down the fixed buoy cable through the termocline, providing records of the effects of prolonged stratification as well as destratification on the primary productivity. (3) As an automatic monitor to determine fate of pollutants in inland surface waters. The objective is development of mathematical models to predict the water quality at various locations in stream and lake systems. One of the very important inputs, both as a source and as a sink for organics and inorganics, into such a model is the primary productivity factor. This will require the measurement of values in the field, in many locations, in order to verify the model; and automatic measurements are considered a necessity. (4) As a short- term analyzer in research cribs to be set up in estuarine waters. A number of adjacent cribs will be established by dropping plastic curtains in water bodies, adding selected materials in various combinations and amounts, and measuring the primary productivity that occurs within the periods.

This project is being conducted in close collaboration with FWPCA.

SUPPORTED BY U.S. Atomic Energy Commission

2.0613, ASSAYS OF TOXIC POLLUTANTS BY FISH BLOOD ABERRATIONS
W.A. CURBY, Lahey Clinic Foundation Inc., *Boston, Massachusetts* 02215

We have developed a biological multichannel analyzer which, using a sensor that operates on the Coulter principle, measures and distribute mixed cell populations by cell size. It provides an analog distribution, a digital printed readout and a binary coded decimal magnetic tape recording for future analysis. Although primarily a pulse height analyzer (applied successfully to studying e.g. bacteria, mammalian blood, inert dusts), it operates as a pulse shape analyzer if the instant at which each pulse height is read is varied. This technique, applied to whole blood from freshly sacrificed Fundulus heteroclitus shows the alterations with time and the variations caused by traces of cadmium and copper in the aquatic environment for 24 hours. The size frequency distribution patterns of each trace element environment differ from each other, and each, markedly from the norm.

We propose to investigate and record the response of Fundulus whole blood cells from fishes living in several aquatic environments of fixed pH and dissolved oxygen contents and temperature at varying intervals of time. We will then compare these data with those which we will obtain from fish subjected in similar environments to dissolved traces of chemical pollutants. We know that blood cell changes do occur and that we can measure them. Our objective is to determine the limits of several types of toxic pollutants.

This work will be performed in the Biophysics Research Laboratories of the Brooks Hospital Division of the Lahey Clinic Foundation at 211 Summit Avenue, Brookline, Mass. 02146.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0614, ASSAYS OF TOXIC POLLUTANTS BY FISH BLOOD ABERRATIONS
W.A. CURBY, Lahey Foundation, *Boston, Massachusetts*

We have developed a biological multichannel analyzer which, using a sensor that operates on the Coulter principle, measures and distributes mixed cell populations by cell size. It provides an analog distribution, a digital printed readout and a binary coded decimal magnetic tape recording for future analysis. Although primarily a pulse height analyzer (applied successfully to studying, e.g., bacteria, mammalian blood, inert dusts), it operates as a pulse shape analyzer if the instant at which each pulse height is read is varied. This technique, applied to whole blood from freshly sacrificed Fundulus heteroclitus shows the alterations with time and the variations caused by traces of cadmium and copper in the aquatic environment for 24 hours. The size frequency distribution patterns of each trace element environment differ from each other, and each, markedly from the norm.

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SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0615, REMOTE SENSING OF WATER QUALITY IN THE MARINE ENVIRONMENT
J.J. COCHRANE, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

Techniques are being developed for the use of colored infrared film with aerial surveillance to detect undesirable algal activity. Black and white infrared is being tested to identify apparent thermal difference on the water surface caused by changes in emissivity by contamination. Experiments are being carried out by using multispectral detection to identify various impurities near the water surface.

SUPPORTED BY No Formal Support Reported

2.0616, ANALYSIS OF MERCURY CONTENT OF SHELLFISH OFF THE MASSACHUSETTS SEACOAST
C.M. JANKOWSKI, Northeastern University, Graduate School, *Boston, Massachusetts* 02115

An initial survey is being made of the mercury uptake by shellfish in polluted coastal waters. Concurrently analysis methods are being developed and compared. Primary emphasis is on atomic absorption and spectrophotometric procedures.

SUPPORTED BY Northeastern University

2.0617, ANALYSIS OF FISH TISSUE FOR MERCURY CONTENT
T. PALERMO, State Div. of Fisheries & Game, *Boston, Massachusetts* 02202

Objectives: To determine if mercury, a problem environmental contaminant, is present in fish from Massachusetts waters.

Procedures: Fish collected statewide during the course of regular fish population sampling activities from the Connecticut, Merrimack and Housatonic Rivers along with fish collected specifically for this purpose from the Millers, Westfield, Deerfield, Nashua, Squannacook, Taunton and Blackstone Rivers will be analyzed for mercury content. The analytical procedure will be as described by Berman, Determination of Cadmium, Thallium and Mercury in Biological Materials by Atomic Absorption, Atomic Absorption Newsletter, Vol. 6, No. 3, May-June 1967.

A Perkin-Elmer, Model 303 Atomic Absorption Spectrophotometer, equipped with a hollow cathode mercury lamp will be used for analysis. If mercury content is found in the above-named river systems, then this job will be expanded.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0618, SHELLFISH TECHNICAL ASSISTANCE
H.A. CARR, State Div. of Marine Fisheries, *Boston, Massachusetts* 02202

Objectives: To provide technical assistance to shellfish officers, town officials and shellfishermen in regard to the regulation and management of the shellfish resources. To provide technical assistance in regard to techniques of modern culture and harvesting of important shellfish found along the coast of Massachusetts. To encourage regional cooperation and planning, and to educate those involved in the fishery by publishing informational material on the shellfish resource and making it available to local interests.

Procedures: Assistance will be given in regard to the regulation of fishing pressure, opening and closing of areas, catch limits, methods of harvesting, etc. Project personnel will also attempt to provide assistance on effective control of shellfish diseases, predation, pollution, and coastal alteration projects that would involve marsh and flat destruction. To aid this program, the effects of introduced pollutants on or near shellfish areas will be monitored. Technical assistance will be given for the modern techniques of shellfish propagation, especially with the oyster, quahog, and soft-shell clam resources. Techniques in oyster propagation will involve the construction of oyster rafts, the use and distribution of cultch, and the promotion of the grant system. The quahog and soft-shell clam resource will involve assistance towards better transplanting techniques and the use of more efficient harvesting equipment. To promote regional cooperation and planning by encouraging cooperative management and harvesting in common shellfish areas; oyster spat collection and distribution; relaying quahogs, soft-shell clams, and bay scallops. Information will be available as to the possible sources for shellfish seed stock.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0619, OPTIMUM LINEAR SYNTHESIS IN URBAN HYDROLOGY, PHASE II
P.S. EAGLESON, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139 (C-1706)

The goal of this research is to develop and evaluate a new method for the prediction of the entire hydrograph of surface runoff given the time-distribution of rainfall excess. The method is to have an accuracy and to involve a computational effort which are compatible with its incorporation into algorithms for the optimal design of urban drainage systems.

Development of the method will involve systematic investigation of the errors introduced into analytical models of surface runoff systems by linearization and by lumping of systems which are inherently distributed and non-linear. These aspects of the research results will be of equal value in the development of improved analytical models for forecasting the surface runoff component of streamflow in rural areas also.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0620, A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC
V.T. BOWEN, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

This project to identify the major problems of man's contamination of the oceans will be carried out in two parts; (1) Samples of the ocean environment including zooplankton, fishes (migratory and non- migratory), benthic organisms sediments, sea water, surface slicks, and airborne material will be analyzed for pollutants (heavy metals, transition metals, pesticides, and petroleum derived hydrocarbons). (2) Following completion of the above program, a study group will be convened in Woods Hole to discuss the results and to interpret them. The final product will be the planning document for a full-scale research program in the Environmental Quality of the North Atlantic Ocean. Woods Hole Oceanographic Institution will provide the large ship sampling effort; chemical analyses of pesticides and petroleum derived hydrocarbons; will ensure intercalibration of the United States and United Kingdom laboratories; and will host the study group responsible for interpreting the results of the baseline study and recommending a course of action for Environmental Quality research in the North Atlantic.

SUPPORTED BY U.S. National Science Foundation

2.0621, GEOSECS - PREPARATIONS R/V KNORR, CONSTRUCTION GEOSECS BUILDING, PROVISION SHIPBOARD EQUIPMENT, AND THE GEOSECS SUMMER INSTITUTES
J.M. HUNT, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

Considering the ocean as a source of food, a disposal area for nuclear and industrial waste products, and a controlling factor in the earth's climatic regime, our ultimate use of the sea is critically dependent on a detailed understanding of processes presently understood in only the vaguest and most qualitative way. These are the stirring and mixing processes in the deep sea, the interchange of material between deep and surface water, the variation of organic productivity throughout the ocean, and the exchange of water and gases with the atmosphere. The GEOSECS program will measure in detail the oceanic constituents along the Arctic to Antarctic sections at all depths, to provide, for the first time, a set of physical and chemical parameters measured on the same water samples. These data will provide the input for quantitative studies of oceanic mixing and organic productivity, and, at the same time, serve as a baseline for the levels of pollutants and of fission and waste products being added to the sea. Woods Hole Oceanographic Institution will prepare and provide R/V KNORR for the first Atlantic cruise logistic support and facilities for shipment of equipment, samples and personnel, provide a collection and distribution center for samples for shore analysis, establish and maintain a 'water library', provide sampling equipment, equipment for shipboard processing for trace elements and particulates, and a series of lectures, discussions and work shops on ocean modeling.

SUPPORTED BY U.S. National Science Foundation

2.0622, MICROBIAL TRANSFORMATIONS IN SEA WATER
H.W. JANNASCH, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

Funds from this grant continue support by the National Science Foundation of investigations of microbial transformations in seawater. The present research has three major aspects: 1) the experimental measurement, by a newly developed technique, of growth rates of marine bacteria isolated from different types of seawater; 2) direct studies of microbial activities by in situ experiments; and 3) the use of pressurized vessels for taking samples and for culturing bacteria for laboratory experiments which eliminate problems caused by sample decompression. These investigations of the microbes of deep sea environments, which serve as the ultimate place of collection of inorganic and organic waste materials, will provide information necessary to our knowledge of the types of organisms which live on the variety of substrates encountered in various oceanic environments. Such information is also needed in order to make knowledgeable decisions concerning off-shore dumping of waste products.

SUPPORTED BY U.S. National Science Foundation

2.0623, WATER QUALITY MONITORING IN DISTRIBUTION SYSTEMS
R.M. BROWN, Natl. Sanitation Foundation, *Ann Arbor, Michigan*

The overall objective of this project is to develop a continuous monitoring system for use in quality control of water purification processes and detection and control of water quality deterioration in distribution systems. During the first year of the project, a well equipped electroanalytical laboratory was established, and a commercially available automatic water quality data acquisition system (Schneider Instrument Model RM 25 Robot Monitor) was acquired and installed in the laboratory.

Specific ion electrode systems for the determination of (a) fluorides, (b) chlorides, (c) nitrates, and (d) hardness have been studied. The performance characteristics of these electrode systems have been established and their adaptability for use in continuous flow systems is currently being investigated. Emphasis has been placed on defining the constraints of a continuous flow system in terms of sensitivity limitations, long term stability and the effect of possible interferences.

A laboratory model of a continuous stability index monitor has been constructed and is currently on-stream. In this mode, 'Stability Index' values are being recorded continuously in terms of changes in pH as well as changes in hardness before and after the water passes through a column of calcium carbonate chips. Hardness measurements are being made with potentiometric ion selective membrane electrodes.

Anodic stripping voltammetry techniques are being investigated for the characterization of trace metals in nanogram as well as the subanogram range. Of specific interest are the measurements of traces of copper, lead, cadmium, and zinc. Preliminary data indicate the analytical feasibility of this system and its uniqueness for trace metals analysis in water supplies. A continuous flow cell is being designed for on-stream monitoring adaptation of this system.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0624, RESEARCH ON THE MACROBENTHOS OF THE GREAT LAKES
J.K. HILTUNEN, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Ann Arbor, Michigan* 48107

The objective of this project is to determine the kinds of bottom dwelling macroinvertebrates and their ecology in the Great Lakes and connecting waters.

2. WATER QUALITY

Research on freshwater macrobenthos cannot only yield data on the availability of fish-food organisms but also provide insights into the relationships between species and water quality. Areas in which studies of bottom fauna are currently underway include Lakes Erie, St. Clair, and Huron. In Lake Erie and the St. Marys River benthological research is confined mostly to taxonomy and ecology of microdrile oligochaetes. Among aquatic invertebrates, populations of oligochaetes are generally the best indicators of pollution.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0625, POTENTIAL ALGAL PRODUCTIVITY AS MEASURED BY A TURBIDOSTAT
J.A. BORCHARDT, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

This project involves the use of the principle of the turbidostat in a multiphased effort designed to give some indication as to whether this technique can yield consistent and relevant data regarding the potential algal productivity of natural waters and wastes.

The study will involve the use of this apparatus on a natural stream with a local source of pollution: the study of effluents from certain advanced waste treatment procedures and evaluating their possibilities for reducing potential productivity; the comparison of the steady state turbidostat with a batch approach to productivity; the development and evaluation of a simple package turbidostat which can be easily used by a sewage plant operator; and the development of an electronic package to monitor and control incident light.

The turbidostat has been operated quite successfully for a decade in the area of stripping nutrients from sterilized and unsterilized sewage effluent and from a variety of synthetic substrates. It would seem logical that the same type of instrument could be used as a potential algal productivity monitoring device.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0626, PREDICTION OF THE MAGNITUDES AND FREQUENCIES OF FLOODS IN MICHIGAN
E.F. BRATER, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

The influence of various rainfall and drainage basin characteristics on the magnitude and time distribution of flood runoff is being investigated on 15 drainage basins in the Detroit metropolitan area. The population of these basins varies from 60 to 7500 persons per sq. mile. The purpose of this research is to determine a better understanding of the surface runoff process with particular emphasis on the effect of urbanization. The specific practical result of the study will be the development of more accurate methods of predicting floods of various frequencies on watersheds of varying size, taking into account the effect of urbanization. This will permit more effective flood plain planning and more economical designs of storm water drainage structures.

SUPPORTED BY U.S. Dept. of Transportation - Public Rds.

2.0627, NUTRIENT ENRICHMENT AND EUTROPHICATION OF LAKE MICHIGAN
D.C. CHANDLER, Univ. of Michigan, Great Lakes Research Division, *Ann Arbor, Michigan* 48104 (AT(11-1)-2003)

Our research program on the nutrient enrichment and eutrophication of Lake Michigan has been designed to determine what specific nutrients in the Great Lakes system, particularly Lake Michigan, are important in artificial eutrophication. The research objectives are: (1) to determine limiting nutrients for phytoplankton populations. (2) To measure seasonal changes in the chemical composition of Lake Michigan waters and phytoplankton. (3) To obtain empirical relationships between chemical composition of the water and the productivity and biomass of phytoplankton. (4) To relate these data to the rate and extent of eutrophication and to identify methods of nutrient control which might be used in lake management.

SUPPORTED BY U.S. Atomic Energy Commission

2.0628, WATER QUALITY, GRAND TRAVERSE BAY, LAKE MICHIGAN
J.J. GANNON, Univ. of Michigan, School of Public Health, *Ann Arbor, Michigan* 48104

To measure the quality, quantity, and sources of microbiological contamination entering Grand Traverse Bay and to determine the behavior of those organisms between source and final point of deposit; to analyze the possibilities of remote sensing for the developmental aspect of the technique itself.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0629, ECOLOGICAL MONITORING OF STREAM SYSTEMS
F.F. HOOPER, Univ. of Michigan, School of Natural Resources, *Ann Arbor, Michigan* 48104

To investigate the feasibility of monitoring changes in stream quality using drift organisms, we plan to investigate the critical relationships between the density of benthic bottom fauna and the quantity and quality of drift. We will (1) construct 4 experimental stream channels, (2) introduce selected species of stream insects (3) vary the density of certain species among experimental and control channels and (4) measure the effects of these manipulations upon drift rate.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0630, DETECTION, IDENTIFICATION, AND DETERMINATION OF OILS, TARS, AND SLIMES BY REFLECTANCE SPECTROSCOPY
H.B. MARK, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan* 48104

Application of two types of reflectance spectroscopy to the detection, identification, and quantitative determination of oils, tars, and slimes in water and sediments are being studied. A rapid, non- destructive optical technique, requiring no sample preparation whatsoever, for the identification and determination of such pollutants is described. Some example experimental applications, which demonstrate its feasibility, have been demonstrated. Using the technique of internal reflection spectroscopy, an infrared spectrum can be obtained from a sample which has been simply smeared onto an internal reflection plate, or mixed with an optically inert solid support. As no sample pretreatment is employed, the resultant spectrum is considerably more representative of the entire original sample than is one obtained by currently employed techniques which require heating, solvent extraction, etc. At present we are cataloging reference data on specific pollutants that can be measured by this method studying the various instrumental and theoretical parameters involved in order to optimize the resolution and sensitivity. We are also applying this method to sediment samples currently being taken by USC and this laboratory in a study of the Santa Barbara Channel blowout of the winter of 1969. A second technique for instantaneous detection and characterization of oily films on water surfaces, which would be suitable for continuous pollution monitering, is being built. This technique employs external (specular) reflectance from the water surface. A study of optical parameters of this system and the optimization of the design of such instrumentation is being carried out.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0631, REMOTE SENSING
F.C. POLCYN, Univ. of Michigan, Inst. of Science & Technology, *Ann Arbor, Michigan* 48104

To provide a multi-spectral aerial map of Grand Traverse Bay as an aid in identifying thermal plumes, pollution gradients, sediment flows, and so forth.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0632, TECHNOLOGICAL ASSESSMENT OF REMOTE SENSING
F.C. POLCYN, Univ. of Michigan, Inst. of Science & Technology, *Ann Arbor, Michigan* 48104

The investigation is designed to critically review, examine, and analyze the applicability of airborne and other remote sensing instrumentation and techniques for the detection and characterization of water pollutants in the following general categories: (a) substances floating on the water, (b) substances suspended in the water, (c) substances dissolved in the water, (d) material on the bottom of ponds, lakes and estuaries.

More specifically this study will define the capabilities of (a) operational and near operational systems, and (b) systems currently in the research and development stage to remotely characterize effluents and receiving waters in terms of water quality parameters. Additionally, this study will attempt to identify areas of research and define concepts which could lead to the development of new remote sensing systems capable of providing the physical, chemical, and biological measurements of interest in water quality management.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0633, INDICATOR PATHOGEN DENSITY RELATIONSHIPS IN TRIBUTARY STREAMS
R.J. SMITH, Univ. of Detroit, Graduate School, *Detroit, Michigan* 48221

Ratios existing between total coliforms (TC), fecal coliforms (FC), fecal streptococci (FS), and Salmonella organisms are currently being investigated in certain tributary streams in southeastern Michigan. The resulting correlations of these organisms to one another are expected to show the value of Salmonella and other enteric pathogens as water quality indicator organisms. Correlative chemical parameters are also under investigation in order to determine toxicity levels. Control and test areas are being monitored two to three times a week on a yearly basis. Field and laboratory Salmonella survival studies are also being performed in order to determine die-off and comparative survival rates.

The techniques used for Salmonella isolation include: enriching with DSE and tetrathionate broth, streaking on XLD agar, testing biochemically and typing serologically. In the survival studies, tagged Streptococcus liquificans and E. coli are being used for comparison with Salmonella. Field pH and DO are determined using a pH meter, Model Porto-matic IL, and DO meter, Model 51-YSI, both of which are calibrated in the laboratory prior to use. Chemical determinations are being made by atomic absorption.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0634, AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION
R.C. BALL, Michigan State University, Institute of Water Research, *East Lansing, Michigan* 48823 (C-2205)

The objectives of the research are (1) to develop indicator indices from analyses of structure and function of selected stream communities for predicting the short term and long term significance of gradual degradation of water quality by human accelerated eutrophication; (2) to obtain sufficient baseline data on water quality and associated community responses in streams on watersheds having different degrees of agricultural and urban drainage to allow for development of systems analysis of aquatic ecosystems; (3) to evaluate the effects of urbanization on stream discharge and concurrently, the relationship of stream stability to the structure of aquatic communities; and (4) to accomplish the preliminary work for developing adequate techniques for quantifying the esthetic and recreational value of a stream and public attitudes toward competing demands on the resource.

Three watersheds on the Lower Peninsula of Michigan have been selected for exhibiting a graded series in degree of eutrophication and urbanization. Four intensive study sites, consisting of from 100 to several hundred meters of contiguous stream, have been located in these watersheds at points where severe, moderate, slight and minimal eutrophication is occurring. The ecosystems of the intensive study sites will be investigated through analyses of (1) community structure, (2) community metabolism, (3) indicators of impending degradation, and (4) water quality. Data concerning these ecosystems will be interpreted in a background of information gathered from the watersheds concerning (1) nitrogen and phosphorus enrichment, (2) pesticide contamination, (3) heavy metal concentrations, (4) stream stability and urbanization, and (5) socioeconomic aspects of stream degradation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0635, POLLUTION OF A MARINA AREA BY WATERCRAFT USE AS INDICATED BY COLIFORM AND CHEMICAL CONCENTRATIONS
W.N. MACK, Michigan State University, School of Natural Sciences, *East Lansing, Michigan* 48823

The normal coliform and chemical concentration of the water in northern Lake Michigan marina will be determined before the boating season. Tests will be done by Standard Methods. As the season progresses, samples of water will be tested for the dissemination of coliform organisms. The radial spread of the pollution will be followed by using pads suspended in the water to accumulate sample and testing bottom samples. The project will continue beyond the pleasure boating season to determine how soon the chemical and bacterial concentrations will return to their preseason base.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0636, STUDIES ON ALGAE FROM EUTROPHIC AND OLIGOTROPHIC WATER AND THEIR USE IN BIO-ASSAY OF WATER QUALITY
B. MOSS, Michigan State University, Graduate School, *East Lansing, Michigan* 48823

Concern about the nutritional quality of stream and lake water is rapidly growing. On one hand, increasing influx of sewage effluent is promoting growth of undesirable algal blooms in many lakes, and on the other, in underdeveloped countries little basic data exists for the optimal fertilization of fish ponds for producing much needed protein food. Additionally, in siting new drinking water reservoirs, data on the potentialities of local drainage water for the growth of possible 'nuisance' algae is required. In all cases a short term biological assay method for water quality (especially in terms of nitrate and phosphate and their interaction) is required, since chemical analysis alone is often inconclusive.

The mineral nutrient needs, especially of nitrate and phosphate, of algal species carefully chosen for their representativeness of oligotrophic and eutrophic environments will be investigated in cultures. The use of a series of these organisms in the bio-assay of eutrophication will then be evaluated in comparison with field observations, chemical analyses and assays using indigenous algal populations. It is hoped that a standard assay system, of widespread use, and of greater ecological relevance than previous systems using 'laboratory' species, will be evolved. Emphasis will be placed on ease of use and economy of apparatus and materials.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0637, PHYTOPLANKTONIC NITROGEN AS AN INDEX OF CULTURAL EUTROPHICATION
R.G. WETZEL, Michigan State University, Graduate School, *East Lansing, Michigan* 48823

This research is designed to quantify several new aspects of the nitrogen cycle in the aquatic ecosystem. The research will permit evaluation of a model describing nitrate uptake from artificial media and natural environment by phytoplankton. The model relies on a new method for determining phytoplanktonic nitrogen in natural seston distinct from that contributed by the zooplankton, detritus and bacteria. This method is based on physiological relationships between organic nitrogen content and the ratio of plant pigments in the three major algal phyla common to algal blooms.

The predictive power of the model will be investigated and improved under laboratory conditions and in situ with natural phytoplankton under N-enriched and natural conditions. Possible applications of these techniques to both N-deficient and N-enriched situations in lakes will be evaluated with particular emphasis on capabilities for predicting stress effects resulting from cultural eutrophication.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0638, NITRIFICATION IN SURFACE WATERS
C.R. BAILLOD, Michigan Technological Univ., School of Engineering, *Houghton, Michigan* 49931

Increasing attention is being paid to the effect of nitrification on the water quality of surface waters. The objectives of the study, therefore, are: 1. The investigation of the extent of, and potential for, the occurrence of nitrification in surface waters tributary to Lake Superior in Michigan's upper peninsula. 2. The elucidation of significant factors affecting nitrification in surface waters.

In order to determine the extent of nitrification in these waters, it is proposed to institute a sampling program in which bimonthly samples would be taken in streams at points below sources of reduced nitrogen. These samples would be analyzed for all forms of nitrogen. The potential of the various surface waters for nitrification would be determined by batch incubation techniques after the addition of known concentrations of ammonia and nitrifying organisms. A dilution technique would be employed to estimate the concentration of nitrifying organisms. These batch incubation techniques will also be employed to determine the effect of other factors upon nitrification.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0639, THE INVESTIGATION AND ANALYSIS OF BIOCHEMICAL PROCESSES OF AQUATIC ORGANISMS UNDER STRESS
G.M. CHRISTENSEN, U.S. Dept. of the Interior, Federal Water Quality Admin., *Duluth, Minnesota* 55804

The objective of this work is to carry out investigations on a molecular level on organisms, organs, tissues, cells and chemicals of aquatic life which have been exposed to toxicological or noxious situations and stress; to establish base-line data, or normal values, for specific biochemicals or biochemical systems in organisms and also, later, to establish parallel experimental values for those systems when under toxicological or noxious situations and stress. It is proposed that work be done to investigate and clarify the interaction between stress source and stressed system, diagnosis and prognosis. It is proposed that research be carried out in order to determine whether it is possible to carry out a qualitative and quantitative analysis on specific biochemicals in an organism and deduce the general state of health or well-being of that organism or diagnose its ill health and have a basis for making a prognosis regarding its future state or health condition.

Initially, work is being carried out with the general 'fight-or-flight' (stress) hormones, adrenaline and noradrenaline. We are in the process of establishing normal values for these two biochemicals in fish, and plan then to determine non-normal values for the organism when under toxicological or other types of stress. Equipment which is particularly useful for this study includes a recording spectrophotometer, thin-layer and paper chromatographic apparatus, a recording spectrophotofluorometer and a sensitive infra-red spectrophotometer.

Other biochemicals that may be investigated in the future include, tentatively, blood glucose, serum non-protein nitrogen, certain inorganic salts, specific serum enzymes, plasma fatty acids and other specific hormones that are known to be inolved in stress-type biological reactions.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0640, BEHAVIOR OF PLATINUM ELECTRODES AS REDOX POTENTIAL INDICATORS IN METALLURGICAL SYSTEMS
I. IWASAKI, Univ. of Minnesota, School of Mineral Engin., *Minneapolis, Minnesota* 55455

Although redox potential measurements are usually made with platinum electrodes, the reliability of the measurements is often overestimated. Certain substances in solution may poison the electrodes so that they give erroneous readings. The nature of these substances, the manner of their absorption on the electrodes, and the means of alleviating their adverse effects are not well understood. This research investigation will start with a few substances known to act as poisons and will be extended to other substances of more interest to the metallurgical industry. The influence of these substances on redox potential measurements will be studied by the triangular wave potential sweep method, the galvanostatic charging method, the differential capacitance method, and by infrared spectroscopy. The knowledge gained will be of practical importance in controlling metallurgical processes in monitoring water pollution problems.

SUPPORTED BY U.S. National Science Foundation

2.0641, EFFECT OF SEWAGE EFFLUENT ON ALGAE IN SHAGAWA LAKE, MINNESOTA
R.O. MEGARD, Univ. of Minnesota, School of Earth Sciences, *Minneapolis, Minnesota* 55455

The first objective of this project is to determine the population densities and daily rates of photosynthesis of the natural phytoplankton populations in Shagawa Lake. This will provide 1) a baseline for evaluating the effectiveness of a tertiary treatment plant that may be constructed and 2) a basis for comparing the productivity of this lake with that of others in the region that have been studied.

The second objective is to perform nutritional bioassays and short- term enrichment experiments in an attempt to determine which nutrients are critical for algal growth at various times of the year. This will be done to help determine what type of nutrient removal is likely to be most effective and to provide a rational basis for designing and estimating the cost of full-scale treatment facilities.

Much of the work will be done in the F.W.P.C.A. laboratory at Ely, Minnesota between September 1, 1969 and August 31, 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0642, ZOOPLANKTON BIOMASS AND INCIPIENT EUTROPHICATION IN LAKE SUPERIOR
T.A. OLSON, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

This research project will be concerned with detailed zooplankton biomass assessments in selected regions of Western Lake Superior. Areas near Duluth-Superior, near Larsmont and at Grand Marais will be studied. Clarke-Bumpus Nets, Miller High Speed Samplers and the Continuous Plankton Recorder will be employed for zooplankton collections in these regions.

The objective of this investigation is to evaluate various types of zooplankton biomass assessment as a means for measuring subtle beginnings of eutrophication as it may develop in Western Lake Superior. In the studies envisioned, biomass analyses and productivity measurements will be carried on throughout the open water season. Total wet volume, organic matter of the biomass, zooplankton identification and enumeration and other pertinent determinations will be made on the samples. The major emphasis will be on ecological factors, especially those which relate directly to the response of zooplankton organisms to a slight but ever increasing enrichment of the environment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0643, BENTHONIC INVERTEBRATES AS AN INDEX OF WATER QUALITY
T.A. OLSON, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

The proposed water pollution study will be made on immature aquatic invertebrates. Primary efforts will continue to be concentrated on the oxygen requirements of each species during its aquatic life cycle. It is believed that through such a study a more exact evaluation can be established on the status of these in-

vertebrates as indicators of water quality or as potential bioassay indicators. A subsequent cataloging of each species should be of value to agencies and persons concerned with water pollution.

Since environmental conditions can be more closely controlled in the laboratory, the work will be centered on this aspect. A limited number of field studies will be included. A flow-through respirometer in which the oxygen is measured by an electrochemical transducer and the conventional Manometric technique will be employed to measure oxygen consumption rates.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0644, LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY

T.A. OLSON, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

This proposal is concerned specifically with the completion of objectives set forth in an approved project of five years begun in 1965. The study dealt with that assemblage of aquatic organisms known as periphyton which grow attached to the submerged surfaces of rocks in Lake Superior.

Of the seven primary objectives stated in the original proposal, only two remain to be investigated. The specific objectives for this proposed final year of the project would be directed toward the determination of (1) the possible changes which occur in the periphyton when polluting substances are introduced into the lake and (2) the possible interrelationships existing between the periphyton and the plankton.

That portion of the study relating to the addition of polluting materials will be undertaken by examining the periphyton by various methods at comparable polluted and unpolluted areas. In addition, certain natural and artificial fertilizers will be introduced in two areas, with a third comparable area serving as a control.

For the purpose of evaluating the interrelationship of periphyton and plankton, simultaneous qualitative and quantitative determinations on the composition of each community will be made with an attempt being made to effectively correlate these.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0645, RELATION OF PHOSPHORUS IN LAKE BOTTOM DEPOSITS AND POLLUTIONAL HISTORY OF MINNESOTA LAKES

J. SHAPIRO, Univ. of Minnesota, School of Earth Sciences, *Minneapolis, Minnesota* 55455

A study is to be made of the phosphorus content of sediment profiles from a wide variety of lakes in Minnesota. The shapes of these profiles will be interpreted in the light of other events as determined through micro-fossil analysis. This study coupled with direct studies of the availability to recycling of phosphorus from different depths in the cores will aid in determining the extent to which sedimentary phosphorus is of meaning to the productivity of lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0646, MATHEMATICAL SIMULATION OF A LARGE WATERSHED USING THE SYSTEMS APPROACH TO QUANTITY AND QUALITY ANALYSIS

C.C. SONG, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414

It is proposed that a comprehensive mathematical model be constructed, simulating the engineering aspect of a typical large water resources system. Starting from suitable mathematical models for each component of the system, such a surface flow, ground water flow, mass transport, movement and change of pollutant, and snow melt, a comprehensive response function of a system will be constructed. The validity of the model will be tested by applying the model to the Minnesota River Watershed using the available field data on physical parameter of the watershed, pollution, and use, precipitation, runoff and the quality of water. Sensitivity analysis of the model will also be carried out.

Depending on the progress made on the initial stage of the investigation, one or more of the following items may also be performed: 1. Stochastic analysis of the input and output of the system and the response of the system to stochastic input. 2. Prediction of the quantity and quality of water in Minnesota river watersheds and comparison with the additional field data. 3. Systems analysis for the purpose of optimum design and management of the watershed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0647, DIATOMS IN LAKES AND LAKE SEDIMENTS AS AN INDEX TO ENVIRONMENT

H.E. WRIGHT, Univ. of Minnesota, School of Earth Sciences, *Minneapolis, Minnesota* 55455 (AT(11-1)2046)

The project includes four aspects, investigated concurrently: (1) Completion of the survey of living planktonic and sessile diatoms in a representative series of lakes across the state of Minnesota, combined with analyses of surface mud samples, (2) continuation of the collation of chemical and other ecological data from the world literature on diatoms, (3) analysis of short cores of paired polluted and unpolluted lakes, to determine the changes in diatom assemblages resulting from pollution, and (4) analysis of long cores so that the recent changes in diatom assemblages can be compared with those that have occurred throughout postglacial time in response to changes in climate or other natural factors in the environment.

Results to date on short-core analysis, especially in conjunction with other biostratigraphic and chemo-stratigraphic studies, are very promising, and stratigraphic diatom analysis may prove to be a very valuable technique for watching the progress of pollution as well as of other environmental changes.

Result to Date: Short-core diatom analyses for Lake Sallie in northwestern Minnesota show striking changes in diatom assemblage starting at the time of agricultural land clearance in the area, as determined by pollen analysis of the same core. Preliminary results for other lakes point to similar relations.

SUPPORTED BY U.S. Atomic Energy Commission

2.0648, MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX

C.R. FREMLING, Winona State College, Graduate School, *Winona, Minnesota* 55987

Hordes of mayflies rise from the Mississippi River every summer and create nuisance problems for river residents and river traffic. The relative abundance of the various species in a given area, however, is probably a reliable indicator of general water quality in that area.

Adult mayflies will be collected systematically along the Upper Mississippi River. An efficient, reliable, large-scale collection system was initiated in 1957 and it has been in continous operation since that date. Past and future collections will be analyzed to determine (1) geographical distribution of the various species, (2) times of adult emergence, (3) areas of scarcity and abundance, (4) population trends, and other basic biological data. Most important, this analysis will determine the present state of the river as habitat for pollution-sensitive organisms. These data will provide a basis for comparison, should the quality of the aquatic habitat change in the future.

I have developed methods for rearing large numbers of burrowing mayflies in the laboratory. Laboratory populations will be maintained to determine the effects of limiting factors such as concentrations of dissolved substances, food supply, temperature, intraspecific strife and interspecific competition. The degree to which burrowing mayflies contribute to total turbidity will be determined. Laboratory populations will also be studied to learn more concerning the environmental factors which coordinate mass rhythmic emergences of mayflies.

Laboratory experiments in conjunction with field investigations will enable me to evaluate the importance of the various roles played by mayflies in the aquatic ecosystem. This evaluation becomes increasingly important as river cities contemplate mayfly control programs.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0649, WATER RESOURCES OF COPIAH COUNTY

T.N. SHOWS, State Geol. Survey & Wa. Reso., *Jackson, Mississippi* 39201

The water resources investigation of Copiah County was started in the summer of 1967. Emphasis was placed on obtaining information on the aquifers within the County as all domestic and industrial supplies are from ground-reservoirs. Surface water data is needed to provide information to industries which might be users of surface reservoirs to supplement ground-water supplies. The Pearl River which forms the eastern boundary is large enough to provide water to industry, except that upstream pollution has limited the usefulness of this water.

The Survey will be able to provide answers to questions of quantity, quality and availability of ground and surface water in Copiah County. Some of the methods used in collecting ground-water information in Copiah County are: running aquifer performance tests, monitoring water level changes, collecting water samples for chemical analyses, drilling test holes to determine the presence and extent of aquifers, inventorying existing wells with emphasis on the large industrial and municipal wells, and running electrical logs.

Records of stream flow, including maximum and minimum flow, and chemical analyses of surface water are being compiled from available published and unpublished sources. Low flow data and partial chemical analyses are being collected on various streams in the County.

SUPPORTED BY Mississippi State Government

2.0650, WATER RESOURCES OF RANKIN COUNTY

T.N. SNOWS, State Geol. Survey & Wa. Reso., *Jackson, Mississippi* 39201

The water resources study of Rankin County was begun in the Spring of 1969. Major study is concentrated on defining the principal aquifers underlying the County as all domestic and industrial supplies are from ground-water sources. Surface water information will determine if a dependable supplementary water supply is available for future use. The Pearl River Reservoir and the Pearl River north of Jackson have the potential of furnishing large amounts of surface water to major users. Presently the water supply for the City of Jackson (on the west side of the River) is from the Pearl River north of Jackson The reach of the River below Jackson is polluted by municipal and industrial waste.

The primary responsibility of the Survey is to appraise the water resources of the County. Questions will be answered as to quantity, quality and availability of ground and surface water in Rankin County. Answers to these questions will assist in the orderly development of the water resources. Some of the techniques used in collecting ground- water information in Rankin County are: running aquifer performances tests, drilling test holes to determine the presence and extent of aquifers, inventorying existing wells with emphasis on large industrial and municipal wells, collecting pumpage and quality of water information, and running electrical logs.

Surface water records including both published and unpublished records are being analyzed for useful information from various governmental organizations.

SUPPORTED BY Mississippi State Government

2.0651, A STUDY OF THE DEPURATION PROCESS IN OYSTERS TAKEN FROM POLLUTED WATERS AND RE-BEDDED IN UNPOLLUTED WATERS

D.W. COOK, State Marine Conserv. Comm., *Ocean Springs, Mississippi* 39564

This phase is a continuation of Phase III of Sub-Project 2-28-R-2.

Objectives: To study the depuration of pollution indicator bacteria from oysters relaid into clean waters and to study the changes that occur in the composition of oyster meats during depuration.

Procedures: Oysters will be moved from polluted waters to clean waters, sampled periodically and analyzed bacteriologically and chemically. Bacteriological analysis for the coliform MPN, fecal coliform MPN and total plate count will be conducted in accordance with 'Recommended Procedures for Bacteriological Examination of Sea Water and Shellfish', American Public Health Service Association, 1962. Chemical analysis for the total dry weight, glycogen, protein and ash content will be made using standard procedures.

Part 2 of 3

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0652, A STUDY OF COLIFORM BACTERIA AND ESCHERICHIA COLI ON POLLUTED AND UNPOLLUTED OYSTER BOTTOMS OF MISSISSIPPI

G GUNTER, State Marine Conserv. Comm., *Ocean Springs, Mississippi* 39564

Objectives: 1) To establish a regular sampling program on transects across Mississippi Sound and extending from fresh water to the Gulf of Mexico and on selected polluted and unpolluted oyster reefs. 2) To perfect technique for collecting comparable samples. 3) To complete bacterial analyses of collected samples. 4) To compare the bacterial flora from polluted and unpolluted areas of Mississippi Sound and adjacent waters, especially as it relates to sewage polluted oyster beds.

Procedures: 1) Field - (a) Surface, mid-water and bottom samples will be collected at established stations where there is sufficient depth of water. Additional samples will be collected as necessary. (b) Techniques to insure the collection of samples under sterile conditions will be established. (c) Temperature and salinity will be determined at all stations. (d) Collected samples will be refrigerated and returned to the laboratory for analysis. 2) Laboratory - (a) The most probable number of coliform organisms and of Escherichia coli of presumptive human fecal origin will be determined by competent bacteriologists. (b) Additional studies will be carried out where feasible.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0653, PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS

L.L. MCDOWELL, U.S. Dept. of Agriculture, Sedimentation Laboratory, *Oxford, Mississippi* 38655 (SWCW1-BE-4)

OBJECTIVE: Extend knowledge of the deleterious and beneficial physical and chemical attributes of sediments in runoff waters, in channel deposits, and in impoundments.

APPROACH: Obtain sediment samples for analysis and evaluation at selected sites in the Lower Mississippi River and some principal tributaries, in selected channels draining agricultural lands, and in selected reservoirs and impoundments. Factors involved include dispersion and flocculation tendencies, exposure to air and sunlight, water depths in reservoirs, age and depth of submerged sediments, and other environments.

PROGRESS: Analyses for pesticides content of streambed samples of the Lower Mississippi River and many of its tributaries taken during 1966 and 1967 generally confirm the findings from the 1967 sampling and reported in the American Society of Agronomy Special Publication No. 8, November 1966. Many of the samples obtained near a manufacturing plant for endrin and heptachlor, or near the plants of formulators, had measurable amounts of dieldrin, aldrin, endrin, isodrin, X, Y, chlordane, lindane, and DDT analogs and metabolites. On the other hand, with only one exception, DDT analogs and metabolites were the only pesticide residues found that originated from nonindustrial sources, i.e., municipal and agricultural; and many of these residues were found at concentrations less that 0.05 ppm. Of 125 samples collected in 1966 from tributary streams in Mississippi, Arkansas, and Louisiana, half had no measurable pesticides, a third contained measurable DDT or its associates only, and a sixth had additional pesticides. Improvements in analysis techniques have resulted in the detection of chemicals not previously found, and in the detection of all at lower levels of concentration. But, the principal conclusion of the 1964 sampling program still holds. That is, that the large quantities of pesticides previously applied to crops in the Mississippi Delta have not created widespread, de-

tectable contamination of streambed materials. This is not to say that no contamination was found.

SUPPORTED BY U.S. Dept. of Agriculture

2.0654, A STUDY OF THE ECOLOGY OF THE MISSISSIPPI TEST FACILITY

L.R. BROWN, Mississippi St. University, Inst. for Space Env. Sci. Eng., *State College, Mississippi* 39762

The objective of this project is to determine the 'baseline' conditions of selected waters and the lands of both the fee zone and the buffer zone at the Mississippi Test Facility. More specifically, qualitative and semi-quantitative estimates of the aquatic and terrestrial flora and fauna will be made along with preliminary chemical and physical characterization of the waters.

It is expected that the information obtained in this investigation coupled with information already available on the area will allow for a reasonably complete characterization of the ecological/environmental conditions existing at the Facility.

SUPPORTED BY U.S. Natl. Aero. & Space Adm

2.0655, DEVELOP IN-HOUSE CAPABILITY IN WATER QUALITY TECHNIQUES FOR ANALYSES OF HEAVY METALS, BACTERIA, AND PESTICIDE RESIDUES

C.F. DERRINGTON, U.S. Army, Corps of Engineers, *Vicksburg, Mississippi*

Technical Objective: The purpose of this program is to develop an in-house capability for analyzing water samples and related materials for pollutants such as heavy metals, bacteria, and pesticides. Optimum parameters will be developed or determined for the analysis of these pollutants. The program will provide the U. S. Army Corps of Engineers with the badly needed capability of analyzing water samples to determine what pollutants are present and their respective concentrations.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0656, POTENTIOMETRIC TECHNIQUES FOR MONITORING IONS INVOLVED IN WATER POLLUTION

S.E. MANAHAN, Univ. of Missouri, School of Arts, *Columbia, Missouri* 65202

New and improved potentiometric techniques are being developed to monitor ions, particularly monovalent anions, of interest in water quality control. Cells without liquid junction using the fluoride electrode as a reference are being used with a standard addition technique to determine concentrations of nitrate and other anions. Methods are being explored to utilize the nitrate ion-selective electrode to follow nitrate assimilations in algal cultures. The nitrate ion-selective electrode enables the continuous monitoring of nitrate ion concentration in algal cultures. The effects of light intensity, carbon dioxide concentration and alternative nitrogen sources are being explored.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0657, AUTOMATED POTENTIOMETRIC TECHNIQUES FOR THE ON-SITE MONITORING OF IONS IMPORTANT IN WATER QUALITY CONTROL

S.E. MANAHAN, Univ. of Missouri, Graduate School, *Columbia, Missouri* 65202

The overall objective of the proposed research is the development of new and improved techniques applicable to the automated monitoring of low concentrations of ions in water. Methods are to be developed which are simple, fast, reliable, sensitive and low in cost per sample. The analysis techniques will require a minimum of operator time.

Methods and hardware to be developed include (1) a multisensor analysis system, (2) a standard addition technique, (3) stable, low- leakage, low-drift reference electrodes, and (4) a flow titration technique. Emphasis initially will be on nitrate and cyanide ions. Later the work will be extended to other ions such as sulfate, fluoride, chloride, bromide, iodide, lead and copper.

Ion-selective electrodes will form the basis of the analysis system.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0658, A STUDY OF THE WATER QUALITY AND PLANKTON DYNAMICS OF LAKE JACOMO, THE PRIMARY RECREATIONAL WATER FOR GREATER KANSAS CITY

D.H. STERN, Univ. of Missouri, Graduate School, *Columbia, Missouri* 65202

The proposed one-year study has as its goals the quantitation, analysis, and interpretation of the interrelationships between physical, chemical, and biological parameters in Lake Jacomo, a 970-acre recreational reservoir serving yearly over 1,000,000 residents of the Kansas City metropolitan area. Physicochemical factors to be examined include water temperature, dissolved oxygen, light transmission, pH, specific conductance, turbidity, ammonia-, nitrite-, and nitrate- nitrogen, phosphate, silica, total and phenolphthalein alkalinities, and total and calcium hardness.

Biological factors examined will include the identification and quantitation of the plankton (determination of standing crop) and productivity studies (light & dark bottle). While gaining the requisite information, we shall consider the following points: (1) the effects of eutrophication of lake water by runoff from surrounding farmlands and feed lots: (2) the quality of the water with respect to primary and secondary recreation and aesthetics; (3) the acquisition of baseline information for comparison of changes in water quality at other seasons and during succeeding years; (4) the presence of sources of pollution in the lake waters; and (5) recommendations for the management of Lake Jacomo and other reservoir lakes soon to be constructed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch

2.0659, WATER QUALITY OF THE NORTH, SALT, AND CUIVRE RIVER BASINS

M.D. MCDANIEL, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To study existing biological conditions in the streams and to acquire the necessary background data for evaluating the effects of pollution at present and in the future.

Procedures: A series of approximately 50 stations will be strategically located within the three stream basins. Biological samples will be collected at these stations once during each season of the year. At the time of these collections, physicochemical and flow measurements will be made by the Missouri Water Pollution Board and U.S. Geological Survey personnel.

Biological collections will include qualitative, semi-quantitative benthos samples which will be collected from both pool and riffle habitats at each station where practicable. A portion of stream will be surveyed at each station for larger aquatic invertebrates such as mussels, crayfish, and snails. Qualitative algae samples will also be taken at each sampling. Fishes will be surveyed once at all stations to determine species present.

A standard form will be used to record kind and relative numbers of benthic organisms present at each station. Identification of organisms will be as follows: (a) Flatworms, annelids, and roundworms will be identified to class. (b) Flies (Diptera) will be identified to family or genus when practicable. (c) Stoneflies, mayflies, caddisflies, crayfish, and mussels will be identified to species when practicable. (d) Snails, crustaceans, and macro-invertebrate groups other than those named will be identified to genus when practicable.

Data from the stations will be tabulated seasonally and compared. As benthos samples will be more qualitative than quantitative, data analyses will emphasize diversity rather than density. Correlation of benthic data to physico-chemical water quality factors will be emphasized in the final report. Information from this report will be included in a comprehensive final report for the entire cooperative project.

2. WATER QUALITY

SUPPORTED BY Missouri State Government

2.0660, A PROPOSAL TO DEVELOP A PLAN FOR THE CONSTRUCTION AND TESTING OF WATER POLLUTION FORECASTING MODELS
G.E. STAATS, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

One important aspect of the overall water pollution program in the United States is the prediction of water needs, quality levels and pollution levels. These predictions can be made with statistical forecasting models. In order to develop these models, a number of different phases must be undertaken. These phases of the research plan are: Phase 1 - An Exhaustive Evaluation of the Pertinent Literature. Phase 2 - Analyze the State Water Supply System and Select a Small Sub- system. Phase 3 - Determine Water and Pollution Inputs, and Water Outputs of the Sub-system Selected in Phase 2. Phase 4 - Develop Potential Relationships Between Independent Variables and the Dependent Variables, Water and Pollution Inputs, and Water Outputs. Phase 5 - Design the Experiment to Test and Evaluate the Relationships Developed in Phase 4. Phase 6 - Develop the Plan for Carrying Out the Experiment Designed in Phase 5.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0661, SOURCES OF SEDIMENT IN A MOUNTAIN RIVER BASIN
M.G. KLAGES, Montana State University, School of Agriculture, *Bozeman, Montana* 59715

This project is designed to test the feasibility of using minerals as tracers to determine the source and type of materials carried in suspension by a river. This would enable one to make a pollution analysis to determine the source and type of pollutants at any point on a stream. This would greatly facilitate the data gathering for pollution analysis.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0662, TESTACEA (PROTOZOA - SARCODINA) AS INDICATORS OF WATER QUALITY IN WESTERN MONTANA
J.F. TIBBS, Univ. of Montana, School of Arts, *Missoula, Montana* 59801

This research would include field and laboratory investigations directed toward: 1. Determination of species composition of the assemblages of testate amoebae characteristic of aquatic habitats in western Montana. 2. Establishing whether association of testaceans may be used as indicators of water quality with reference to chemical and biological criteria. 3. Study of the biology of selected species which are amenable to laboratory culture. 4. Study of the ecology and the utility as indicator organisms of the Cyphoderia ampulla complex.

Associated chemical and physical data would be collected in a variety of aquatic habitats. Each of these habitats would be repeatedly sampled in 1969 and 1970, and pertinent chemical and physical data would be collected at the times of sampling.

Determinations of Species and other laboratory work will be correlated with field data with a view toward practical application of the findings.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0663, MERCURY CONCENTRATIONS IN THE AQUATIC LIFE FORMS AND THE WATERS OF THE UPPER CLARK FORK RIVER
W.P. VANMETER, Univ. of Montana, School of Arts, *Missoula, Montana* 59801

This research effort will be directed to establishing analytical techniques to establish mercury concentrations in fish, aquatic insect and crustacean or mollusk tissues. There has been considerable recent attention given to the fact that mercury has been found in the tissues of wild game fish in Western Montana.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0664, HEAVY METAL RESIDUES IN CHANNEL CATFISH FROM SELECTED WATERSHEDS IN NEBRASKA
N. STUCKY, State Game & Parks Commission, *Lincoln, Nebraska* 68509

Objective: To determine whether channel catfish in selected watersheds throughout Nebraska are carrying residues of any, or all, of the following heavy metals: Mercury, chromium, lead, zinc, cadmium, and copper.

Procedure: 1. Channel catfish were collected from seven drainage systems throughout Nebraska during segment 16. Additional collections will be made from four lakes. 2. All samples will be analyzed for mercury whereas selected samples will be analyzed for the other heavy metals. 3. Analysis will be performed with an atomic absorption spectrophotometer for all the metals except lead. The method of choice for lead is dithiozone colorimetric analysis. 4. Those aspects of the study which warrant publication will be published.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0665, UTILIZATION OF THE STORAGE POTENTIAL OF RIVER VALLEY AQUIFERS
R.R. MARLETTE, Univ. of Nebraska, School of Engineering, *Lincoln, Nebraska* 68508

The Water Resources Research Category of this project would be IV. Water Quantity Management and Control, Groundwater Management. The first work would augment the meager water quality data available in the lower Platte River basin with a systematic sampling and analysis of the physical, chemical and biological features of these rivers' water. The aim would be to determine the important characteristics and develop simplified testing procedures for using river water to recharge valley aquifers.

The seasonal quality of the Elkhorn, Loup and Platte rivers will be analyzed to determine the treatment, if any, that may be required in order to use these waters to recharge through infiltration basins located near production wells. The sampling will take place within a fifty mile radius of Lincoln, Nebraska. Some of the analysis will be done in the field, but most of this work will be performed in the Sanitary Laboratory of the Civil Engineering Department.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0666, INTERACTION OF RADIO-LABELLED BIOCIDES AND HEAVY METALS WITH MICROBIAL ECOSYSTEMS
R. KOKKE, Technische Hogesch. Te Delft, *Delft, Netherlands*

A study is made on: 1. With radiotracer methods of accumulation, retention, excretion and conversion of biocides and heavy metals by microbes in pure culture, in soil and in an aqueous ecosystem (activated sludge). 2. The effects of the chemical on microbial strains and ecosystems. Particular attention is paid to synergistic and antagonistic effects. 3. Improvement of analytical and quantification techniques which are required for the study of the interactions of the chemicals and the microbes.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0667, LIMNOLOGICAL INVESTIGATIONS OF LAKE MEAD
D. LOCKARD, State Dept. of Fish & Game, *Las Vegas, Nevada*

Objectives: To determine significant physical or chemical changes within Lake Mead which may be attributed to upstream impoundments.

To determine the extent of pollution which is occurring at the Las Vegas Wash portion of Lake Mead.

Procedures: Standard methods will be used in collecting temperature profiles, dissolved oxygen and various chemical and physical data from established sampling areas of the lake. This data will be gathered on a seasonal basis. Correlation of this information with previous samplings and upstream conditions will be accomplished.

In conjunction with local and State pollution control agencies, a systematic monitoring of the Las Vegas Wash area will be accomplished.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0668, ENVIRONMENTAL REQUIREMENTS OF SELECTED ESTUARINE CILIATED PROTOZOA
A.C. BORROR, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

This study is designed to determine the possible role of ciliated micro organisms (phylum protozoa, class ciliophora) as water pollution indicators. It will involve investigation of factors affecting species composition and micro distribution of populations of intertidal ciliates of the tidal marshes of the Great Bay-Little Bay Estuary, New Hampshire, where they reach particularly high population densities. The relationship of ciliates to the rest of the decomposor food chain, and their role in estuarine productivity will be investigated. Measurements of relative and absolute abundance of members of microbenthos, correlated with variations in physical and chemical factors, will be employed in assessing diurnal and seasonal changes in ciliate community structure.

The research will be carried out using facilities at the Univ. of N.H. and at the Jackson Estuarine Laboratory, Univ. of N.H., on Adams Point, Great Bay, N.H. Research will include examination of living ciliates augmented with material prepared according to standard fixation and staining procedures as well as associated environmental data. The project is due to commence on October 1, 1969 and is to conclude on September 30, 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0669, POPULATION STUDIES OF MARINE AMPHIPOD CRUSTACEANS
R.A. CROKER, Univ. of New Hampshire, School of Liberal Arts, *Durham, New Hampshire* 03824

The investigations supported by these funds concern a comparative field and laboratory study of population structure and ecological specialization in two groups of marine amphipod crustaceans found in estuarine and shallow sea environments. Organisms of one group (Gammaridae) live on rocky, algal and muddy substrata; while those of the other group (Haustoriidae) are found living within sediments. The objectives of this research are to investigate: (1) population structure, including local and regional patterns of distribution, fluctuations, clines, intergradations, peripheral populations and ecological replacement of species; and (2) the morphological variation of species as related to ecological specialization. The data resulting from these investigations will be valuable in predicting the consequences of modification of estuarine and shallow sea environments, and will contribute to a better understanding of the population biology of crustaceans in estuarine complexes which experience changing levels of pollution.

SUPPORTED BY U.S. National Science Foundation

2.0670, A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE
A.C. MATHIESON, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

In the present investigation the species composition, periodicity and abundance of algal populations from three areas (Newfound Lake, Winnisquam Lake and New Hampton Stabilization Pond and Lake Winnepesaukee differing with respect to water quality, will be compared in order to assist in the prediction, prevention, and control of algal blooms in New Hampshire water supplies. These three areas show a marked difference with respect to pollution, i.e., Newfound Lake has no pollution, Winnisquam Lake is moderately polluted and New Hampton Stabilization Pond is an oxidation pond, or sewage lagoon, which is extremely polluted. A comparative study of this nature will assist in the maintenance of a high quality water supply.

Weekly samples will be taken at New Hampton Stabilization Pond, while collections will be made on alternate weeks at Winnisquam and Newfound Lakes. Samples from New Hampton Stabilization Pond will be primarily restricted to phytoplankton and floating mats of algae, while those from Newfound and Winnisquam lakes will include the attached bottom forms and the epiphytic types as well. The types, abundance, and occurrence of algae at all three areas will be enumerated throughout the year. Various techniques will be employed - Sedgwick-Rafter slide technique as outlined by Palmer (1959), a modificaton of the Hess Method for floating vegetation, collection of host plants and epiphytes, bottom sampling by dredging. Statistical differences will be determined between the various populations and areas studied. Routine culturing of several of the algae will be an integral part of this study - for identification of species and determination of nutrient requirements.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0671, DETECTION AND ENUMERATION OF VIRUS IN NATURAL WATERS
T.G. METCALF, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

It is proposed to introduce equipment and methods which will make it possible to determine the presence of virus populations in surface waters on a quantitative basis. The proposed study is directed towards development of the capability for routine quantitative monitoring of the microbiological quality of surface water. The proposal recognizes the great need for addition of a quantitative capability to existing qualitative methods for detecting the presence of viral macromolecules in water. The proposed study anticipates the forging of a powerful technical tool which can be directed toward the solution of a variety of existing problems of both fundamental and applied nature involving the virus macromolecule in water.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0672, CONFERENCE ON POLLUTION OF ESTUARIES
L. WOOD, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

Funds from this grant support, in part, a symposium entitled 'Pollution of Estuaries: A NEERS Symposium', held in late May 1970 at the New England Center for Continuing Education, Durham, New Hampshire, under the sponsorship of the New England Estuarine Research Society (NEERS). The major objectives of the symposium are an assessment of current estuarine pollution and the related problems; the identification of those by-products and practices of human society that clearly endanger these important waters; the disclosure of areas in need of further study; and the promulgation of recommendations for actions which will be economically feasible and ecologically sound.

SUPPORTED BY U.S. National Science Foundation

2.0673, SPECIAL TEMPERATURE SURVEY OF RIVER AND ESTUARINE AREAS IN RELATION TO THERMAL POLLUTION AND FISHERY PROBLEMS
T. AZAROVITZ, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Highlands, New Jersey* 07732

The objective is to determine seasonal variations in the surface temperature configuration of rivers and estuaries. These near-synoptic data are to provide baseline temperatures for present and future fishery and ecological studies, especially where thermal additions are a critical factor.

Infrared sensors mounted in helicopters will be the principal method of obtaining temperatures. Surveys will consist of a general gathering of temperature data in rivers and estuaries as well as detailed studies of specific areas where ecological conditions may be obtained by lowering a thermistor and other sampling devices from the helicopter. The cooperation of Federal and State researchers working at areas of interest will be sought to provide additional data.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0674, DISTRIBUTION OF AUTOTROPHIC NITRIFYING BACTERIA IN A POLLUTED STREAM
M.S. FINSTEIN, Rutgers the State University, School of Arts, *New Brunswick, New Jersey* 08903

It is proposed to investigate the distribution of autotrophic nitrifying bacteria in parts of the Passaic River.

The densities of ammonia and nitrite oxidizing autotrophs will be determined in the following environments: water, suspended particulate matter, mud-water interfaces, slimes on rocks and other projecting surfaces. It will be determined if nitrifying bacteria are present as single cells or in multi-cell aggregate in the water phase. Field sampling will be scheduled during different seasons to evaluate the effect of temperature. Sampling sites will be at various distances from outfalls. Ancillary chemical data collected will include - organic nitrogen (tentative), protein, ammonia, nitrite, nitrate and pH; water temperatures will be recorded.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0675, A STUDY OF THE FACTORS DETERMINING THE OXYGEN UPTAKE OF BENTHAL STREAM DEPOSITS
J.F. HUNTER, Rutgers the State University, Graduate School *New Brunswick, New Jersey* 08903

The proposed research involves both a field and laboratory investigation into the factors that determine the oxygen uptake of benthal deposits. The field analyses will involve mud pH, O2 uptake (in situ), temperature, depth, extent or area and water temperature, pH, flow, velocity and depth. Samples of water will be obtained and returned to the laboratory for phosphate and nitrogen determinations, sample of mud for percent moisture, phosphates, particle size distribution, volatile solids, warburg BOD, organic carbon, organic nitrogen, COD, extractables, proteins, carbohydrates, DNA and humic acid.

The information obtained in this study would lead to a better understanding of the process of benthal decomposition, the effect of resuspension of such deposits on the stream and the nutrient reservoir represented by such deposits.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0676, DYNAMICS OF BIOCHEMICAL OXYGEN DEMAND
W. WHIPPLE, Rutgers the State University, Water Resources Research Inst., *New Brunswick, New Jersey* 08903

A quantitative evaluation of biochemical oxygen demand in the rivers of Northern New Jersey. Preliminary studies have indicated that the pollution in these rivers is much larger than can be accounted for by BOD of known effluents. Further research will be conducted into various aspects which might affect this relationship including sedimentation and scour, benthal effects, temperature variation of parameters, nitrogenous BOD, the reliability of 5-day BOD's, and the mathematical variation of carbonaceous BOD with time. Results obtained should be of scientific interest, and also important from planning viewpoints.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0677, GROUND AND SURFACE WATERS - POLLUTION
A.J. KAPLOVSKY, Princeton University, Agricultural Experiment Sta., *Princeton, New Jersey* 08540 (NJ00527)

OBJECTIVE: Development of analytical methods for detecting pesticides, herbicides and phenols in water; determine presence and morphological, cultural, physiological and chemical characteristics of populations of bacteria in polluted waters; environmental factors affecting bacterial pollution of well waters and stream self- purification; factors affecting efficiency of septic tank operations

APPROACH: Current analytical methods will be modified, tested and used in analyses of representative samples of potable waters. Model systems will be developed for laboratory studies of bacteria appearing in polluted water. Effectiveness of various diatomaceous materials for removing bacteria from polluted water will be evaluated in relation to flow. The relative rates of oxidation of organic particles of varying sizes will be determined. Septic tank efficiency work will relate effluent characteristics to soil characteristics.

PROGRESS: Runoff from crop raising areas was primary source of nutrients in sufficient concentration to cause eutrophication. Drainage from pastures contributed to nutrient level but significant source of pollution from area was coliforms. 'Straight-line' or linear estuary built in control temperature room which permits concentrating upon biological parameters of estuary. Will demonstrate the predictability of nitrification in estuarine waters. Simple, sensitive and rapid procedure was developed for separation and identification of extremely low concentrations of halogenated phenols in water. Procedure involves conversion of phenols into corresponding antipyryl or p-nitrophenyl azo derivatives. The rate and extent of oxygen uptakes of stream waters representing various land usages were determined. Role of nutrients, nitrification, and sedimentation under study. Data collected to determine whether or not photosynthetic reoxygenation can be predicted from knowledge of light intensity and such stream analyses as temperatures, color, turbidity, nutrient level and chlorophyl. Data under analysis and evaluation. Lab reaeration apparatus consisting of cylinders mixed in manner analogous to streams modified to contain river muds. Using Passaic River water no significant differences between measured and literature oxygen saturation values. Evaluation of effect of river contaminants on reoxygenation rate in progress.

SUPPORTED BY U.S. Dept. of Agriculture

2.0678, UPPER DELAWARE WASTE ASSIMILATIVE CAPACITY MODEL
P.K. MACEWEN, Delaware River Basin Comm., *Trenton, New Jersey*

The proposed work will be done in two phases: In Phase 1, the efforts would be concentrated on the fifty-mile reach of the Delaware River between Trenton and Phillipsburg. Measurements will be made of the following instream quality parameters: 1) dissolved oxygen; 2) temperature; 3) pH; 4) long-term BODs at selected stations; 5) suspended solids; 6) nitrogen series; 7) chlorophy 11 (A); and 8) soluble phosphate. In addition, measurements will be made of the same parameters of each of the major dischargers. Results of this preliminary field survey, together with historic information will be employed to develop a preliminary steady state mathematical model of DO in the Delaware River. It is anticipated that this preliminary work will be adequate to define the major factors which are influencing water quality within this stretch of the river. In addition, Phase 1 will more clearly define the sampling stations which will be needed under the Phase 11 field investigation.

Phase 11 would consist of an intensive sampling program coupled with the application and full verification of a time variable mathematical model. These models would be used to evaluate the assimilative capacity of the river, study increases in aquatic plant growth and, where needed, allocate receiving capacity to waste dischargers.

SUPPORTED BY Delaware River Basin Comm. - Washington

2.0679, SURVEY OF LAKE NO. 1, WINSLOW TRACT
R.W. STEWART, State Div. of Fish & Game, *Trenton, New Jersey* 08625

Objective: To monitor the development of the fish population and selected environmental factors for the purpose of establishing baselines upon which to consider management of Lake No. 1, Winslow Tract.

Procedure: Efforts during this project segment will be directed toward obtaining additional biological data on the present fish population and further development of procedural sampling techniques.

Information on species composition, abundance and reproductive success along with data necessary for the determination of growth rates and food habits will be collected during the

spring and/or summer by one or more of the following methods: a. Swingle seining techniques. b. Gill nets. c. Short-period simultaneous mark and recovery technique utilizing electro-fishing gear to capture fish. d. Any other method that shows promise. Routine water chemistry data will be collected as considered appropriate.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0680, TIME-OF-TRAVEL MEASUREMENTS IN NEW JERSEY STREAMS
E. DONSKY, U.S. Dept. of the Interior, Geological Survey, *Trenton, New Jersey* 08607

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of New Jersey and the Delaware River Basin Commission.

Purpose: To obtain more knowledge of the movement of materials introduced into river systems such as contaminants that are either water soluble or dispersed in a fine suspension.

Methods: Fluorescent dyes or similar materials will be used to accurately estimate the time required for a soluble contaminant to pass through finite lengths of the major stream systems in New Jersey.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0681, RECOVERY, SEPARATION AND IDENTIFICATION OF PHENOLIC COMPOUNDS, NEW JERSEY
S.D. FAUST, U.S. Dept. of the Interior, Geological Survey, *Trenton, New Jersey* 08607

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of New Jersey.

Purpose: To investigate the recovery, separation, and identification of phenolic compounds from streams.

Methods: Samples were collected from streams where significant 'total' phenolic compound concentrations have been observed previously. Solvent extraction and/or steam distillation techniques will be employed to recover the phenolic compounds from the water samples. Gas-liquid and thin-layer chromatography, and ultraviolet, visible, and infrared spectrophotometric techniques will be employed for separation and identification.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0682, TIDAL DISCHARGE RESEARCH, NEW JERSEY
A.C. LENDO, U.S. Dept. of the Interior, Geological Survey, *Trenton, New Jersey* 08607

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of New Jersey, the Corps of Engineers, and the Federal Water Pollution Control Administration.

Purpose: To develop and improve techniques for the collection of tidal stage, discharge, quality of water, and sediment data.

Methods: Synchronous records of tidal stage have been collected by digital recorders at estuary stations, computer programs are used to compile these records. Discharge equations have also been programmed and calibration has been based on observed discharge by diographs and other parameters by field measurement. Suspended-sediment, particle- size, and other water-quality information is collected during discharge calibration measurements to define changes during tidal cycles.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0683, SOILS, PESTICIDES AND THE QUALITY OF WATER
H.E. DREGNE, New Mexico State University, Agricultural Experiment Sta., *Las Cruces, New Mexico* 88070 (NM00149)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to pesticide transport through the soil in infiltrating water, and pesticide desorption from eroded soil into surface waters. Develop mathematical model(s) which will provide semiquantitative prediction of pesticide movement in soil-water systems based on input data obtained in objective above. Measure pesticide transport through and over soil in the field or in lysimeters, using well characterized initial and boundary conditions.

APPROACH: Determine adsorption, desorption, and movement of 3 herbicides (2,4-D, 2,4,5-T, and picloram) in soils, using laboratory columns, soil thin-layer plates, bioassay, radiotracers, and large greenhouse lysimeters.

PROGRESS: 2,4-D is capable of persisting for months in a water- logged soil. Approximately 40 percent of the 2,4-D applied to the surface of a slowly permeable (0.3 ml/hour) silty clay loam was recovered in the leachate after continuous leaching over a period of ten months. Bioassay tests of the soil after leaching showed that 2,4-D remained in the soil at phytotoxic levels, using cucumbers as the test plant. Single factor correlation between 2,4-D movement and soil organic matter level, clay content, carbonate content, and pH was poor in six soils from New Mexico that were tested by soil thin-layer chromatography. The importance of any one soil factors tends to be obscured when other factors vary simultaneously or at random. Preliminary tests on soil thin-layer plates indicated that relative solubility of 2,4-D and 2,4,5-T is a good predictor of their movement. It should also be a good indicator of absorption and desorption by soils.

SUPPORTED BY U.S. Dept. of Agriculture

2.0684, BIOASSAYS OF QUALITY IN WATER RESOURCES OF MAJOR IMPORTANCE TO NEW MEXICO
G.S. SMITH, New Mexico State University, School of Agriculture, *Las Cruces, New Mexico* 88001

Samples of water will be collected seasonally from resources of major importance and assayed for quality in terms of usage by animals and humans. Bioassays will involve study of effects upon pregnant female mice and their offspring when samples serve as the sole source of drinking water. Number, size, mortality and other features of offspring in litters will be scored quantitatively as well as growth rates for offspring from birth to weaning. Samples will be assayed also in terms of effects upon rumen microorganisms cultured in vitro, using urea nitrogen utilization and cellulose degradation as primary criteria. Conventional analyses for chemical constituents and coliform counts will be employed, as well as gas chromatography to measure organic components in samples. All data will be programmed and analyzed by computer for interclass correlations and multiple regressions to identify and quantitate effects of individual components and significant interactions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0685, INVESTIGATION OF THE THERMAL PATTERNS IN THE VICINITY OF THE CRYSTAL RIVER
R.C. ZIEGLER, Cornell Aeronautical Lab. Inc., *Buffalo, New York* 14221

The objective of this program is to collect surface temperature data for the Gulf of Mexico in the vicinity of Crystal River, Florida, which will be used as a basis for predicting the thermal pollution of water areas influenced by the cooling water discharge of a nuclear power plant. The surface temperature data will be collected using CAL'S Piper Aztec Aircraft equipped with a Barnes PRT-5 radiation thermometer (radiometer) and a camera system. The axis of the cameras and the radiometer are aligned so that the photographs, which are taken simultaneously with the radiometric data, can be used to locate the positions of the temperature data points. Two surveys, each consisting of about four flights, will be conducted. Maps containing contours of equal surface temperature will be prepared. The program was initiated April 4, 1969 and is scheduled for completion by October 1, 1969.

SUPPORTED BY Florida Power Corporation

2.0686, EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS
S. AARONSON, City University of New York, School of Liberal Arts, *Flushing, New York* 11367

2. WATER QUALITY

The secretion by algae of large quantities of cellular metabolites into the environment will be examined. Two principal methods will be employed to evaluate the accumulation of metabolites and secretory ability: (1) The olive-green chrysomonad, 'Ochromonas danica', will serve as a model organism for determining the conditions of growth and stress which lead to the accumulation of micromolecules (amino acids, nucleic acid constituents, sugars, etc.), macromolecules (proteins, polysaccharides, enzymes, RNA, DNA), and membranous vesicles and (2) Inhibitory concentrations of metabolite analogs will be used to select (a) for algae which can synthesize large quantities of target metabolite and (b) against specific algal groups.

SUPPORTED BY U.S. National Science Foundation

2.0687, TAXONOMY AND ECOLOGY OF AQUATIC PLANTS, FIELD AND CULTURE STUDIES
H.S. FOREST, State University of New York, Graduate School, *Geneseo, New York* 14454

These activities continue with some changes in emphasis: 1) Reference herbaria of aquatic angiosperms and algae, 2) Taxonomic review of aquatic plants (emphasis on Western New York), 3) Studies on environment of Conesus Lake with particular view to its value as a model for problems in phosphate fertilization of lakes, 4) Identification and reclassification of algae in principal culture collections of world, 5) Projector slide library for identification of algal species (expansion and availability as professional resource), and 6) Training in aquatic plant taxonomy and ecology.

During 1969-70 a land utilization study for the Conesus Basin was completed. This includes some comparison of on-ground information with that retrieved from the photograph-computer system maintained at Cornell University. Lake studies were intensified around the mouth of Wilkins Creek, bearing municipal sewage effluent with the objective of obtaining base data for the condition of the area before removal of the effluent to a treatment plant (1972?). Activity was extended to Canandaigua Lake for preliminary assessment of the effect of effluent from a proposed high-density development near the mouth of Seneca Creek, and during the summer of 1970 a study of two input streams, Naples Creek and West River, will be conducted to provide further information on their condition and their probable effect on the quality of water in the lake.

Cooperative studies were initiated on bottom sediments of Conesus Lake by members of the Earth Sciences Department of the College.

The majority of the studies will be conducted in the Geneseo, New York vicinity. The project began Jan. 1968 and will conclude June 30, 1971.

SUPPORTED BY New York State Government - Albany

2.0688, FEASIBILITY OF A MOBILE SUBMERSIBLE FOR USE IN CONTROL, MANAGEMENT, STUDY OF NATURAL PROCESSES, PROTECTION & CONSERVATION OF INLAND WATERS
E.T. CRANCH, Cornell University, School of Engineering, *Ithaca, New York* 14850

The proposed research project is directed toward determining the feasibility and design criteria for a mobile submersible vehicle so instrumented that it could perform the function of gathering the data base information for the following wide range of water resource needs: conservation, pollution (including thermal), limnology, ecology, natural cyclic processes, construction, control and management. Such a submersible would greatly enhance the full three-dimensional exploration of lakes and offshore ocean environments including the water-sediment interface. Contemplated is a mobile submersible which could be moved by truck from site to site.

The research project will involve determining the structural and instrumentation requirements for such a vessel and these requirements will be incorporated in an overall systems plan. The feasibility of such a submersible will be established and especially difficult constraints or knowledge gaps will be identified.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0689, FINITE ELEMENT APPROACH TO THE POLLUTION ANALYSIS OF LAKES
J.A. LIGGETT, Cornell University, School of Engineering, *Ithaca, New York* 14850

This research will apply the finite element techniques to the solution of problems related to the dynamics of lakes. The results will be applicable in particular to various pollution problems such as thermal effects and the transport and diffusion of particulate matter. In particular the research will include: 1. Integral relationships for formulation of the finite element representation of the fluid-thermal lake flow problem. 2. Transformation of the integral relationships derived in the initial step into algebraic representations for isoparametric, three dimensional elements. 3. Performance of analyses of component problems in one or two-dimensional heat transfer or fluid flow order to verify the accuracy of the solution. 4. Definition and solution of simplified one-, two, and three-dimensional lake problems which have been studied previously. 5. Definition of a plan of implementation of a full scale, highly realistic model based upon the prospective use of massive general purpose computer programs.

SUPPORTED BY U.S. National Science Foundation

2.0690, A STUDY OF THE NUTRIENT INPUTS INTO CAYUGA LAKE AND SENECA LAKE
G.E. LIKENS, Cornell University, School of Biological Sciences, *Ithaca, New York* 14850

The quantitative input of various cations and anions to Cayuga Lake and Seneca Lake will be determined from routine analysis of precipitation and tributary streams. The effects of varying watershed utilization on nutrient inputs to these lakes will be evaluated. The study will provide basic data on the interrelationships between a lake and its watershed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0691, MICROBIAL FORMATION OF POTENTIALLY HAZARDOUS ORGANO-METAL COMPOUNDS IN WATER
M. ALEXANDER, State University of New York, School of Agriculture, *Ithaca, New York* 14850

The research is designed to determine what organo-metal compounds are biologically formed in water, establish conditions for their formation and identify microorganisms responsible for the conversion. Metallic and carbonaceous compounds will be added to model aquatic ecosystems to assess the possible microbial reactions. Individual microorganisms capable of forming organo-metal compounds will be isolated, and the pathway of biosynthesis will be characterized by using these isolates. The compounds produced will be characterized by gas and thin-layer chromatography, and mass spectrometry. Particular interest will be placed on the methylation of mercury, selenium, cadmium and arsenic. The possible use of chelates as sources of metals involved in methylation reactions will also be investigated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0692, MINERALIZATION OF ORGANIC PHOSPHORUS IN OLIGOTROPHIC LAKE SEDIMENTS
D.A. WEBSTER, State University of New York, School of Agriculture, *Ithaca, New York* 14850

The availability of sediment phosphorus in a shallow, oligotrophic lake will be increased by altering the mechanisms of inorganic phosphate fixation and stimulating microbial mineralization of organic phosphorus. These changes will be effected by raising the pH and base saturation of the sediments through lime application.

The proposed research plan will attempt to evaluate the effects of liming on the organic phosphorus in the sediments. Specifically, the following information will be sought: 1. The total organic phosphorus content of the sediments. 2. The specific organic phosphorus compounds present, as determined by chemical

fractionation, chromatography, and enzyme assay. 3. The origin and stability of these compounds in the sediments. 4. The solubility and hence, availability of these compounds as substrates for enzyme reactions. The effect of pH, calcium, iron, and aluminum are specific factors involved. 5. A comparison of rates of hydrolysis, before and after treatment. 6. An evaluation of the significance of the organic phosphates and their products to the phosphate metabolism of the lake.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0693, MODELING THE FUNCTIONAL RELATIONSHIPS WITHIN SALT MARSH EPIPHYTIC COMMUNITIES
J.J. LEE, City University of New York, School of Liberal Arts, *New York, New York* 10031

This study involves the development of mathematical models of microcosms which can be used as tools for judging water quality in inshore salt-marsh environments in the Greater New York City area. These mathematical models are based upon data previously obtained from ecological studies of marsh communities, and will include populations ranging from microbes through birds, finfish, and shellfish. The data obtained will permit the definition of environmental variables which regulate community structure and succession. In many of these marsh communities these variables include domestic sewage, industrial waste, hydrocarbon pollution from airplanes and boats. Such data when converted to use in mathematical models can be used to predict changes in community structure which will result from various forms of pollution. Such information is essential in the study of significant environmental problems which loom larger each year and which require decisions with respect to the utilization and management of salt marshes near metropolitan areas.

SUPPORTED BY U.S. National Science Foundation

2.0694, STUDIES OF APPLICATIONS OF RADIOISOTOPES FOR ESTUARY POLLUTION CONTROL
M.D. DISKO, Quirk Lawler & Matusky Engrs., *New York, New York* 10017 (AT(30-1)-4120)

Dissolved oxygen concentration is used as a principal index of organic waste pollution in a waterway. The important source of replenishment of dissolved oxygen is the reaeration or transfer of atmospheric oxygen into the waterway. Basic studies in the pollution control field have resulted in a fundamental relationship for reaeration prediction in non-tidal rivers. In estuaries and tidal rivers, the reaeration transfer is calculated by the difference in a material balance. Practical problems of measurement of flow, dispersion, biochemical reactions, etc., place the validity of the calculated estuarine reaeration in considerable doubt.

Investigations by the United States Public Health Service (Tsivoglou) have resulted in a technique for in-situ measurement of reaeration using krypton and tritium. However, additional work must be performed to adapt the Tsivoglou technique to tidal rivers and estuaries. A prime objective of the project is the development and demonstration of equipment and techniques for direct measurement of reaeration, using radioisotopes, in tidal rivers and estuaries. Data obtained for various tidal and meteorological conditions will be used in the development of an analytical expression to predict oxygen transfer in tidal rivers and estuaries.

SUPPORTED BY U.S. Atomic Energy Commission

2.0695, RIVER ESTUARY POLLUTION CONTROL STUDIES WITH RADIOISOTOPES
J.P. LAWLER, Quirk Lawler & Matusky Engrs., *New York, New York* 10017

The project is to develop and apply radioisotope methodology in river/estuary pollution control studies. Specific efforts are being made to develop routine methods for (1) longitudinal dispersion (2) reaeration and (3) flow attenuation measurements. For the dispersion and flow attenuation studies, the radioisotope technique will be specifically compared with dyes. However, radioisotopes provide the only means for direct determination of reaeration. For reaeration, several of the radioactive rare gases will be studied in combination with Tritium.

SUPPORTED BY U.S. Atomic Energy Commission

2.0696, ENTEROVIRUSES IN DEPURATED HARD CLAMS, 'MERCENARIA MERCENARIA'
G. STROBEL, State Div. of Fish & Game, *Oakdale, New York* 11779

The purpose of this phase is: 1) To survey hard clams from moderately polluted waters of Long Island for enteroviruses (Polio Types I, II, and III; Coxsackie B Types; ECHO). 2) To observe release rate of enteroviruses in hard clams during the depuration process, and thus obtain information on the efficacy of the process for virus removal.

Samples will be collected from the Depuration Plant, West Sayville, New York and examined for the presence of viruses in the Department of Biology, State University of New York at Stoney Brook, New York.

Hard clam samples will be homogenized and rendered bacteriologically sterile with antibiotics and high speed centrifugation. Viruses will be detected using an indicator system of commercially purchased Rhesus monkey kidney monolayer cell culture tubes. Inoculated tubes will be observed during 10-14 days incubation for viral cytopathogenic effects.

Release data will be evaluated in conjunction with the bacterial studies to determine if any correlation exists between the bacterial release rates and the viral release rates.

Work will commence immediately and continue for the duration of the project.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0697, MONITORING WATER EFFLUENTS FROM A NUCLEAR POWER PLANT
E.E. CHERMACK, State University of New York, Graduate School, *Oswego, New York* 13126

A study of the thermal characteristics of the waters of Lake Ontario near East Nine Mile Point (Mexico Bay) be undertaken in order to detect the distribution of heated effluent from a nuclear power plant in the area. The degree of change in the thermal structure of the lake in the Nine Mile Point area will help determine the extent to which such a heated effluent need be considered as a serious meteorological or ecological factor. An extensive measurement program, including both surface temperature and temperature profiles before and after plant operations are started is suggested.

This project is being carried on under the auspices of the Lake Ontario Environmental Laboratory (LOTEL) of the State University of New York, College at Oswego.

SUPPORTED BY State University of New York - Albany

2.0698, GEOCHEMICAL STUDIES OF CONTINENTAL WATERS
W.S. BROECKER, Columbia University, Lamont Doherty Geolog. Observ., *Palisades, New York* 10964 (AT(30-1)-2493)

The research carried out under this contract is aimed at understanding interactions of sediment, water and atmosphere. The major categories of research include: (a) gas exchange studies to understand mechanisms of air-water interactions, and the role that pollution may play in affecting exchange; (b) geochemical cycles in closed basin lakes, which will aid in understanding how processes of sedimentation affect the chemistry of the remaining waters; (c) chemical processes in weathering and soil development, to better understand the origin of detrital minerals, and factors affecting the chemical nature of soils; (d) thermodynamics and kinetics of low temperature processes. Development of theoretical models to explain phenomena observed in the various studies mentioned above.

Chemical tools used in these studies include measurement of H,C, and O isotopes, radioactive nuclides C-14, H-3, Sr-90, Cs-137, Rn-222, and U and Th daughter products, measurement of concentrations and activities of major and trace elements and of gases (pCO_2, pO_2, etc.) as well as pH and Eh of the solutions, and mineralogical determinations of the sediments.

2. WATER QUALITY

SUPPORTED BY U.S. Atomic Energy Commission

2.0699, GEOCHEMICAL OCEAN PROGRAM - CAPITAL EQUIPMENT FOR ANALYTICAL WORK AT SEA AND AT LAMONT

W.S. BROECKER, Columbia University, Lamont Doherty Geolog. Observ., *Palisades, New York* 10964

Considering the ocean as a source of food, a disposal area for nuclear and industrial waste products, and a controlling factor in the earth's climatic regime, our ultimate use of the sea is critically dependent on a detailed understanding of processes presently understood in only the vaguest and most qualitative way. These are the stirring and mixing processes in the deep sea, the interchange of material between deep and surface water, the variation of organic productivity throughout the ocean, and the exchange of water and gases with the atmosphere. The GEOSECS program will measure in detail the oceanic constituents along Arctic to Antarctic sections at all depths, to provide, for the first time, a set of physical and chemical parameters measured on the same water samples. These data will provide the input for quantitative studies of oceanic mixing and organic productivity, and, at the same time, serve as a baseline for the levels of pollutants and of fission and waste products being added to the sea. The Lamont- Doherty group will develop procedures and equipment for collection and analysis of near surface and near bottom samples for 'in situ' radon content, as well as Ra226 content of the 100 liter samples returned to laboratories, mass spectrometric procedures to measure barium content, a shipboard extraction and shore analysis system for Ra228 and Ra226 in these same samples; they will construct infrared analyzers and equilibrators for shipboard CO2 partial pressure analysis, two CO2 gas chromatographs to measure CO2 content of returned samples, develop the extraction systems for C14 and Cs137; they will develop deck handling of large-volume samples and perfect large-volume sampling bags.

SUPPORTED BY U.S. National Science Foundation

2.0700, ECOLOGY OF YEASTS IN LAKE CHAMPLAIN

W.L. COOK, State University of New York, Graduate School, *Plattsburgh, New York* 12901

The yeast population of Lake Champlain has never been determined. This makes it imperative that the normal yeast population be determined before pollution, which usually follows increasing human utilization, changes the environment. Yeasts could possibly be used as indicators of pollution.

Beginning February 1968, monthly water samples are being taken from two selected sites in Lake Champlain. Yeasts are collected with Cobet Sterile Water Samplers, concentrated with a Millipore filter, isolated and identified by standard biochemical and morphological means. The water samples are further analyzed for temperature, oxygen, carbon dioxide, alkalinity, pH and conductivity.

SUPPORTED BY State University of New York - Albany

2.0701, A LIMNOLOGICAL INVESTIGATION OF IRONDEQUOIT BAY, ROCHESTER, NEW YORK

W.H. DIMENT, Univ. of Rochester, School of Arts, *Rochester, New York* 14627

This project consists of a series of measurements to determine the characteristics of Irondequoit Bay, New York. The Bay presently serves as the prime water resource of Monroe County and recieves a significant nutrient load from the Rochester City sewage system. A sewage interceptor system is to be completed in approximately two years which will divert much of this nutrient from the Bay and should result in reducing its eutrophication. This study will provide a body of information on the Bay prior to the proposed changes.

Physical, chemical and biological measurements will be made, including analyses of all major ions and some of the more significant minor elements. The phytoplankton and microorganism populations in the Bay will be identified and geochemistry of the sediments of the Bay will be examined.

SUPPORTED BY U.S. National Science Foundation

2.0702, COMPOSITION OF RESIDUES FROM PULP BLEACHING TREATMENTS

C.W. DENCE, State University of New York, School of Forestry, *Syracuse, New York* 12224

The spent liquors from kraft chlorination and alkali extraction pulp bleaching sequences are to be examined by various chemical and physical means to determine the structure and composition of the modified liqnin residues contained therein. Special emphasis will be placed on establishing the presence or absence of o-quinone intermediates in the chlorinated pulps and in the chlorination spent liquors. This phase of study will be prefaced by a detailed study of the reactions lignin- like (model) compounds with chlorine in which attempts will be made to isolate and characterized the anticipated o- quinone intermediates. Attempts also will be made to characterize the products arising from reactions of the (proposed) o-quinone intermediates and other substances likely to be present in the bleaching system. Finally the reactivity of chlorolignin toward alkali will be examined to gain an insight into the structure of the resulting residues particularly insofar as the location of the chlorine substituents on the chlorolignin molecule is concerned.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0703, DIATOM POPULATIONS CHANGES IN LAKE GEORGE - PHASE III

N.L. CLESCERI, Rensselaer Polytechnic Inst., School of Engineering, *Troy, New York* 12181 (C-2209)

This work is designed to characterize and measure the diatom populations in the plankton and periphyton over a three year period at various depths and locations in Lake George. These biological measurements are being combined with water quality measurements at the same depths and locations to identify the causative factors for the biological changes taking place and to obtain base line data to aid in the development of an ecosystem model for the lake.

The last phase of the program (Phase III) will include enumeration and characterization of the periphyton and plankton diatoms in regions of the lake affected by nutrient input, analysis of recent sediments in these regions, and measurement of periphyton diatom reproduction rates under different environmental conditions, but will be mainly concerned with the mathematical analysis and interpretation of the data from all three phases of the program and the formulation of a diatom growth model of general applicability to northern oligotrophic-mesotrophic lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0704, ORGANIC NUTRIENT FACTORS AFFECTING ALGAL GROWTH

N.L. CLESCERI, Rensselaer Polytechnic Inst., School of Engineering, *Troy, New York* 12181

The main purpose of the study is to ascertain and identify those organic compounds extant in treated secondary wastewater effluents which have an effect on algal growth.

The methodology for fractionation of wastewater chemicals by gel permeation chromatography has been developed in the first year of the project. The effect of wastewater fractions on algal growth is being studied.

The test organisms being considered are 'Selenastrum capricornutum', 'Microcystis aeruginosa', and 'Anabaena flos-aquae'. The medium for growth of algae and the method for the inoculation of these cultures will be as per the Provisional Algal Assay Procedure (1969).

The response of the test organisms to various wastewater fractions will be measured by: 1) Photosynthetic rate as a function of C14 uptake using a modification of the Goldman method. 2) Measuring growth by gravimetric or counting or nephelometric measurements.

Statistical experiment design will also be employed so as to test the synergistic effect, if any, of varying combinations of fractions.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0705, ACCUMULATION OF RADIOACTIVITY BY ORGANISMS IN EXPERIMENTAL MARINE ENVIRONMENTS
T.W. DUKE, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Beaufort, North Carolina* 28516

The ultimate purpose of laboratory experiments on the uptake, accumulation, and retention of radionuclides from sea water by marine organisms is to collect sufficient data to be able to anticipate the dangers from any intentional or accidental pollution of an estuary or the oceans. To have some assurance that predictions concluded from results of laboratory experiments will be valid, it is necessary that laboratory data be compared with data collected as nearly as possible under field conditions. This, it is believed, can be accomplished by comparing laboratory findings with results obtained on the accumulation of radionuclides by communities of organisms held in large tanks or in ponds.

Research activities include experimentation in the laboratory and in the field. Laboratory experiments are being conducted with communities of marine organisms maintained in large tanks (1000-liter capacity) and exposed to flowing sea water containing various radionuclides including zinc-65, iron-59, iodine-131 and cesium-137. Also, a marine community composed of oysters, clams, fish, snails, crabs, algae, and marsh grass was placed in a shallow salt water pond and exposed to zinc-65 and chromium-51. Organisms, sediments, and water are being removed periodically, their radioactive content measured, and then returned to the pond. Upon completion, samples will be analyzed for total element so that the specific activity of the components in the pond can be determined. Data obtained in such experiments also will be useful in determining the trace metal requirements of various marine organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

2.0706, NATURE OF EXOTIC SUBSTANCES IN SURFACE WATERS AND IMPLICATIONS AS WATER SUPPLY CONTAMINANTS
C.M. WEISS, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

The presence of exotic organic and inorganic material in surface waters, that might be used as water supplies, will be determined by the use of macro-invertebrates and periphyton as bioconcentrators. These will be collected on standard substrate collectors. The main stream of the Haw and New Hope Rivers will be compared with non-polluted tributaries using the substrate collectors as well as, for comparison, processing batch samples of water by freeze concentration cascades. Through suitable analytical procedures following sample clean up, flame ionization and electron capture detectors on gas chromatographs and atomic absorption spectrophotometry, a qualitative and quantitative assessment will be made to establish whether the presence of detected

$ substances might countervene the use of these waters as a water supply when impounded as New Hope Lake. A monthly sampling frequency for the collectors and bi-monthly for the water samples will establish seasonal patterns that may be related to agricultural activities. This project will be initiated in FY 72 with establishment of validity of procedures by FY 73.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0707, DEVELOPMENT OF PROVISIONAL ALGAL ASSAY PROCEDURE
C.M. WEISS, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

The general objective is to evaluate the two techniques, batch and continuous-flow, for assaying the algae growth-nutrient concentration relationships in natural and enriched waters. To accomplish the general objective, specific objectives will be: 1. To compare the growth response of selected algae in batch and chemostat growth units as to sensitivity to concentrations of the presumed limiting nutrients (at least N and P). 2. To evaluate the growth response of selected algae in batch and chemostat growth units in accordance with current theoretical concepts describing algal growth. 3. To make a statistical evaluation of growth kinetic constants calculated from data obtained from both batch and chemostat growth units. This will allow conclusions to be made as to whether the two procedures yield comparable or significantly different results. The growth contants, K sub s (saturation coefficient), mu (maximum specific growth rate), and Y (yield coefficient) are considered most significant and sensitive and those constants will be evaluated statistically first, and possibly other parameters. 4. To determine the most accurate technique for cell mass determinations.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0708, OPERATE A NETWORK FOR THE COLLECTION OF PRECIPITATION
M. GEOGEVICH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Provide a network for the collection of precipitation from selected sites within the U.S. These samples can be used to determine various chemical species contained therein in order to provide information on wash-out and soil entrainment.

Approach: Precipitation is collected with automated samplers at selected sites. Six of these sites also double as part of the WMO international precipitation network.

Goal: Samples will be collected from 16 sites and submitted to the laboratory on a two week schedule as applicable.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

2.0709, THE RELATION OF ESTUARINE ALGAE TO WATER QUALITY
V.J. BELLIS, East Carolina University, Graduate School, *Greenville, North Carolina* 27835

To describe spatial and temporal patterns of distribution among algae of the Pamlico River Estuary. This project will explore the computer multifactor analysis of phytoplankton data collected by the Pamlico Marine Laboratory of North Carolina State University (Project B- 004-NC). Project includes assembly of data, preparation of data matrix, analysis of data deck, clustering and interpretation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0710, CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER
T. ITO, East Carolina University, School of Arts, *Greenville, North Carolina* 27834

The objective of this research is to try to develop a more adequate than presently available method to extract and concentrate pesticides from a large mass of natural water.

Reversed-phase partition column chromatography is the method of choice to determine what specific requirements are to be satisfied to accomplish such objective.

Suitability of various types of solid supports and stationary phases will be examined to find the best condition. 'Anchored' stationary phases, which are covalently bonded to solid supports, will be prepared to determine their suitability for extraction and concentration of pesticides from a large mass of water.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0711, BIOLOGICAL MONITORING.
R.L. HOGAN, State Wildlife Resources Comm., *Raleigh, North Carolina* 27602

The initial approach towards the ultimate objective of biological monitoring will be to determine the structuring and size of small shelters that prove most attractive to resident macrobenthos and from which the organisms can be most easily recovered.

During fiscal year 1971, it is proposed to test the comparative attractivity to macrobenthos of easily dismantled cubes of masonite laminea (following the precedent of Hester and Dendy, 1962), similar cubes constructed of the plastic 'spawning matrix'

developed by the Minnesota Mining and Manufacturing Company, and cubes of other material as may be found suitable. Cubes of each type will be both suspended near the surface and anchored near the bottom at selected locations. Cubes of each type will be retrieved at intervals, dismantled, and the inhabitants recovered for both quantitative measurement and toxonomic identification to the degree necessary to permit direct comparisons of the attractivity of the matrices. Once comparative preference between matrices is established, the next exploration will concern the optimum size and location for the shelters. Initially, the comparative tests will be conducted in a small, acid-water lake, a major Piedmont River and a major Coastal river which seasonally receives intermittent pollution with stored pulp-mill wastes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0712, EXPLORATORY STUDY OF LIMITATIONS OF BOD FOR ANIMAL WASTE EVALUATION
F.J. HUMENIK, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

Although the Biochemical Oxygen Demand (BOD) test is probably the most widely employed analysis for the measurement of organic pollution in terms of oxygen demand waste effluents will have upon receiving waters, it is readily acknowledged that this bio-assay is subjected to many interferences and errors. In particular, BOD values for many animal wastes are extremely variable and correspondingly misleading.

The purpose of this research is to explore the influence of dilution, toxic metals (feed additives) and antibiotics upon the BOD of effluent from animal waste lagoons. The concentrations of antibiotics in swine waste and lagoon effluent samples will be found by biological assay. The presence and concentration of toxic metals will be determined by an atomic absorption spectrophotometer. The Total Organic Carbon (TOC) and Chemical Oxygen Demand (COD) tests will be conducted on the lagoon effluent. Relationships will be developed to relate effluent temperature, antibiotic concentration, toxic metals, COD, TOC and sample dilution with the resulting BOD.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0713, ADVANCED STUDY OF COASTAL ZONE OCEANOGRAPHIC REQUIREMENTS FOR EARTH RESOURCES TECHNOLOGY SATELLITE
D.A. ADAMS, Coastal Zone Resources Corp., *Wilmington, North Carolina* 28401

Coastal Zone Resources Corporation as a subcontractor to Ocean Data Systems, Inc., is responsible for identification of significant coastal zone problems and related information needs in the areas of fisheries, transportation, pollution, and coastal oceanic phenomena.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0714, AUTOMATED FORECAST PROCEDURES FOR RIVER QUALITY MANAGEMENT
R.J. BOES, Ohio Riv. Val. Wat. San. Comm., *Cincinnati, Ohio* 45202

Data from 13 electronic water quality monitors along a 168-mile section of the Ohio River will be transmitted hourly to a central receiving station at ORSANCO headquarters. This data together with river flow forecasts and water-quality and waste-load information from municipal and industrial water users will be used to verify a 'dynamic' mathematical model of the segment of the river under study.

The project objectives are: (1) Continuous evaluation of the influence of wastewater discharges, storm water runoff, tributary flow and other factors on quality conditions in a river system; (2) Verification of a dynamic mathematical model relating the effects of runoff and wastewater discharges to resulting river quality conditions; (3) Continuous forecasts of river-quality changes at selected river locations; (4) Application of findings to water-quality control and water resources management.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0715, WATERBORNE DISEASE ETIOLOGY
S.L. CHANG, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Cincinnati, Ohio*

Objective of the project is to develop an understanding of etiological agents of waterborne disease, their source, survival and pathogenicity. Techniques of isolating pathogens from water are developed. Persistence and factors affecting survival are studied. Infective doses are determined.

A new aspect of the research is to develop methodology for use in studying the epidemiology of meningoencephalitis caused by the free- living amoeba 'Naegleria gruberi', which occurred in clusters in 4 geographic areas - Orlando, Florida; Richmond, Virginia; South Australia, and Czechoslovakia - associated with swimming in warm lakes, estuary, and indoor swimming pool. This free-living amoeba is frequently found in large numbers in sewage effluent, in polluted surface waters, in well water, and was isolated twice in outdoor swimming pools in the Cincinnati area. Hence, it is important to ascertain factors such as: Do there exist pathogenic and nonpathogenic strains? Is the brain invasion a complication of asymptomatic infection (carrier) of the nasopharyngeal region? Is there a critical density of this amoeba in water, above which infections among swimmers are more likely to occur? How to ascertain the pathogenecity status of the 'N. gruberi' strains isolated from water? Is pathogenecity of 'N. gruberi' associated with cytopathic effect on cell cultures, with growth characteristics, and fluorescent antibody pattern? The present project is to develop methods that can be used to identify these factors.

Project was started in January 1968 and will continue.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0716, IDENTIFICATION OF INDICATOR ORGANISMS FOR EVALUATION OF WATER QUALITY
E.E. GEIDREICH, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Cincinnati, Ohio* 45213

The long-range goals of this project are to develop a firm ratio between the various non-pathogenic indicator organism systems and enteric pathogens so that potential health hazards can be accurately predicted from an evaluation of the concentrations of indicator organisms. The relationship between total coliform organism density and enteric pathogen concentrations is not well-known. Because this is true, water quality evaluations by the total coliform method may be unduly restrictive. By expanding the number of indicator organisms from total coliform alone to total coliform plus fecal coliform plus fecal streptococci, and relating concentrations of these indicator organism systems to enteric pathogen content of a given water, which can be measured by newly improved techniques for enteric pathogens, a reliable ratio can be developed between indicators and pathogens. Besides widening the number of indicators available for evaluation of water quality, this project has improved the indicator organism test so that it may be carried out within one 8-hour working day. This will facilitate rapid evaluation of the potential health hazards in water used for drinking and/or recreational purposes. This project also has developed a sampling and evaluation technique for determining the enteric pathogen content of bottom muds. This project started in July 1967 and is continuing.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0717, TOXICOLOGICAL INVESTIGATIONS OF ORGANICS FOUND IN WATER SUPPLIES
R.G. TARDIFF, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Cincinnati, Ohio*

Objective of the project is to provide a toxicological base for water quality standards and water supply practices. The organic chemicals found in or proposed to be used in drinking water are subjected to toxicological testing. Recovery techniques for contaminants must be developed to provide material for animal testing. Project was started in April 1968 and will continue with minimal support.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0718, DISSOLVED INORGANIC REMOVAL BIOASSAY OF ALGAL GROWTH POTENTIAL
W.H. IRWIN, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

A major objective of some treatment processes of wastewater is to so reduce the concentration of nitrogen and phosphorus that the medium will no longer support a luxuriant growth of algae. While it is generally thought that phosphorus is the ion that limits growth, there is evidence that other, but unknown ions or compounds may be limiting as well. It is the objective of this study to develop an empirical but standardized biological assay to determine whether an effluent has been sufficiently treated to limit the growth of algae. The approach to the development of bioassay will consist of culturing various algae species in purified cultures under controlled physical and biochemical conditions. Rate of growth and total population will be monitored by light-scattering techniques. Growth comparisons will be made of algae in the presence of 1) untreated water, 2) water treated by a tertiary process, 3) water intended to receive the effluent and, 4) various mixtures of treated and stream water. The project will consist of three distinct phases: 1) development of laboratory procedure, 2) evaluation of test under field practical usefulness and, 3) demonstration of the wide and general applicability of the test.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0719, CORRELATIONS OF BACTERIAL PATHOGEN OCCURRENCES IN WATER WITH FECAL COLIFORM DENSITY LIMITS PROPOSED FOR WATER QUALITY STANDARDS
E.E. GELDREICH, U.S. Environ. Protection Agcy., Division of Water Hygiene, *Cincinnati, Ohio* 45213

Research activities are to be directed toward the occurrence and persistence of water-borne pathogens in recreational waters of varying quality and the subsequent correlation of their frequency of occurrence with varying levels of fecal coliforms per 100 ml. This goal will necessitate development, evaluation and field test of methods for the detection and enumeration of Salmonella, Shigella, enteropathogenic E. coli, and Leptospira in polluted water. Attention is currently being directed to an investigation of the prevalence and persistence of enteropathogenic E. coli (EEC) in water. This information is necessary to evaluate the hazard involved in a wide range of natural waters representing a broad spectrum of pollution intensity.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0720, URBAN RUNOFF CHARACTERISTICS
L.M. LAUSHEY, Univ. of Cincinnati, School of Engineering, *Cincinnati, Ohio* 45221

The objective of this project is to establish a reliable methodology for the control of the magnitude, frequency, and quality of combined sewer runoff from urban watersheds. Extensive data are currently being collected from a typical urban watershed in Cincinnati, Ohio, and will be used for the verification of a mathematical model which is being basically developed by others under FWPCA. It is intended that the University of Cincinnati will verify and improve the basic mathematical model as field data become available so that it can be applied for practical usage.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0721, A SYSTEMS ANALYSIS OF THE WESTERN BASIN OF LAKE ERIE
G.P. HANNA, Ohio State University, Water Resources Center, *Columbus, Ohio* 43210

The purpose of the research is to conduct a systems analysis of the Western Basin of Lake Erie and adjacent areas that will combine on-shore economic relationships with in-lake ecological relationships. The connections are viewed in both directions. Pollutants generated by economic growth in the drainage area of the Western Basin have given rise to biological phenomena in the lake. Pollutant controls, intended to improve water quality, will impose costs on the economic community. The system that this research proposes to develop will be designed to measure the effects of abatement costs, imposed in various ways, on the affected industries, on employment in the region and on other attributes of the local economy.

The proposed research will (1) establish the economic relationships relevant to the problem and (2) integrate the results of other water resources research projects that are already under way in the area. Included in the latter are studies of pollutant effects on biological processes in the lake. The system is visualized as comprised of two major subsystems, the economy of the Detroit Toledo Metropolitan Area, and the in-lake ecological subsystem; and two related subsystems, the geological effects and recreational demand. Linkages between these subsystems are envisioned as mainly the pollutants, and the resulting water quality. Special studies are proposed to determine pollutant costs and markets of the products that give rise to pollutants. Costs of municipal sewage treatment and the impact of municipal taxes are other special studies that will be investigated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0722, A STUDY OF BIOLOGICAL SYSTEMS IN THE SCIOTO RIVER AS INDICES TO WATER QUALITY
J.H. OLIVE, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The proposed research plan involves laboratory and field investigations directed toward developing biological indices to water quality conditions in the Scioto River (Ohio) basin and their application to other stream systems. A biological systems analysis approach is planned in which populations of representative organisms and communities of organisms will be intensively studied in relation to physical and chemical parameters. Species diversity indices will be developed and correlated with physical and chemical parameters.

Field investigations will involve: (1) Establishment of study stations in the Scioto River above and below present and anticipated zones of water quality influence. (2) Collection at two-week to four- week intervals of biological organisms in representative habitats. (3) Collection of water and soil samples at locations described in (2).

Laboratory investigations will include: (1) Laboratory identifications of organisms by taxonomic specialists and quantification of results. Correlations between biological organisms and physical and chemical parameters will be determined. (2) Laboratory determinations of trace elements by emission spectroscopy. (3) Species diversity indices will be derived by formulas developed by Patten (1962). (4) Field determinations of chemical conditions for alkalinity, dissolved oxygen, carbon dioxide, chlorides, iron, nitrates, phosphates, silicates, and sulfates.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0723, INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER
R.M. PFISTER, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The proposed investigation is to study the interaction of environmental contaminants (defined as substances not formed biologically or naturally, and which are not normally indigenous to the water) on the microbial portion of the ecosystem. The particulate materials (detritus) will be examined on a physical, chemical, and biological basis, and the materials will be characterized using differential and gradient centrifugation in conjunction with electron microscopy. The characteristic fractions of suspended particulate material will ultimately be examined for ability to influence biological reactions. This particulate fraction of water is important to microbial relationships in the area of interfaces and biological activity. It is known that particles and molecules in solution accumulate at interfaces (this includes chemicals which can either act favorably (e.g., nutrients) or unfavorably (e.g., pesticides) to organisms) and that enzymatic reactions are concentrated at membranous surfaces. Therefore, it is of significant importance to study the capabilities of non-

biologicals that commonly end up in the waters on such colloidal or molecular interfacial systems.

The investigation will be confined to a small river or creek basin which enters into Lake Erie, and to the lake itself.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0724, THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE

R.M. PFISTER, Ohio State University, Graduate School, *Columbus, Ohio* 43210

Particulate matter in Lake Erie water will be examined on a physical, chemical, and biological basis, and this matter will be characterized using density gradient centrifugation, electron microscopy, and certain chemical analyses. Microbial portions of the Lake Erie ecosystem will be characterized on the basis of physiological types (not identification). Primary productivity, chlorophyll distribution and photosynthesis-pigment relationships will be examined to obtain information pertinent to particulate and bacterial interactions. Algae will be collected and treated to remove physically associated bacteria. Cultures of bacteria obtained from the algae will be examined in the same manner (e.g., determine physiological types) as the non-algal associated bacteria in water. Surface tension and water content of selected chemicals will be experimentally altered to study the effects on microbial populations (physiological types) and on types of particulates found in the water. Data from these experiments will be correlated in an attempt to establish cause-and-effect relationships.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0725, CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND TO LAKE ERIE

G.O. SCHWAB, Ohio State University, School of Agriculture, *Columbus, Ohio* 43210

Water samples were collected and analyzed from four 1/2-acre field plots near Sandusky, Ohio. Tile effluent was collected from two plots and surface runoff from the remaining two plots. Half of the plots are farmed with conventional tillage and the other half receive no tillage. Higher than average fertilizer rates were applied and all plots received two 3-inch irrigations. Water samples have been analyzed for 11 plant nutrients, sediment, pH, BOD, COD, electrical conductivity, atrazine, aldrine, heptachlor, and paraquat. Soil samples have also been analyzed for plant nutrients and pesticide residues. Special proportional water samplers were designed and installed early in 1970. Field facilities have been modified to permit sampling during the winter season. Laboratory studies have been started with the soil from the field plots and other areas to measure phosphorous movements. Special techniques have been developed to measure phosphorous diffusion constants which will supplement the teaching studies. Leaching studies are being conducted with rain simulation equipment. Anaylses of soil and water are being completed and the data are in process of being evaluated for 1970.

SUPPORTED BY Ohio State University

2.0726, CLADOPHORA AS RELATED TO POLLUTION IN WESTERN LAKE ERIE

C.E. TAFT, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The proposed research involves mapping and quantitative studies of attached Cladophora along the shorelines and on shoals adjacent to the Lake Erie Islands, and of the detached Cladophora beds that drift across the lake bottom. The approach will determine the quantity of Cladophora on the basis of dry weight, its periodicity, the chemical composition relative to that of the lake water, and the relationship of Cladophora to oxygen concentrations over the beds. Studies to evaluate harvested Cladophora as special products such as fibrous filter material, food, and/or as a mulch will be initiated. Field investigations include: 1) Aerial mapping of Cladophora beds. 2) Observations of periodic growth on the beds. 3) Quantitative measurements of Cladophora on attached and drifting beds. Laboratory investigations include: 1) Chemical analyses of Cladophora. 2) Chemical analysis of lake water. 3) Culture of Cladophora. 4) Suitability of Cladophora as a special filter medium. 5) Suitability of Cladophora as an animal food supplement. 6) Suitability of Cladophora as a speciality mulch.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0727, DETERMINATION OF TRACE METAL POLLUTANTS IN WATER RESOURCES AND STREAM SEDIMENTS

C.R. COTHERN, Univ. of Dayton, School of Arts, *Dayton, Ohio* 45409

The proposed research plan involves using the technique of X-ray fluorescence to determine the presence and amount of trace metal pollutants in water supplies, rivers and stream sediments. Also involved will be development of methods to trace the origin of pollutants and sediments. This project will yield information concerning water pollution not obtainable with previous techniques. This information along with a description of a standardized technique will be distributed to the relevant agencies and groups.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0728, A STUDY OF SELECTED SPECIFIC ION ELECTRODES, NO.II

J.M. PAPPENHAGEN, Kenyon College, Undergraduate School, *Gambier, Ohio* 43022

Research is to be conducted for the purpose of evaluating certain specific ion electrodes. The initial and primary effort will be directed toward the development of an analytical method, using the nitrate ion electrode, for the determination of nitrates in wastes and waters. Such development will consider the behavior, accuracy, precision, and sensitivity of the electrode as well as diverse ion studies and applicability of the method for the analyses of real samples. Other electrodes to be investigated, as time permits, for the purpose of determining if their usage might be applicable in wastes and waters include those for certain heavy metals such as Ag, Pb, Cu, and Cd ions.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0729, THE ALGAE AND ZOOPLANKTON OF PROTECTED AND EXPLOITED LENTIC HABITATS IN NORTHEASTERN OHIO

G.D. COOKE, Kent State University, Graduate School, *Kent, Ohio* 44240

A long-term survey of the species composition, distribution, and ecology of algae and aquatic microcrustacea in four representative bodies of water in Northeastern Ohio has been initiated. Two of the study sites (a lake and a reservoir) were selected on the basis that they have not been subjected to sewage or septic tank effluents or other pollutants, and the other two sites (strongly eutrophic lake and reservoir) were selected for comparative purposes.

The major objective is to prepare comparative species lists based on extensive seasonal collecting in pelagic and littoral areas. This information is to be compared with the ecological and cultural history of each body of water. This project is part of a larger study of the trophic typology of Ohio lakes.

SUPPORTED BY Kent State University

2.0730, A SYSTEMATIC AND ECOLOGICAL SURVEY OF THE ZOOPLANKTON AND PHYTOPLANKTON OF NORTHEASTERN OHIO GLACIAL LAKES

G.D. COOKE, Kent State University, Graduate School, *Kent, Ohio* 44240

Many glacial lakes on the Cuyahoga River Watershed (Northeastern Ohio) are subjected to intense cultural enrichment, thus providing an excellent opportunity for the comparison of lakes in various stages of eutrophication. The purposes of this project are: 1) to provide a thorough biological, chemical,

and physical description of several closely related lakes which are representative of other such lakes on the watershed, and 2) to field-test the hypothesis that eutrophication is not a process of ecological aging but actually results in an ecosystem with the properties of early successional stages. The hypothesis will be examined through comparative limnology. The lakes will be again studied intensively after the construction of a sewer line around them, thus providing a 'before-after' comparison.

SUPPORTED BY Kent State University

2.0731, A BIOLOGICAL SURVEY OF THE CUYAHOGA RIVER - LAKE LADUE TO KENT, OHIO
L.P. ORR, Kent State University, Graduate School, *Kent, Ohio* 44240

The major purpose of this research is to determine the water quality of the Cuyahoga River in northeastern Ohio from Lake LaDue in Geauga County to Kent, Ohio (Portage County). This is the only remaining segment of the Cuyahoga that has not been studied within the past three years. Water quality will be determined from fish and bottom fauna species composition and from physicochemical measurements that will include determinations of CO2 and O2 concentrations, pH, M.O. alkalinity, phenolphthalein alkalinity, nitrites, nitrates, and dissolved particulate organic matter.

Fish species collected will be compared to those collected in the same stretch of the River by Trautman in his 1925-50 studies. Of special interest will be a comparison of biological and physicochemical measurements in this study immediately below the Kent Sewage Treatment Plant with those made in a study conducted at the same station in 1966 just prior to the addition of secondary treatment facilities at this plant.

Hopefully, the data gathered in this study will serve as bench mark data in the unpolluted reaches of the River while those data made in polluted portions will be of value in assessing the severity of pollution and also the extent of recovery in areas where improvements have been made in water treatment.

SUPPORTED BY Kent State University

2.0732, FLORISTIC AND FAUNISTIC SURVEY IN THE CUYAHOGA RIVER WATERSHED
R.G. RHODES, Kent State University, Graduate School, *Kent, Ohio* 44240

The major objectives of this study are twofold. The first objective is to develop for the Ohio Biological Survey a detailed list of algal and fish species in waters of the upper Cuyahoga River Basin. The second objective is to compare floral and faunal surveys made at selected Cuyahoga River stations above and below the East Branch Reservoir. An effort will be made to detect and assess biotic changes associated with the East Branch Reservoir and with the inflow from a tributary of the Cuyahoga River. Complete physical data will be collected at each station.

This project is a part of master plan which will involve the prosecution and integration of long-term surveys of flora and fauna in this river system and determination of the effects of pollution water impoundment, and tributary inflow on the indigenous biota.

SUPPORTED BY Kent State University

2.0733, A FIVE YEAR LIMNOLOGICAL STUDY OF A NEWLY CREATED ACID MINE WATER IMPOUNDMENT
C.V. RILEY, Kent State University, Graduate School, *Kent, Ohio* 44240

A limnological study of a newly created 3.5 acid mine water impoundment is being conducted. The impoundment was created on the site of a former 'gob' waste dump and mine drainage ditch. Physico- chemical data concerning the mine drainage were collected prior to impoundment. Analyses have been continued on the impounded water, at various levels, as the waste materials were submerged. Analyses include pH, specific conductance, total acidity, total alkalinity, dissolved O2, free CO2, dissolved solids, Fe, Zn, Al, Mn, hardness, Ca, Mg. etc. Continuous monitoring of pH, D.O., solids, total alkalinity and temperature will be included.

SUPPORTED BY Kent State University

2.0734, EFFECTS OF AUGMENTED STREAM FLOW ON WATER QUALITY
D.B. BAKER, Heidelberg College, Undergraduate School, *Tiffin, Ohio* 44883

This project is designed to directly measure the effects of augmented stream flow on water quality in the Sandusky River. Special aspects of this study include the use of an upground reservoir for augmentation and the measurement of a wide variety of chemical and biological components. At present we are terminating the initial phase of the project wherein variations of water quality with flow volume are being measured prior to actual flow augmentation experiments.

During the period from July 1, 1969 through October 30, 1970, water samples were collected 4 to 5 times per week at each of 13 sampling locations within a 60 mile stretch of the river. Measurements included fecal coliform bacteria, chlorophyll a and b, suspended solids, conductivity, temperature, pH, D.O., B.O.D., ortho phosphate, total phosphate, nitrate, fluoride, alkalinity, calcium, magnesium, potassium, and sodium. Flows were determined at four of the sampling locations using U.S.G.S. wire weight gages and stage-discharge tables. Sampling and measurements have continued at a reduced level from Nov., 1969 through June, 1970.

In addition to examining water quality as a function of flow, data evaluation will include nutrients loading curves under a wide range of flow conditions and nutrient concentration - chlorophyll concentration relationships. The pre-augmentation phase of the project started in January, 1969 and will terminate in June, 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0735, EFFECT OF IMPOUNDMENTS ON WATER QUALITY
W.R. DUFFER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

The purpose of this investigation is to optimize reservoir water quality with regard to dissolved oxygen, excess nutrients, algal blooms, toxic chemicals, and releases to maintain flow and support stream life.

Pre-impoundmental data for the Arbuckle system have been collected at four stream stations since December 1965. Arbuckle reservoir was closed in January 1967, and biweekly sampling of chemical and microbiological parameters continues at pre-impoundment stations. Background data also exist on benthic macroinvertebrate population structures for these stations. The four pre-impoundment stream stations will be used to monitor water quality changes after the reservoir fills and can be used for comparison with background data collected prior to filling.

When Arbuckle Reservoir fills, sampling locations and schedules will be established for monitoring reservoir water quality changes. The immediate objective of this project is to relate biological and chemical parameters to the water quality of the reservoir by measuring the extent of their change in a relatively undisturbed system. Future studies will measure the extent of change in critical parameters in reservoir systems receiving waste materials.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0736, PIGMENT ANALYSIS FOR THE DETECTION OF ENRICHMENT
W.J. DUNLAP, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

Enrichment of surface waters by fertilizing nutrients from waste effluents and other sources is of major concern in water pollution control. Quantitative assessment of the extent and effect of enrichment is, however, very difficult by presently available methods. Previous studies have indicated that pigment compositions, particularly carotenoids-chlorophyll a ratios, of phytoplankton may vary in a regular and predictable manner with changes in nutrients present in the aquatic environment. The purpose of this research is to determine if analysis of phytoplankton pigments may be conveniently utilized for detection and evaluation of enrichment in surface waters.

2. WATER QUALITY

Current research involves development of improved methods for the qualitative and quantitative determination of phytoplankton pigments in aqueous media. Methods developed will be employed for study of the effect, under controlled environmental conditions, of single nutrients and mixtures of nutrients on pigment compositions of unialgal cultures, mixed algal cultures, and mixed bacterial-algal cultures. Emphasis will be placed on definition of pigment concentrations and ratios indicative of enrichment; possible utilization of phytoplankton pigment concentrations for prediction of impending nuisance algal blooms will also be investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0737, STUDY OF MICROBIOLOGICAL-BIOCHEMICAL PHOSPHATE SORPTION MECHANISM BY ACTIVATED SLUDGE

W.J. DUNLAP, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

Study the fundamental microbiological-biochemical aspects of the sorption of orthophosphate by activated sludge. Biochemical mechanism of uptake and release of orthophosphate by mixed cultures of bacteria comprising activated sludge. Concurrently predominant species of bacteria in activated sludge of high phosphate sorbing capability will be identified. Individual species found to predominate in phosphate sorbing sludges will be subjected to metabolic studies to determine mechanism.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0738, REMOTE SENSING FOR SPECTRAL ANALYSIS OF HYDROLOGIC VARIABLES IN THE SOUTHERN PLAINS

B.J. BLANCHARD, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Chickasha, Oklahoma* 73018 (SWC-023-ECH-6)

OBJECTIVE: Determine the remote sensing techniques that can be used to index hydrologic characteristics of watersheds, index and map physical characteristics of watersheds, measure pollutants and measure combinations of remote sensing data that will indicate watershed response to rainfall.

APPROACH: Collect remote sensing data over areas where extensive ground data is presently being collected and test signals for significant relationship to known measurable hydrologic data such as geology, soil moisture, soil types, soil temperature, and hydrologic condition. Remote sensing signatures related to the watershed parameters will then be tested over the instrumented watersheds under study in the Anadarko to Alex, Oklahoma study area.

PROGRESS: Preliminary data has been collected. All analysis and addition activities have been stopped - no funds available for this work.

SUPPORTED BY U.S. Dept. of Agriculture

2.0739, TIDAL FLATS IN ESTUARINE WATER QUALITY

D.A. BELLA, Oregon State University, School of Engineering, *Corvallis, Oregon* 97331

The project involves a study of estuarine water quality with emphasis on the role of the tidal flat regions. The approach being used employs feedback between finite-difference mathematical models and lab- field experiments. Significant errors found in finite-difference methods were studied during the past year and methods were developed to control these errors. A tunnel recirculating benthal respirometer is being employed to measure exchanges between tidal flat muds and the overlying water. The first year's experiments measured benthal oxygen uptakes of tidal flat muds. The past year's work also involved estuarine dispersion studies; however, emphasis will shift more toward the water quality aspects of tidal areas as this is the area in which the least amount of information is currently available.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0740, AN IMPROVED TEMPERATURE PREDICTION MODEL FOR SMALL STREAMS

G.W. BROWN, Oregon State University, School of Forestry, *Corvallis, Oregon* 97331

The real problem lies in translating research findings into less complex models that will allow field foresters to anticipate the effect of proposed clearcutting on water temperature. Only in this way will foresters be able to adjust their practices to comply with established water quality standards. A secondary benefit of such a model is that it will aid water quality control agencies in developing realistic standards.

A model such as this has been prepared from the research data previously collected. This model is currently being tested by field foresters throughout Oregon, particularly those in public agencies. After one field season's use, this first model has shown, as expected, some deficiencies. Its lack of accuracy on some streams indicates that further work will be required before a simplified 'Universal' prediction model can be derived. The model works very well on other streams, however, indicating the promise offered by this technique.

Simply stated, the objective of the proposed research is to redefine and test the temperature prediction model now in use so that it may more nearly become a universal predictor of the effect that clearcutting induces in the temperature regime of small streams.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0741, AIR PHOTO ANALYSIS OF OCEAN OUTFALL DISPERSION

F.J. BURGESS, Oregon State University, School of Engineering, *Corvallis, Oregon* 97331

The objectives of this research project are to: (a) develop photographic remote sensing methodology for the quantitative evaluation of dispersion of wastes from existing or proposed ocean outfalls and (b) relate the diffusion coefficients and plume patterns to physical oceanographic parameters. Although the investigation is limited to coastal waters, the procedures are applicable to the evaluation of waste disposal practices in estuaries, lakes and streams.

Field studies include simultaneous measurements of ocean outfalls waste plumes by aerial photography and conventional boat sampling. Three aerial cameras provide the photographic imagery for the measurement of waste concentrations, water currents, and diffusion coefficients. A densitometer converts the photography to digital data. The photographic film densities for the spectral bands are compiled and analyzed by a computerized procedure. This photographic method is evaluated by comparing the waste concentrations determined from the aerial photography with those measured by boat sampling.

Steady state diffusion coefficients are determined from the concentration within each flight while non-steady state diffusion coefficients are computed from the change in concentrations between flights over the area. Vertical concentration gradients in the waste field are estimated by comparing the light return in the near infrared band with the light return in the red band.

The research project began June 1, 1968 and will be completed December 31, 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0742, GEOSECS - AUTOMATED NUTRIENT ANALYSES AND MEASUREMENT OF ORGANIC CARBON

J.V. BYRNE, Oregon State University, School of Science, *Corvallis, Oregon* 97331

Considering the ocean as a source of food, a disposal area for nuclear and industrial waste products, and a controlling factor in the earth's climatic regime, our ultimate use of the sea is critically dependent on a detailed understanding of processes presently understood in only the vaguest and most qualitative way. These are the stirring and mixing processes in the deep sea, the interchange of material between deep and surface water, the variation of organic productivity throughout the ocean, and the exchange of

water and gases with the atmosphere. The GEOSECS program will measure in detail the oceanic constituents along Arctic to Antarctic sections at all depths, to provide, for the first time, a set of physical and chemical parameters measured on the same water samples. These data will provide the input for quantitative studies of oceanic mixing and organic productivity, and, at the same time, serve as a base-line for the levels of pollutants and of fission and waste products being added to the sea. Oregon State University will develop and test for nutrient and dissolved organic carbon (D.O.C.) analytical systems capable of obtaining precise nutrient and D.O.C. data necessary to understand the basic nutrient budget. With the aid of oxygen, carbon dioxide, alkalinity, and pH data, they will realistically assess the oxidative and preformed nutrient concentrations, the preformed nutrient data to be used for water mass characterization.

SUPPORTED BY U.S. National Science Foundation

2.0743, A PRELIMINARY BASELINE STUDY OF DILUTED POLLUTANTS IN THE PACIFIC OCEAN

N. CUTSHALL, Oregon State University, School of Science, *Corvallis, Oregon* 97331

This program is composed of three identifiable efforts as follows: (a) Samples from the ocean including zooplankton, squid, and fish will be analyzed for pollutants (heavy and transition metals, chlorinated hydrocarbons and polychlorinated biphenyls). The samples will be from suitable existing collections and from transects across the Pacific (southwest to northeast) during 1971. (b) Similar measurements will be made on samples from coastal waters (Mexico to Washington and north) to define distribution of pollutants in the food chain, sediments, and suspected source areas. (c) The results of those measurements will be studied by an interdisciplinary group of West Coast oceanographers, later meeting with a similar East Coast study group to design a scientific plan for a long-term research effort in the Environmental Quality of the Oceans.

SUPPORTED BY U.S. National Science Foundation

2.0744, A CLASSIFICATION OF THE LAKES OF THE STATE OF OREGON

J.R. DONALDSON, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The primary objective of the proposed research is to continue to make an accurate appraisal of the quantity and quality of the lakes of the state of Oregon in order to document for posterity the existing conditions and to serve as an aid to the present and future water use manipulations.

The specific project objectives are as follows: (1) Assemble information presently available concerning the lakes of Oregon. (2) Continue to sample selected lakes by differing geological areas and/or drainage basins in order to accumulate limnological data essential for a statewide classification. (3) Set up a format for recording and processing the collected information with the eventual purpose of making the results available in published form.

The field work involves the collection of information on the morphological (dissolved oxygen, pH, alkalinity, major cations, total solids and specific conductivity) and the qualitative and quantitative aspects of the biota of each lake visited.

An intensive study of four oligotrophic lakes (Crater, Woahink, Odell and Waldo) was begun in June, 1968. Routine limnological and basic environmental data is being assembled and compared. Phytoplankton primary production is being estimated for each lake employing the carbon-14 in situ technique. During the summer and autumn of 1969, nutrient limiting factors relative to phytoplankton will be evaluated using an in situ bioassay technique. Hopefully, this research will provide a more precise set of criteria for decribing oligotrophic lakes and predicting the future of lakes in general.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0745, STUDY OF AN UNSPOILED ESTUARY

B. GLENNE, Oregon State University, School of Engineering, *Corvallis, Oregon* 97331

The objective is to conduct a detailed study of Netarts Bay to develop guidelines for sound management of water quality and wise development of an essentially 'unspoiled' estuary. The Bay is one of the few estuaries on the Oregon coast which has not been touched yet by industrial activities, pollution, or shoreline development.

Basic studies have been initiated on water quality, flushing of the bay by the tides, mixing of salt and fresh water, properties of the mud flats, and the likely effects of discharging treated sewage or other wastes into the 5-mile long bay. Tide recorders have been put in selected locations to monitor water movement and elevation and to check the 'choking' of water in the entrance of the bay.

The mud flats which show during low tide are under study as are the streams which feed into the bay and the conditions which help or hinder growth of marine life.

SUPPORTED BY Louis W. & Maud Hill Family Found. - Minn.

2.0746, EFFECTS OF WATERSHED PRACTICES ON STREAMS

J.T. KRYGIER, Oregon State University, School of Forestry, *Corvallis, Oregon* 97331 (ORE-F-00803)

OBJECTIVE: Determine effects of logging and road building on stream temperature and sedimentation; predict water temperature changes associated with cover type and vegetational density along streams.

APPROACH: Temperature change in streams will be continuously monitored with thermographs established in three large watersheds. Sedimentation will be measured at the outlet of eight watersheds with DH-48 hand samplers. Data will be collected for several years before and after logging. The watersheds will be logged in 1966. Prediction equations for water temperature changes will be based on heat budgets along several stretches of the experimental streams.

PROGRESS: Temperature prediction studies have continued. Additional work to determine the rate of heated water as it moves into shade has just been completed in the North Umpqua Basin. A device for spatially integrating solar radiation beneath a forest canopy was developed as part of this study.

SUPPORTED BY Oregon State Government

2.0747, PHYSIOLOGICAL ECOLOGY OF BENTHIC ALGAL COMMUNITIES IN STREAMS AND ESTUARIES OF OREGON

C.D. MCINTIRE, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00871)

OBJECTIVE: Determine, through physiological and ecological studies in the laboratory and field, the extent to which various environmental factors influence the vertical, horizontal, and seasonal distribution and abundance of attached algae in selected streams and estuaries in Oregon.

APPROACH: Conduct a taxonomic survey of lotic algae; quantify seasonal changes in species composition and diversity at selected field stations; relate productivity and community structure to environmental factors in controlled, laboratory ecosystems; relate the dynamics of communities of attached algae to the distribution and abundance of consumer organisms; determine what changes in the algal communities would have predictive value or could be used as bioindicators of water quality.

PROGRESS: Progress in the Laboratory: An analysis of the fatty acid composition of algal communities developed at different light intensities and current velocities in laboratory streams was completed. These data indicated an inverse relationship between fatty acid redundancy and species diversity. Some effects of light intensity, exposure to desiccation, salinity, and temperature on the growth and vertical distribution of marine benthic diatoms in a laboratory model ecosystem were determined. These variables had a significant effect on the species composition of the diatom flora, and biomass accumulated most rapidly on substrates subjected to high light intensities, without exposure to desiccation. Progress in the Field: A study of the diversity and similarity of diatom communities collected at seven stations in Yaquina Estuary was initiated. Results of an analysis of data obtained during August 1968 indicated that diatom diversity was higher in

brackish water than at the stations in the lower bay. A regression analysis indicated that mean salinity, salinity range, and competitive interactions with macroalgae were important factors affecting diatom diversity.

SUPPORTED BY Oregon State Government

2.0748, STUDIES ON AQUATIC MYXOBACTERIA
R.E. PACHA, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

Ecological studies are being carried out to determine the role and activities of myxobacteria in the freshwater environment. In particular it is of interest to ascertain the importance of these organisms in the decomposition of pollutional materials and their possible application in water quality surveillance and stream purification. Surveys of a number of streams receiving various types of pollutants are in progress to obtain information on the occurrence and distribution of myxobacteria in these habitats. The effects of environmental parameters on the myxobacterial population of water are being considered as well as the interrelationships between myxobacteria and other microorganisms present in water.

Taxonomic studies on a number of myxobacteria isolated from the aquatic habitat are in progress to permit qualitative determinations to be made on the myxobacterial flora of water. Additional studies on the nutrition and physiology of selected myxobacterial isolates are planned in order to obtain more basic information on this group of microorganisms.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0749, MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY
D.W. HUBBELL, U.S. Dept. of the Interior, Geological Survey, *Portland, Oregon* 97208

Two reaches of the Columbia River estuary have been instrumented for discharge determination. These have been calibrated by direct measurements of flow from a boat at different stages and through several tidal cycles during the last two years. The data have been fitted to a existing one dimensional mathematical model. The mathematical model has been determined to be reasonably accurate and two other reaches have been instrumented similarly. In addition water samples for salinity and other chemical characteristics and sediment content are taken during all direct discharge measurements. Gross description of radioactivity in the estuary has been obtained by a sled-mounted in situ radiation detector as well as from analyses of water and sediment samples. Data compilation and integration has been augmented by a study of typical environments such as islands, tidal flats and shorelines. The mechanics of sediment transport and deposition particularly under the influence of salinity changes and flow reversal will be studied to define empirical relations to be used in calculating sediment loads. The project was initiated in FY 1964 and all field work and data collection has been completed. Final reports will be written and project terminated in FY 1972.

SUPPORTED BY U.S. Atomic Energy Commission

2.0750, THERMAL AND INDUSTRIAL POLLUTION - DELAWARE RIVER
E.W. PARKER, Lehigh University, Graduate School, *Bethlehem, Pennsylvania* 18015

In the seven mile stretch of the Delaware River from Riegelsville, N.J. down river to Milford, N. J., there are four paper mills which produce variable discharges into the river. About half way between these two limits is a steam-electric generating station which discharges heated water from condensers. At full capacity this station is generating 134 Megawatts. This corresponds to a waste heat rejection of about 6.7 x 10 to the 8th power B.T.U. per hour.

We propose to operate automatic monitoring stations at the bridges at Riegelsville and at Milford to develop comparative data for the river above and below the areas of cited pollution. Five diagnostic parameters would be recorded: Oxygen, Turbidity, pH, Conductivity, and Temperature. Sunlight intensity at Riegelsville is useful as the primary index of photosynthesis and oxygen production. The automatic water quality monitor station at Riegelsville was developed and operated by Lehigh from 1958-61 under agreement with INCODEL. We also developed a portable monitor station which records the five parameters.

The Del. Riv. Basin Comm. has succeeded INCODEL in ownership of the monitor equipment. DRBC plans to reactivate the Riegelsville Monitor Station and to let us use the portable monitor station for this proposed research.

In addition to collection of information by automatic intrumental methods we would employ standard field sampling methods such as: a. Collection of microscopic plants and animals by Millipore filter and immerser slide techniques; b. Observation of macroinvertebrates and determination of distributions in terms of types and relative abundance; c. Observation of distributions and types of rooted aquatic plants and algae; d. Measurement of Temperature and Sampling for B.O.D., C.O.D. and bacteriological counts.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0751, CHARACTERISTICS OF DRAINAGE FROM DEEP BITUMINOUS COAL MINES IN WESTERN PENNSYLVANIA
G.H. EMRICH, State Bur. of Sanitary Engin., *Harrisburg, Pennsylvania* 17105

The chemical characteristics of drainage from coal mines vary throughout western Pennsylvania. These characteristics must be known prior to mining in order to design and build waste-treatment facilities.

All recent data on deep mine drainage that were contained in files of Pennsylvania Department of Health were sorted and analyzed according to coal seams and to active and inactive mines. The gross character of the drainage from each seam was plotted by county and related to the geology. Chemical characteristics of drainage for each seam were summarized.

SUPPORTED BY Pennsylvania State Government

2.0752, ESTIMATING ACID MINE DRAINAGE POTENTIAL FROM COAL BEDS BY USE OF THE SOXHLET EXTRACTOR
G.H. EMRICH, State Dept. of Health, *Harrisburg, Pennsylvania* 17120

Acid mine drainage degrades many miles of streams in the coal mining regions of the United States. In order to properly design treatment facilities for acid mine drainage, the character of the mine drainage must be known before mining begins.

While many tests have been proposed, very few, if any, reproduce the natural conditions that produce acid mine drainage which this study will do. The study uses a Soxhlet Extractor packed with inert material and crushed coal. Distilled water is passed over the coal sample which is constantly being aerated. When the Soxhlet Extractor is filled with water, the water siphons back through a flask and is recirculated through the coal again. After four complete passes the fluids are analyzed for acidity or alkalinity, sulfate and iron. This is continued for a sufficient number of passes until the character of the mine drainage can be estimated. Preliminary results show close correlation of drainage from existing coal mines and estimated character of mine drainage.

Continuing research will also be performed to evaluate the effects of temperature, bacteria and sample size.

SUPPORTED BY Pennsylvania State Government

2.0753, HYDROGEOLOGY OF PUBLIC GROUND WATER SUPPLIES IN PENNSYLVANIA
G.H. EMRICH, State Dept. of Health, *Harrisburg, Pennsylvania* 17120

This study will critically evaluate the ground water yields and chemistry of the ground water from all public ground water supplies in the Commonwealth of Pennsylvania. The information in the files of the Pennsylvania Department of Health has been compiled in a readily usable form. Work is done cooperatively with the regional staff of the Pennsylvania Bureau of Sanitary En-

gineering,State Geologist, the U.S. Geological Survey. All public water supplies using ground water sources in Pa. have been included and the data has been coded for computer analysis. Analytical programs are being developed. The data will be analyzed in order to categorize the yields and the water chemistry of ground water for each hydrostratigraphic unit. Trends in water chemistry changes will be monitored to provide information for water management programs and specific programs to abate ground water pollution.

SUPPORTED BY Pennsylvania State Government

2.0754, PREDICTION OF WATER QUALITY CHANGE IN A STREAM DUE TO HIGHWAY CONSTRUCTION ON THE DRAINAGE BASIN
L.M. YOUNKIN, Bucknell University, School of Engineering, *Lewisburg, Pennsylvania* 17837 (2R23202669)

A method is being developed for predicting water quality change in a stream due to highway construction on the drainage basin. Data are being collected on two local basins. Construction is essentially complete on the first, with the study continuing through a stabilization period. Completion is expected on the second by the summer of 1971. Hydrologic studies include precipitation, stream discharge, sediment concentrations, and soil moisture. Data describing processes and phases of construction, exposed soil characteristics, and down slope ground surface conditions are being collected.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - F.H.A.

2.0755, UPPER DELAWARE RIVER PLANKTON STUDY
R. PATRICK, Acad. of Nat. Sci. of Phila., *Philadelphia, Pennsylvania* 19103

The purpose of this study is to provide for a program of comprehensive research to determine the type and density of plankton organisms present, the conditions which control their growth and survival on the main stream of the Delaware River between Trenton and Tocks Island and the effects of plankton on taste, odor, and other water quality problems. Field work will include net and diatometer sampling at a number of key stations along the river.

SUPPORTED BY Delaware River Basin Comm. - Washington

2.0756, BACTERIAL GROWTH AND THE DELAWARE ESTUARY MODEL
E.R. GLASER, Drexel University, School of Engineering, *Philadelphia, Pennsylvania* 19104

Equations describing the growth rate of aerobic bacteria and also equations specifically for the enterococci and total coliform bacteria will be added to the model and simulation developed by the Delaware Estuary Comprehensive Study. The proposed model will be useful in predicting bacterial concentrations for expected improvements in estuarine water quality parameters. This will be a valuable tool in planning for water-contact recreation on the estuary.

SUPPORTED BY U.S. National Science Foundation

2.0757, QUANTITATIVE METHODS FOR PESTICIDES IN NATURAL WATERS
I.H. SUFFET, Drexel University, Graduate School, *Philadelphia, Pennsylvania* 19140

The long-term objective of this study is to develop reproducible quantitative analytical techniques for organophosphate and carbamate pesticides in natural waters. These objectives can be fulfilled by the development of the most efficient liquid-liquid extraction and cleanup procedures.

The best analytical conditions for liquid-liquid extraction and cleanup should be based upon thermodynamic data. Presently, the choice of extraction parameters is based upon the criteria of intuition which is then followed by empirical trial and error analysis. This study will attempt to develop thermodynamic data based upon the partition coefficient expressed as a p-value so that a rational choice of extraction parameters can be made for different natural waters.

The primary goal of the study will be directed toward the analysis of the capability of the p-value for rational choice of extraction parameters in different types of natural waters; a clean low turbidity type, a polluted high turbidity type, and a high dissolved solids type. The extraction parameters obtained then will be evaluated in terms of the concentrations found in natural waters. As necessary, cleanup of natural water extracts will also be guided by p-values between immiscible solvents.

The determination of the p-values for organic pesticides will enable a theoretical approach a) to devising quantitative multiple screening procedures for organophosphates and carbamates, b) delineating the conditions to avoid cleanup problems for quantitative analysis of these pesticides in natural waters and c) devising quantitative cleanup procedures for these pesticides.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0758, EVALUATION OF PYRITIC OXIDATION BY NUCLEAR METHODS
R.A. BAKER, Carnegie Mellon University, Graduate School, *Pittsburgh, Pennsylvania* 15213

This project will be directed toward making use of the Mossbauer ef.. t through spectroscopically monitoring the oxidation processes taking place on iron pyritic materials during acid mine drainage formation. A specific objective is to determine the role of chemoautotrophic organisms in such oxidative mechanisms. These organisms may promote ferrous and sulfide dissolution from pyritic strata, accelerate the oxidative reaction once these ions are present in aqueous solutions or contribute by some combination of these mechanisms.

Natural and synthetic pyrites are to be exposed to carefully controlled gaseous and aqueous environments, with and without selected microorganisms. The nature and rate of reaction products are to be monitored by various chemical and biological techniques with emphasis on Mossbauer effect spectroscopy and radiochemical procedures. The oxidation mechanisms for ferrous and sulfide ions, the effect of specific and mixed chemoautotrophic organisms and the effect of pyritic properties on acid mine drainage are to be determined.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0759, HEAVY METALS - ENVIRONMENTAL CONTROL SYSTEMS DESIGN--FAIRBANKS PLACERS
T.D. MOORE, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

To design and develop costs for environmental control systems for mining permafrost, with special emphasis on such factors as thermal gradients, airflow patterns, and control of the environment for problem areas.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

2.0760, DETECTION AND LOCATION OF CONCEALED ABANDONED UNDERGROUND MINES AND ASSOCIATED DRAINAGE BY GEOPHYSICAL AND GEOCHEMICAL TECHNIQUES
W. FISHER, H R B Singer Incorporated, *State College, Pennsylvania* 16801

The exact location of concealed voids in abandoned coal mines is a problem resulting from over 150 years of mining. The drainage resulting from these mines has caused serious pollution problems. Without knowing the exact location of the concealed openings and the extent of the mine, the application of known abatement techniques would be impossible. Drilling is the only known method for determining the location and extent of the mine voids. This is an extremely expensive method. This project will investigate the use of the following geophysical methods: self-potential, resistivity, induced polarization, inductive, precession magnetometry, seismic refraction and reflection, infrared radiometry, gravimetry; and the following geochemical techniques: ground water analysis, surface water analysis, dye tracers and suspension tracers.

The above mentioned techniques will be applied to an area where precise mining records are available and the locations and extent of underground voids are well located. The test results will then be compared with the actual mining map.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0761, ENERGY EXPENDITURES FOR OSMOTIC AND IONIC REGULATION IN DAPHNIA

B.G. ANDERSON, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01742)

OBJECTIVE: Determine effects of various concentrations of salts, both singly and in combinations, on energy expenditures of Daphnia magna.

APPROACH: Daphnia are found in waters varying in salinity, both qualitatively and quantitatively, body fluid of accilimated animals is always maintained hyperosmotic to the medium. It is expected that the greater the difference between the osmotic concentration of the environmental medium and that of the body fluid, the greater will be the energy expended. Differences in specific ion concentrations are also expected to influence the energy expended. If a certain combination of ions requires the least expenditure of energy for maintenance of the hyperosmotic condition of the body fluid such a combination may prove to be optimum for other activities such as growth and reproduction and their ability to withstand adverse conditions. The information gained by this study should be especially valuable in the development of standardized culture and assay media since Daphnia have come into general use for the bioassay of pesticides in relation to water pollution.

PROGRESS: The rate of oxygen consumption of adult female Daphnia magna varies directly with the oxygen tension of the medium. The rate of oxygen consumption decreases linearly as the oxygen tension decreases from full saturation to 10-20 percent of saturation at which point it is about half that at saturation. Below 10 percent of saturation the rate drops abruptly as the oxygen tension approaches zero saturation. The overall rate of oxygen consumption is cyclical in that it increases during the instar up to the time the young are released and the animal undergoes ecdysis after which the overall rate decreases but increases again during the next instar. The overall rate increases by as much as 50 percent during the instar. The overall rate increases also from instar to instar as the animal grows older and increases in size. Neonate Daphnia pulex live longer in solutions made up of 5.54 mM NaCl, 0.25 mM KCL, 1.19 mM CaCL(2), 0.37 mM MgCL(2) buffered with 0.09 mM NaHCO(3) and 0.008 mM NaH(2)PO(4) to pH 8 than in solutions with lower or higher concentrations of these salts. Presumably the animals utilize less energy for ionic and osmotic balance at the above concentrations so that more of their available energy can be expended for other functions.

SUPPORTED BY Pennsylvania State Government

2.0762, THE BEHAVIOR OF SMALLMOUTH BASS AS RELATED TO ARTIFICIAL COVER

R.L. BUTLER, Penn. State University, State Coop. Fishery Unit, *University Park, Pennsylvania* 16802

Reason for study: Although cover is recognized necessary for the maintenance of many species, the characteristics of cover and the response of the organism to it have not been studied to any great extent. In some marginal streams the variability of cover may be the limiting factor for the bass population. If cover is a limiting factor, a species dependent upon it may have low population levels even where food is abundant. Much money has been spent on 'stream improvement' devices without knowledge of the preferences of fish for these structures. Since response to cover is a behavioral paramenter of a species, measures of it may be used for bio-assay.

Objectives: (1) To determine those components of cover that are attractive to smallmouth bass. (2) to demonstrate the effects of water velocity on the utilization of cover by smallmouth bass. (3) To test response to cover as a bio-assay for mine acid pollution.

Design of Project: An experimental stream trough will be built and placed in operation at a nearby impoundment. One fish at a time will be introduced into the stream trough and exposed to a series of cover objects designed to simulate various features of natural cover. Current velocity will be varied to determine its effect on utilization of the cover. The tests will be run in high carbonate and low carbonate water for baseline measures under unpolluted conditions. Bio-assay of mine acid water will be done at several stream sites offering various degrees of mine acid pollution.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0763, ESCHERICHIA COLI SEROTYPES IN MICROBIAL POLLUTION OF WATER

P.J. GLANTZ, Penn. State University, Inst. for Res. on Land & Water, *University Park, Pennsylvania* 16802

The variety and frequency of Escherichia coli serogroups isolated from water will be compared with those found in humans and animals. These data will then be used to determine the most important and prevalent serogroups that should be completely serotyped. An evaluation of the identity in respect to pathogenicity and virulence of the E. coli serotypes from a variety of sources will then be possible. Prevalence and survival of potential pathogens in the aquatic environment due to fecal contamination will then be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0764, AN INVESTIGATION OF ACID MINE DRAINAGE CHEMICAL POLLUTANTS USING LASER-RAMAN AND INFRARED SPECTROSCOPIES

T.V. LONG, Penn. State University, Inst. for Res. on Land & Water, *University Park, Pennsylvania* 16802

Laser-Raman and infrared spectroscopies will be used to investigate aqueous solutions containing chemical pollutants important in acid mine drainage, which includes the soluble products of Fe (III) hydrolysis, sulfuric acid and other sulfur-containing species. Spectra of solid ferric oxy-hydroxide hydrates will also be measured, and the structures of the polymeric solution moieties will be determined by comparison with these solids and through standard vibrational techniques. A specification of the environment in which acid waters are formed in terms of participating chemical species will be attempted. The solution chemistries of other metal ions (aluminum, zinc, manganese, chromium) whose hydrolytic equilibria are fundamentally relevant in natural water equilibria, including metal ion control, soil fertility, and treatment of water for public utilization, will also be studied. The primary goal of this investigation will be to delineate the major solute species present as a function of metal ion concentration and acidity. The possible importance of photochemical reactions in hydrolytic phenomena may also be investigated using laser radiation as the source of photochemical excitation.

SUPPORTED BY Pennsylvania State University

2.0765, DETECTION OF NUTRIENT LIMITATIONS OF ALGAL GROWTH IN SURFACE WATERS

A.J. MCDONNELL, Penn. State University, School of Engineering, *University Park, Pennsylvania* 16802

The study is developing and testing the utility of using enzymatic analyses as well as ammonium absorption and respiratory responses to define the availability of nitrogen and phosphorus for algal growth in eutrophic and oliogotrophic waters. Laboratory evaluations include: 1. Tests for alkaline phosphatase activity in selected algal species. 2. Extraction of surplus-stored cell phosphorus. 3. Measurements of ammonium uptake by selected algal species sampled under different environments of nitrogen deficiency. 4. Tissue analyses for total nitrogen and phosphorus. Correlations are being made with productivity estimates, and water quality analyses for a variety of waters with a wide range of fertility.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0766, CHEMO-DYNAMICS OF LIMESTONE GROUNDWATER

W.B. WHITE, Penn. State University, Inst. for Res. on Land & Water, *University Park, Pennsylvania* 16802

Water resource management and pollution control of carbonate groundwaters requires a much more detailed knowledge of the mechanics of water movement and the chemistry of water-rock interactions than is presently available. This study is part of a long term program to understand the mechanisms by which carbonate aquifers become modified by solution and the mechanisms of groundwater movement.

An effect of flow dynamics on the empirical rate of solution for carbonate rocks will be determined by a laboratory model. This model is designed to give actual rate constants and perhaps some insight into the rate-controlling processes (which can then be used to check several theories of solution kinetics now in the literature). Flow regimes will range from laminar, through turbulent with a laminar sub- layer, to totally rough turbulent flows. Significant changes in solution kinetics are expected at the laminar-turbulent transition.

Waters from limestone aquifers will be sampled at many points of known geological relation within the aquifer. These will be analyzed chemically for the usual carbonate variables and fitted to thermodynamic equilibrium expressions. Deviations of the waters from chemical equilibrium can be used to trace sources of these individual waters and the way in which they mix to form the main groundwater body of the aquifer.

SUPPORTED BY Pennsylvania State University

2.0767, COMPARATIVE STUDY OF THE BENTHIC MICROBIAL BIOTA IN SOME COASTAL AREAS OF PUERTO RICO

E. ANGEL, Univ. of Puerto Rico, Water Resources Research Inst., *Mayaguez, Puerto Rico*

Three marine areas of the Southwest coast of Puerto Rico supposedly affected or not by chemical or animal residues are to be studied. (1). The characteristic bacteriological biota of the neritic benthic zone is going to be studied in order to find the actual population. (2). The standard physical and chemical characteristics of sea water are going to be studied in the three different areas. (3). Comparative studies will be conducted in order to establish relations between pollution and physical change to bacterial population changes, and to establish which are the believed 'normal' bacterial population (unaffected areas) and 'abnormal' bacterial population (affected areas).

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0768, TERRESTRIAL ECOLOGY

R.G. CLEMENTS, U.S. Atomic Energy Commission, Puerto Rico Nuclear Center, *San Juan, Puerto Rico* (AT(40-1))

The present emphasis is on the hydrologic cycle, animal behavior and food web analysis. Investigations are in progress on the characterization of rainfall by storm classes. The study is designed to measure the relationship between the quantity of rainfall and the quantity of throughfall and stemflow by storm classes. Chemical analyses for major and minor elements in individual rains and associated throughfall and stemflow will be made. The purpose is to develop predictive equations for the movement of radioactive and stable isotopes via the hydrologic cycle in a tropical forest ecosystem. Tracers will be used to measure the rates, amounts and pathways in selected food chains.

RESULTS: Investigations have indicated that the movement of radioisotopes is a relatively slow process in the tropical forest under study. Measurements on fallout nuclides and tracers suggest that foliar interception and absorption is the major mode of uptake while root uptake may play a minor role under undisturbed conditions. However, recent studies on 3 year old Cs134 plots suggest that disturbance of the canopy results in considerable uptake by early successional species.

SUPPORTED BY U.S. Atomic Energy Commission

2.0769, THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS

H.W. FISHER, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

In the present study we are determining the titration endpoints of toxicity of water pollutants by quantitative determinations with mammalian cells cultured in vitro. The research plan proposes to extend this study in two ways. In the first series of experiments, the plating efficiency and growth rate assays would also be carried out with a cell culture of a cold-blooded vertebrate, such as the cell line derived in 1960 by Wolf and Quimby (Science 135, 1965 (1962) from gonadal tissue of rainbow trout, Salmo gairdneri. In the second study, chromosomal analyses of cells growing in toxic concentrations of the pollutants would be carried out. Cells would be grown in concentrations of the pollutants at the threshold of toxicity as determined in our present experiments and chromosomal aberrations or changes in ploidy produced by the inorganic pollutants, herbicides, pesticides, or detergents would be documented.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0770, CRITERIA FOR RECOGNITION OF ESTUARINE WATER POLLUTION BY AERIAL REMOTE SENSING

J.F. FISHER, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

The proposed study is to develop criteria for study of water pollution in the estuarine environment by aerial remote photographic sensing. Field confirmation of water pollutants will be related to patterns as delineated by aerial photogrammetry of an estuarine area.

Four photographic emulsions will be tested: 1. Aerial panchromatic black and white, negative. 2. Infrared black and white, negative. 3. Kodachrome color, positive. 4. Infrared ektachrome color, positive.

Five aerial photographic camera systems will be used: 1. Aerial camera, 9 x 9 inch. 2. Aerial camera, 4 x 5 inch. 3. Panoramic camera, 35 mm. 4. Motorized telephoto camera, 35 mm. 5. Telephoto camera, 16 mm.

In addition to criteria for determing water pollutants from aerial photographic sensing, recommendations will be made as to what is the most efficient and simplest camera - film emulsion system for use by local and state agencies in surveillence and study of estuarine pollution.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0771, THE INSECT ORDER PLECOPTERA AS A BIOLOGICAL INDEX OF FRESH WATER QUALITY

T.W. KERR, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00616-NF)

OBJECTIVE: Determine the degree of water 'pollution' on the presence of the insect order Plecoptera in a stream system in Rhode Island. The stream system will contain certain branches where type and degree of contaminants can be defined.

APPROACH: Select and map 5 sampling sites in a stream system having several branches. Sampling would be accomplished to quantify the species of Plecoptera present at each individual site. Concurrently, water samples would be taken at individual sites and bioassays undertaken to determine the percentage of organic matter, free ions, acids, etc. The 'quality' of the water including temperature/oxygen tension at each individual site would then be correlated with the number and species of Plecoptera nymphs present.

PROGRESS: Monthly determinations were made at 8 sites on the Hunt River (to July 17, 1968) of stream velocity, depth, width, bottom type, temperatures, dissolved oxygen, percent saturation of oxygen, pH, total alkalinity and carbon dioxide content. Field observations of stone fly (Plecoptera) populations were made periodically. Two species, Peltoperla (arcuata Needham?) and Taeniopteryx nivalis Fitch, predominated and in only 3 upstream, unpolluted sites. Laboratory studies were made to find the limits which nymphs could survive of dissolved oxygen, water velocity, temperature, pH, chromium and phosphates. Highway construction has changed the initial ecosystem and project.

SUPPORTED BY Rhode Island State Government

2.0772, BAY WATCH

B. LEVINE, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

2. WATER QUALITY

The Bay Watch Program has a series of multiple but related goals. One is the design of a physical (and eventually a biological) monitoring system for the Rhode Island Coastal Zone. Such a system would have a variety of uses including pollution control. It is not our present intention to implement fully such a monitoring system, since this appears to be a task better suited for a state or federal agency. However, we do expect to operate a system sufficient to assist in the development and verification of the various physical and biological models previously discussed.

Our plan is to develop a limited operational capability by the summer of 1970 using standard instrumentation and processing techniques where possible in order to gain operational experience. At the same time we will be undertaking limited development work in instrumentation and data processing, these developments will be fed into the operational system as practicable. The predicted state of the bay from the analytical models will be compared with the available data and new data from the bay instrumentation system.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0773, SENSITIVITY OF BENTHIC MICROFLORA TO POLLUTION GRADIENTS

N. MARSHALL, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

Recent investigations show that the major share of the high productivity of shoal estuarine environments is due to the photosynthesis of the benthic microflora. This community, composed of one-celled forms, is probably quite vulnerable to pollution. We have developed a technique for assaying the productivity of this benthic community from the C-14 uptake, using small undisturbed samples. This program, based on such assays, has the following objectives: (1) Continue to refine and verify the C-14 technique for assaying the productivity of the benthic microflora of undisturbed sediments. (2) Establish with this technique the norms for three coastal areas that are free of pollution. These observations of norms are being conducted over a three-year period to establish satisfactory base lines. One site to be studied is adjacent to the Millstone Point Nuclear Power Plant and later will be affected by 10 degree Fahrenheit temperature increase and low-level radioactive input when the plant goes active (scheduled for 1969). The other two sites are nearby estuarine areas of Point Judith Pond and the Pettaquamscutt River. (3) Investigate for a three-year period the effect of thermal change and domestic pollution on the productivity of the benthic microflora. This involves the Millstone site for thermal effects and the polluted Mystic River for effects of domestic pollution. The major microflora present and key ecological parameters are being determined for the observation sites.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0774, THE GAUZE PAD METHOD FOR THE ISOLATION OF VIRUSES FROM INLAND AND ESTUARINE WATERS

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The bacterial flora of coastal and inland waters have been studied repeatedly, but information is very fragmentary concerning water pollution with human enteric viruses.

Phase 1. Evaluation and Development of Methodology. Under controlled laboratory conditions, water will be artificially polluted with known levels of enteric and other viruses. Experiments will be done to evaluate the adsorption capacity of various types of gauze pad as well as threads of synthetic fibers. Attempts will also be made to compare the elutability of virus from gauze pads of cotton and synthetic fibers in different buffers, namely phosphate, borate, tris, and others. Virus in these eluates will be concentrated by using the salts indicated above. A standard gauze pad technique will be developed for viral isolation in water and this will be used for the phase 2 study.

Phase 2. Field Investigation of Water Pollution. Samples will be collected periodically from selected areas in Rhode Island by using an appropriate standardized gauze pad technique developed in Phase 1. Attempts will be made to isolate their viral flora by inoculating the concentrates into a spectrum of cell cultures, suckling mice and avian embryos. Concomitantly, the waters for viral sampling will be tested for coliform MPN, E. coli, and fecal streptococcal contents. The viral isolation results will be correlated with those of the bacterial indicator tests.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0775, COLLECTION AND ESTABLISHMENT IN CULTURE OF SPECIES AND STRAINS OF MARINE PHYTOPLANKTON ORGANISMS

T.J. SMAYDA, Univ. of Rhode Island, School of Oceanography, *Kingston, Rhode Island* 02881

The University of Rhode Island Graduate School of Oceanography shall supply a large number of species and strains of marine phytoplankton which should be at the disposal of the National Marine Water Quality Laboratory, at all times, so that various environmental, physiological, and toxicological tests can be accomplished. Cultures of the various species and strains shall also be made available to other FWPCA laboratories involved in pollution control activities for use in bioassays and other tests developed by NMWQL for the detection and evaluation of pollutants. The diversity of environmental requirements of phytoplankton necessitates the establishment of individual species and strains in culture.

Further, the contractor shall develop the mechanics of a system for obtaining these organisms so that the culture collection will become complete for the purpose at hand; shall develop an orderly arrangement for accession to the collection. The contractor shall also, scientifically identify each species and/or strain of phytoplankton by established procedures; utilize as the basis for the proposed collection, organisms already being maintained by the University Laboratory, NMWQL, and those available from academic institutions and research organizations. He must further provide the NMWQL with required data, and advise the NMWQL of the progress and status of the cultures and program as requested.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0776, ROLE OF NEMATODES AND RELATED MEIOFAUNA AFFECTING FRESH WATER QUALITY IN RHODE ISLAND

G. STESSEL, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00615)

OBJECTIVE: Estal lish population patterns of dominant and associated nematode species in the benthos and nekton of 'unpolluted' and 'polluted' fresh waters. Study the detritus degradation of the dominant nematode species. Determine the feasibility of nematodes as biological indices of water quality when complemented with chemical indices.

APPROACH: Sediment cores and overlying water samples will be taken at monthly intervals from July, 1967 to August, 1968 at seven sampling stations along the Hunt River, Rhode Island. Sites 1, 2, 3, and 4 are upstream from industrial plants and are rural (unpolluted). Sites 5, 6, and 7 are downstream from industrial plants and in urbanized areas (polluted). The following measurements will be made and recorded on or about the 15th of each month: oxygen and temperature by means of a YSI D. O. meter; width, depth, and velocity using meter sticks and a Dutchman's log; pH using a Photovolt pH meter; and chemical measurements (PO_4), Cl, Cr, and CO_2) by standard analytical techniques. Two 24- hour surveys will be made at stations 1, 4, 5 and 6 during July, 1968. Measurements of oxygen and temperature will be made at hourly intervals using the YSI meter. Three 10 sq. cm. cores will be obtained from each of the seven stations monthly and taken to the laboratory for biological study. Nonperiodic samplings of sediments from other lakes or streams in Rhode Island will be obtained for studies of meiofauna contained in them.

PROGRESS: Core sediments were taken monthly (July, 1967 to Aug., 1968) at 4 'unpolluted' and 3 'polluted' stations on the Hunt River, R.I., and analyzed for meiofauna and nematode content and for chemical- physical parameters. Average density of populations and frequency of occurrence of meiofauna were determined over one year at the seven stations. Maximum nematode populations occurred in late winter-early spring. Dis-

solved oxygen levels, stream dimensions, phosphate and carbon dioxide levels showed no correlation with meiofauna or nematode populations. 'Polluted' sites were similar in population dynamics. Predaceous nematodes favored smaller particle size sediments, less than 50% sediment water content, and more than 12% sediment organic matter.

SUPPORTED BY Rhode Island State Government

2.0777, ANALYTICAL PHYSICAL MODEL
F. WHITE, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

An analytical physical model of the Bay is being constructed. The long term objective is to produce a mathematical model which can predict hydrodynamic, thermal, salinity and oxygen changes in the Bay as a function of location and time. The analytical model of the Bay must include all types of equations, algebraic or possibly stochastic in nature, which accurately model the turbulent transport. Although there is already considerable work reported in this area, it will be necessary in Narragansett Bay to have supporting equipment to verify these models and, in the case of specific pollutants, data which refine presently proposed models. A pilot study of a three dimensional hydrodynamic model has been successfully completed for the Harbor of Refuge at Gallilee. A similar model is being constructed for Narragansett Bay and Providence River.

To assist in the development and verification of mathematical models, the 'Bay Watch' Program is developing a limited capability to measure various physical, chemical and biological parameters. For ease of operation, the majority of the initial experiments are being conducted in West Passage.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0778, PERIPHYTON AND PHYTOBENTHON AS INDICATORS OF WATER QUALITY
R.D. WOOD, Univ. of Rhode Island, School of Arts, *Kingston, Rhode Island* 02881

The proposed research aims to determine the effect of pollution on the attached plant growth, specifically the periphyton (--on structures or other plants) and phytobenthon (--on the bottom). The approaches are analysis of physical-chemical factors and pollution on the one hand, and periphyton-phytobenthon species and community structure on the other.

Field investigation includes study of the biota, monitoring chemical-physical factors, and sampling for pollutants: 1. Set out study areas above/below pollution effluents. 2. Monitor factors and pollutant concentration and follow plant growth throughout the year.

Laboratory work includes analysis of samples, and establishment of species and community composition of the periphyton-phytobenthon: 1. Routine analysis for factors; millipore membrane coliform count for sewage; fluorimetry for domestic wastes; and industrial tests for their wastes. 2. Identification, count, and measurement of periphyton and phytobenthon with respect to species, community structure, and biomass.

Laboratory and field data would be correlated for practical application of periphyton-phytobenthon as indicators of nature and intensity of pollution; and species data would be organized for use in related research disciplines.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0779, INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE
L.R. WORTHEN, Univ. of Rhode Island, School of Pharmacy, *Kingston, Rhode Island* 02881

The proposed research involves both collecting blue-green algae from several stations over a two year period and the propagation of axenic cultures of several representative species.

Those collected from natural sources will be examined to determine the extent of pesticide (DDT and dieldrin) accumulation. Radioactive isotopes of the two pesticides will be used to determine if absorption of these compounds takes place, and if these compounds are accumulated in the organism, or more important, if they are degraded and the pesticide metabolites formed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0780, SIGNIFICANCE OF THE FECAL STREPTOCOCCI, COLIFORM BACTERIA AND COLIPHAGE IN RELATIONSHIP TO ENTERIC VIRUS POLLUTION IN SEWAGE AND RIVERS
V.J. YATES, Univ. of Rhode Island, School of Agriculture, *Kingston, Rhode Island* 02881

Due to the ease of measurement, the coliform group of bacteria have for many years been used to indicate the degree of pollution of water with wastes from human or animal sources. The limitation of such a method rests upon the fact that coliform bacteria are normal inhabitants of human or animal bodies and normally are not pathogens. So long as the rivers containing large numbers of coliform group of bacteria are condemned and cleaned, it can be said that such tests do serve their purpose. But the status of today's rivers in Rhode Island clearly indicate that many are heavily polluted with coliform bacteria; some have coliform counts equal to that of the raw sewage. Provided such an environment does exist, it is important to find out the concentration of viral contaminants.

The objective of the present proposal is to correlate the concentration of coliform bacteria, fecal streptococci, or coliphage in polluted water to viral pathogens, such as Coxsackie and poliovirus. It is hoped that a correlation can be established between the two, so that the measurement of one may provide a quantitative estimate of the other.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0781, THE DEVELOPMENT OF DATA FOR BATHING BEACH CRITERIA
V.J. CABELLI, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

This study will explore the feasibility of and prepare a project proposal for an epidemiologic study to determine the relationship of illness among swimmers to the sanitary quality of the water at salt water beaches.

Following a review of the literature and criteria examination of previous studies directed at this question, a tentative experimental design will be formulated. Possible sites for the study will be screened using available information on bather density and pollution loads. Contact will be established with the public health authorities at the tentative study sites. A draft proposal for the study will be prepared and reviewed both within BWH and with the above-mentioned health authority in a series of coordination meetings. The revised proposal will be submitted for funding to the appropriate agency. Assay methods for select indicator and pathogenic bacteria are being examined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0782, EVALUATION OF MICROBIOLOGICAL STANDARDS FOR SHELLFISH GROWING WATERS
V.J. CABELLI, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

The rationale for the project derives from the fact that at some unknown level of infectious hepatitis in the 'discharging' population, the existing microbiological, indicator standard for shellfish growing waters could be breached. Thereby, shellfish associated cases of infectious hepatitis could occur from the raw consumption of animals taken from approved waters. The documentation of this occurrence requires that 'bootlegging' and untold pollution levels due to run off and bypassing of sewage treatment facilities be eliminated as explanations for the shellfish associated cases of infectious hepatitis.

Three inputs to the study are necessary: (1) morbidity data on the overall incidence of infectious hepatitis (IH) in the area as published by NCDC, (2) epidemiologic follow-up of shellfish associated cases of IH to determine from where and when the shellfish were harvested--this is being done in Rhode Island by CDC--EIS officer--and (3) continued surveillance of the approved grow-

ing areas for untoward pollution loads as seen by excessive levels of the indicator organisms. Three requisites are needed for the study: (1) an increasing incidence of IH in the discharging population, (2) a geographic situation relative to the major sources of sanitary pollution favorable to continuous monitoring of the area and (3) a minimum of 'bootlegging.' The approved growing areas in upper Narragansett Bay in Rhode Island meet the above criteria for the study.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0783, DIRECT, LOW TEMPERATURE ENUMERATION METHODS FOR FECAL COLIFORMS IN WATER
A.P. DUFOUR, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

Methodology will be examined towards obtaining a differential and or selective procedure for the enumeration of fecal coliforms without recourse to the use of elevated incubation temperatures or certain inhibitors.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0784, QUANTITATIVE RECOVERY OF PSEUDOMONAS AERUGINOSA FROM POTABLE AND RECREATIONAL WATERS
M.A. LEVIN, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

An effort will be made to develop a quantitative method for the enumeration of Pseudomonas aeruginosa in potable waters and in fresh and estuarine waters used for recreational purposes. Emphasis will be placed on methodology which will permit the examination of relatively large volumes of water.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0785, STUDY OF GROWING AREA STANDARD BY EXAMINING ENTEROPATHOGENS AND INDICATOR LEVELS
O.C. LIU, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

The microbiological standard for shellfish growing waters (median coliform MPN is less than 70/100ml)assumes that the probability of enteric infection from the consumption of shellfish taken from the area is negligible. Validity of correlation of the coliform indicator with outbreaks and sporadic cases of infectious hepatitis associated with the consumption of shellfish is being examined by determining the relationship of indicator levels to enteropathogenic viruses and bacteria in selected shellfish growing areas through 1) correlation of frequency of isolation of enteric viruses and Salmonella sp. to coliform, fecal coliform and ET coliform levels; 2) longitudinal survey of estuaries and shellfish for presence of human enteric viruses; 3) comparative survival of coliforms, Salmonella species, and viruses in seawater; and 4) sanitary significance of members of the coliform group. Various enteric viruses were isolated from two species of shellfish and the overlying waters in a preliminary study conducted in the Pawcatuck River, Rhode Island. A rapid plating method for enumerating coliform capable of growth at an elevated temperature (ET coliform) has been developed and evaluated at three locations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0786, OCCURRENCE OF HUMAN ENTERIC VIRUSES IN WATERS AND SHELLFISH
O.C. LIU, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

Outbreaks of infectious hepatitis associated with drinking water and shellfish are well documented. Recently two waterborne outbreaks of hepatitis were reported from Wisconsin and Massachusetts respectively. The high incidence of infectious hepatitis throughout the year in this country may partially be attributable to polluted drinking water supplies from communities practicing marginal treatment. In order to identify this problem by using laboratory approach, a longitudinal survey has been initiated since 1969 monitoring the water supply of three northeastern communities for the presence of human enteric viral pollutants. It is hoped that the presence of any cultivable enteric virus in these supplies may serve as an indicator of potential pollution with the hepatitis virus. Periodically, 4-gallon samples were collected from these communities and processed as follows: (a) hydroextraction by using polyethylene glycol to reduce the sample volume to 1-gallon, and (b) to further concentrate this volume to 20 ml using the two-phase polymer separation method. The concentrates were examined in 3 tissue culture systems, primary monkey kidney, human amnion and human embryonic kidney bottles (3 oz.). To date, 3 isolates were obtained from these samples. This effort will continue in FY71 with a constant effort in improvement of the sampling and concentration methods. During the course of the limited survey, bacteriologic data and treatment practice have also been collected. The viral isolation data will be correlated with this field information.

The significance of this study, if positive, follows: (a) methods used are at least effective inasmuch as uncovering the viral pollutants under the particular conditions; (b) continued use of the water or consumption of the aquatic animals therefrom, may be potentially hazardous to public health, e.g. infectious hepatitis, idiopathic myocarditis, etc.; (c) leads for further epidemiologic follow-up of the population to determine the effects, if any, on those being exposed to such environmental hazards; and (d) to validate, or invalidate, the currently used bacteriologic standards as far as indication for viral pollution is concerned.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0787, OCCURRENCE OF HUMAN ENTERIC VIRUSES IN DRINKING WATER
O.C. LIU, U.S. Environ. Protection Agcy., Northeastern Water Hyg. Lab., *Narragansett, Rhode Island* 02882

The objective of this project is to conduct a longitudinal survey of raw and finished water supplies of selected communities for viral pollutants.

Accomplishment in FY-71: A preliminary survey of water supplies of several New England communities has been conducted in the past one and a half years. Samples were obtained periodically from both raw and finished water. Each sample contained 20 liters of water. Initially, the samples were treated by dialysis against polyethylene glycol flakes, followed by a two-phase polymer separation. The final volume of each sample was about 20 ml, thus constituting a 1000x concentration of viruses therein. These concentrates were passaged three times in both primary monkey kidney and human embryonic kidney tissue cultures. During this period, 93 samples were examined. Viruses were isolated from some of these samples. It should be stressed, however, that the possibility of the isolates resulting from a lab contamination cannot be ruled out at this time.

Plans for FY-72: The effort will be increased in this year. The methods used to collect samples and to concentrate virus therein will be altered. The gauze sample will be used to collect water samples, the volume of each sample will be increased to 100 gallons. The eluate from each gauze sampler will be further concentrated by using the two phase polymer separation procedure. All concentrates will be examined for virus in primary monkey kidney and human embryonic kidney tissue cultures and suckling mice. Data relating to coliform tests of the supplies and treatment practices will be concomitantly collected.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0788, DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE
C.S. HEGRE, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

Objectives: To develop a method which will permit exposure of algal populations to constant low levels of test compounds, as well as monitoring of population dynamics or metabolic effects.

Procedures: 1. A suitable culture apparatus will be made and tested. 2. Normal population dynamics and optimal medium exchange rates will be determined. 3. The utility of the apparatus will be tested by determining minimal requirements for a few known nutrients.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0789, STUDY OF NITROGEN METABOLISM IN MARINE ALGAE
C.S. HEGRE, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

Objectives: To develop a method based on in vivo enzymatic activity which can be used as a bioassay parameter in determining the biological effects of potential pollutants.

Procedures: 1. An in vivo system for the assay of nitrite reductase activity in marine algae has been established. 2. Environmental factors which influence the expression of nitrite reductase activity will be investigated. 3. Cells preexposed to test compounds will be assayed for nitrite reductase activity. The results of such studies will be compared as indicators of biological effect with those of similar studies in which growth is measured.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0790, USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS
T.E. MALONEY, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

This project is concerned with the development of bioassay methods and techniques, employing various species of marine phytoplankton and zooplankton, for determining the toxicity and identity of pollutants in the marine environment and for determining and predicting the short- and long-term effects of lethal and sublethal concentrations of pollutants upon planktonic organisms and other organisms in the marine environment.

The test species will include those which are ecologically important and, in the case of zooplankton, their various life stages.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0791, REARING AND SENSITIVITY STUDIES OF VARIOUS LIFE STAGES OF MARINE MACROINVERTEBRATES
G. MORRISON, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

The goal of this project is to determine the relative sensitivity of various stages of marine macroinvertebrates to specific materials and the evaluation of marine invertebrates as indicators of extreme levels of known toxicants over extended periods.

This work will eventually be incorporated in broader areas of research to determine the effects of these toxicants upon growth, reproduction, activity, metabolism, and the activity of hormones and enzymes.

The organisms studied to date are the first larval stages of Callinectes sapidus, Carcinus maenas, Uca pugilator (?), and Palaemonetes pugio and their reaction to various levels of copper.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0792, RADIONUCLIDES IN SAVANNAH RIVER ESTUARY AND COASTAL WATERS
C.M. PATTERSON, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801

The objective of this program is to develop the capability to predict the fate of radionuclides in the Savannah River, its estuary and coastal waters. The distribution of selected radionuclides, primarily tritium, released by the Savannah River Plant will be studied. The wide range in radionuclides will require the use of many analytical techniques.

A facility for analyzing a wide range of tritium concentrations has been established and sampling and analysis has begun.

SUPPORTED BY U.S. Atomic Energy Commission

2.0793, FEASIBILITY STUDY OF WATER RESOURCE POLLUTANT IDENTIFICATION BY DIGITAL COMPUTER ANALYSIS OF REMOTE INFRARED SENSOR SPECTRAL INTENSITIES
B.E. GILLILAND, Clemson University, School of Engineering, *Clemson, South Carolina* 29631

This study will determine the effectiveness of a remote, multiband, solid-state, infrared sensing system as an aid in water resources management, including detection of industrial contaminants, thermal pollution surveys and surveillance, in the Piedmont area of South Carolina.

The research task of this proposal involves: 1) characterization of a representative sample of industrial pollutants in terms of their emission spectral signatures; 2) definition of a scanning infrared sensor system with appropriate optical and electronic instrumentation; 3) development of suitable algorithms for computer identification of pollutants using information obtained from the sensor array; and 4) laboratory and field testing a complete system including the correlation of the results with data obtained at the sites.

It is proposed that pollution events can be identified and monitored on-line in an essentially real-time operation. The final configuration of the system will use a small general purpose integrated circuit digital computer, plus the infrared sensing system, in an overall form that would be compatible with small commercial aircraft. This would afford federal, state and private agencies and organizations with an on-line means for monitoring municipal and industrial effluents.

SUPPORTED BY South Carolina State Government

2.0794, BIOLOGIC DETECTION AND CONTROL OF WATER POLLUTION
R.K. GUTHRIE, Clemson University, School of Agriculture, *Clemson, South Carolina* 29631

This project will determine the existing presence and balances of microbial populations. These determinations will be made by use of standard culture techniques and membrane filter-fluorescent antibody method at selected sampling stations in Hartwell Reservoir. Under laboratory conditions, the stability of relative populations and balances will be tested. The effects on populations and balances produced by selective additions of pollutants, will be determined. Attempts will be made to remove pollutants and reverse such pollution effects by controlled addition of selected microbial populations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0795, FEASIBILITY STUDY OF AERIAL PHOTOGRAPHY FOR DETERMINING PHYSICAL FEATURES OF TIDELAND & ESTUARINE AREAS, BEAUFORT CO., SOUTH CAROLINA
C.P. GUESS, State Water Resour. Commission, *Columbia, South Carolina* 29201

This study is to determine the feasibility of using aerial photography (and photo interpretation) to delineate significant physical characteristics of tideland estuarine areas.

This project will consist of making an aerial survey of designated tideland and estuarine areas of Beaufort County, South Carolina, and interpreting the photographs. Survey and related activities shall include: 1. The running of vertical and horizontal control into the area; 2. The reduction of tidal gage data to the Coast and Geodetic Survey Datum; 3. The establishment of tidal bench marks as required; 4. The performance of aerial photography with infra-red black and white film at mean high tide and also of infra-red color, pan-chromatic, standard and minus blue color film; 5. The preparation of a tideland base map showing cultural detail, edge of marsh, drainage, etc., but no final shore lines; 6. The addition of the mean high tide line to the base maps by various procedures basic to the purpose of the pilot project; 7. The field verification and checking of the various procedures used to delineate the mean high water shoreline, and the determination of the most suitable procedures for the different shoreline conditions; 8. Plotting of source and apparent extent of pollution on the base maps; 9. Feasibility of navigation channel bottom mapping and the addition of hydrographic contours to the base maps; 10. The investigation of the technical feasibility and economics of a land use study including the delineation of the limits of the salt water flood plain zone; 11. Narrative explaining procedures, problems, legal interpretation, limitations, and definitive estimate of the cost and time required to undertake the study on a statewide basis; and 12. Maps show-

ing the mean high water line as established by the survey, drainage pattern.

SUPPORTED BY Coastal Plains Regional Commission

2.0796, BACTERIOLOGICAL WATER QUALITY ANALYSES OF METHODS FOR DETECTING FECAL POLLUTION

P.R. MIDDAUGH, South Dakota State University, School of Agriculture, *Brookings, South Dakota* 57006

The proposed research involves laboratory and field investigations to improve the specificity, speed and reliability of bacteriological methods for determining kinds and number of fecal bacteria in surface water resources. The main objective is to develop bacteriological methods to distinguish between human versus animal sources of pollution by fecal indicator and pathogenic bacteria.

Laboratory investigations: 1. Fecal bacteria isolated from water samples would be used to evaluate modified bacteriological methods designed to detect differences in kinds and numbers of coliform, fecal coliform and especially fecal streptococci of human versus animal sources. 2. Samples of polluted surface waters would be stored in controlled laboratory environments to determine the relative rates of die-off coliform, fecal coliform, fecal streptococci and fecal pathogens e. g., salmonellae.

Field investigations would employ the bacteriological methods to determine the ratio of numbers of fecal coliforms and fecal streptococci in the same sample of selected stream and lake waters. This ratio has been reported to distinguish between human and animal fecal bacteria.

Laboratory and field data would be correlated for practical application in attempts to trace sources of fecal bacterial pollution of surface water resources and to attempt to distinguish between human and animal wastes with emphasis on farm animal wastes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0797, CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES

J.G. NICKUM, South Dakota State University, School of Agriculture, *Brookings, South Dakota* 57006

The research plan proposes to make it possible to describe the chemical, physical, and biological dynamics of heretofore unstudied lakes. This will provide information concerning the relationship between land use and water quality of lakes.

The project will study the present, the seasonal variation, and the possible year to year variation of water quality. This will be accomplished by biweekly sampling during June, July, and August, and monthly throughout the remainder of the year. In addition, samples of water flowing into the lakes will be taken whenever rainfall is sufficient to cause a runoff into each lake.

The chemical content of the water will receive special attention in that the levels of various chemical biocides in the ecosystem will be determined. Pesticide residues will include endrin, dieldrin, aldrin, heptachlor, heptachlor epoxide, DDT, DDD, DDE, lindane, toxaphene, and the chlorophenoxy compounds. Pesticide residues will be extracted from five types of materials including water, mud, plant material, small aquatic animals and fish.

The field data will be used to provide information concerning the relationship between land use and the dynamics of a lake.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0798, INVESTIGATION OF LAKE WATER QUALITY IN EASTERN SOUTH DAKOTA WITH REMOTE SENSING TECHNIQUES

F.A. SCHMER, South Dakota State University, Remote Sensing Institute, *Brookings, South Dakota* 57006

This proposed research is directed toward hydrologic research, utilizing remote sensing techniques, in eastern South Dakota with special emphasis on geology and its relationship to lake water quality. The specific objectives of this research are: 1. To determine the applicability of available remote sensing techniques for evaluation and monitoring the quality of lake water in eastern South Dakota. 2. To accomplish geological mapping, by utilizing remote sensing techniques combined with ground truth information, of 50 square miles surrounding 10 lakes in eastern South Dakota. 3. To relate variations of water quality in eastern South Dakota lakes to climatic conditions, seasons, changes in water level, and geology and hydrology of the surrounding area.

Remote sensing aircraft will be flown diurnally and seasonally over selected transects across the lakes and surrounding area under investigation. Flight schedules will take advantage of the time dependent characteristics and phenomena that may provide information for determining lake water quality and the causes of lake water quality fluctuations. Ground truth data including geologic information and water quality data will be collected.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0799, PHYSICAL STREAM INVENTORY OF THE MAJOR WATERSHEDS IN THE BLACK HILLS

R.D. GLOVER, State Dept. of Game Fish & Pk., *Pierre, South Dakota* 57501

Objectives: To document the factors responsible for the degradation of water quality and quantity in lakes and streams of the Black Hills.

Procedures: The major watersheds will be physically inventoried from their headwaters to the point at which they are no longer considered an integral portion of the Black Hills fishery. The inventory will involve walking the streams and recording observations on factors affecting water quality and quantity. No chemical or biological tests will be conducted. Observations will include: 1. Land ownership - private, state or federal, 2. Land use i.e. forestry products, cropland, grazing, etc., 3. Stream bank cover, 4. Pollution sources i.e. mining, homes, stock-yards, road grades, sewage treatment plants, etc., 5. Natural obstructions in the stream i.e. beaver dams, 6. Fisherman access to streams, 7. Topography.

Additional observations will be added according to need. Improvement recommendations will be made. Streams will be identified by proximity to their headwaters and subdivided into 4 sections A,B,C,D, i.e. Rapid Creek 1-A, would be the headwaters; 1-B the next one-fourth mile, etc. Rapid Creek, 2-A, would be the first quarter mile section of stream in the third mile below the headwaters.

The following is a tentative order of inventory: 1. Rapid Creek, 2. Spring Creek, 3. Castle Creek, 4. Boxelder Creek, 5. Spearfish Creek, 6. Elk Creek, 7. Battle Creek, 8. French Creek, 9. Fall River, 10. Cascade Creek, 11. Bear Butte Creek, 12. Englewood Creek, 13. False Bottom Creek, 14. Crow Creek, 15. Iron Creek (south), 16. Grace Coolidge Ck.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0800, PREOPERATIONAL AND OPERATIONAL RESERVOIR MONITORING - BROWNS FERRY NUCLEAR PLANT

B.B. CARROL, U.S. Tennessee Valley Auth., *Knoxville, Tennessee* 37902

The objective of this segment of these investigations is to determine species composition and relative abundance of fish in 67,000- acre Wheeler Reservoir prior to and following the introduction of heated cooling water from the Browns Ferry Nuclear Plant.

Fish samples are taken on a regular basis by electroshocking, gill nets, trap nets, and rotenone to evaluate relative abundance, diversity, density, growth, movement, food, and for radiological analyses, before and after the plant becomes operational. The plan has been amended to include a study of the production and survival of larval game fish in the littoral area above the plant before and following plant start up to appraise possible losses through condensers during operation.

Data for ten quarterly preoperational sampling periods have been collected and reported.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.0801, SURVIVAL OF INDICATOR ORGANISMS AND ENTERIC BACTERIA IN WATER
J.D. WOMACK, Univ. of Tennessee, School of Engineering, *Knoxville, Tennessee* 37916

The proposed work involves a study of indicator organisms and enteric bacteria in three areas. The survival of coliform bacteria and fecal Streptococci will be compared with other organisms found in the intestinal tract of man and in contaminated waters. Especial attention will be given to the enteric pathogens in the Salmonella group responsible for food intoxication. The effects of the employment of a new secondary treatment plant by the city of Knoxville, Tennessee on the survival and persistence of indicator organisms in Fort Loudoun Lake will be investigated. Also to be examined in this project is the effect of nitrogen nutrient levels on the growth and persistence of fecal Streptococci in lake water.

Field and laboratory studies will be conducted to measure the numbers of indicator organisms surviving in the lake. Time of flow will be determined with dye tracer techniques. Diffusion cell techniques will be employed to reveal the survival characteristics of enteric pathogens and naturally occurring pathogens will be investigated.

Data already in hand on the 'before' characteristics of Fort Loudoun Lake will be correlated with new information on survival of indicator organisms after the new secondary plant is brought on the line. This data will be taken from samples taken from the lake on a time-of-flow basis using dye tracer techniques.

The natural nitrogen nutrient level variations in a small lake will be related to the survival and growth of fecal Streptococci. Laboratory studies under controlled conditions will also be performed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0802, EFFECTS OF INDUSTRIAL EFFLUENTS ON PRIMARY PHYTOPLANKTON INDICATORS
B.R. STAUB, Christian Brothers College, Undergradute School, *Memphis, Tennessee* 38104

The purpose of the study is to select feasible indicator organisms from the completed sampling results of Project B004-Tenn on the natural aquatic communities of the Memphis area. Means of interpreting the community or population response of these phytoplankters will be sought in order to recognize the kind(s) or degree(s) of pollution involved. Diatoms and other primary producers will be investigated. Pure and mixed cultures will be utilized, originating from the Mississippi and Wolf Rivers and Nonconnah Creek. Statistical analyses using diversity index, maximum and minimum diversity, and redundancy will be pursued. The ion exchange properties of these selected organisms will be studied using labeled pollutants to determine adsorption isotherms, distribution coefficients, and rates of reaction so as to interpret the nature of the uptake.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0803, GEOHYDROLOGY OF SHALLOW AQUIFERS IN HENRY AND WEAKLEY COUNTIES, TENNESSEE
J. WILSON, U.S. Dept. of the Interior, Geological Survey, *Nashville, Tennessee* 37203

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Tennessee.

Purpose - To determine the cause or source of contamination of ground water and to appraise the shallow water-bearing formations.

Methods - An inventory of representative wells will be made. Water from wells will be sampled and analyzed to determine the bacteriological and chemical quality of ground waters. Test holes will be augered, observation wells will be constructed and pumping tests will be performed to define the areal extent and water bearing characteristics of shallow aquifers.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0804, INTERRELATIONSHIP OF METEOROLOGICAL FACTORS AND THERMAL PLUMES
P.D. KROLAK, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

An analysis of the random character of meteorological variables will be carried out. Time series analysis of the requisite data have been undertaken. The correlation of the various parameters with each other will be made. A sensitivity analysis of the results will be undertaken. For predictive purposes, to determine the maximum and minimum degrees of cooling of the heated discharge waters, a means of generating operational meteorological data similar to the methods of establishing an operational hydrology will be determined. It will then be possible to determine on a statistical basis the degree of impairment of the water resource to be expected per unit time.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0805, TEMPERATURE DISTRIBUTIONS RESULTING FROM COOLING WATER DISCHARGES
E.M. POLK, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

Additional field temperature distribution data for both the mixed and stratified cases of thermal discharges below power plants are necessary to adequately test proposed distribution models or develop new ones. A resurvey of the Johnsonville and Bull Run electric generating plants of the Tennessee Valley Authority will be carried out as they have both the mixed and the stratified categories which depend upon the flow levels in the receiving reservoirs. The John Sevier TVA site and others will also be studied this year. The non-conservative type of temperature distribution has not yet been studied. The major problem is to find plants which create a 10 degree F or higher mixed temperature rise in the receiving stream. The field work will include a variety of site geometries, river flow conditions, and meteorological conditions. Four of the sites tested to date have had densimetric Froude numbers of 0.257 to 0.970. The fifth site had a Froude number greater than one. During the survey of new sites, the densimetric Froude numbers will be determined. Sites will be sought that have a distribution of Froude numbers that are similar to the distribution Froude numbers at the sites surveyed. Theoretical work has been proceeding on wedges, jets, and diffusion models. The field data will enable evaluation of the mathematical models and provide guidelines for improving them. Laboratory studies have been carried out to determine entrainment coefficients, critical Froude numbers, and jet drag coefficients. Field data will be necessary to provide final verification.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0806, TEMPERATURE INCREASES BELOW DAMS
E.L. THACKSTON, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

Because mixed temperature rises in streams below thermal power plants are so small, the inverse of the problem, the heating up of cold hypolimnetic waters in streams might better be utilized to determine the individual components of the heat budget. The same physical mechanisms which contribute to the cooling of heated waters should also contribute to the heating of cooled waters. Therefore, we propose to test discharges from the hypolimnion below the dams. There are few sites at steam plants where the mixed river temperature is sufficiently above equilibrium to provide heat transfer rates which can be measured accurately. However, there are several hydroplants where the discharge temperature during the summer is as much as 40 degrees F below equilibrium temperatures. This should provide a fruitful opportunity for study, since the heat transfer mechanisms are essentially the same for heating and cooling.

The site chosen for this year's preliminary study is below Wolf Creek Dam on the Cumberland River in south-central Kentucky. There is approximately 80 miles of open river below the

dam to the first major tributary, and the outflow stays below 50 degrees F all summer. It is proposed to tag a slug of cold water within a fairly uniform discharge and follow it downstream for two days with drifting boats carrying weather equipment. The temperature of the water will be measured continuously and compared with predicted values computed from the measured weather data. A fluorometer mounted on one of the boats will be used to locate and follow the center of the dye cloud used to identify the slug of water to be monitored. Weather instruments will also be placed on the bank nearby. Data from the nearest U. S. Weather Bureau station will be tested for its ability to predict the rate of warming of the water at the river. This project was begun in August 1969 and is scheduled for completion in September 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0807, THE QUANTITATIVE DETERMINATION OF LEAD IN LAKE WATER VIA ATOMIC ABSORPTION SPECTROPHOTOMETER
H.D. MCAFEE, Univ. of Texas, Undergraduate School, *Arlington, Texas* 76010

The object of this work was to determine the adaptability of atomic absorption spectrophotometric techniques to the study of water pollution in terms of lead, cadmium, and other heavy metals. It was determined that these techniques could indeed be used in the detection of lead in trace (less than 0.2 mg/l) amounts.

The first series of tests were made on water from a lake which is used for municipal supply and for recreational purposes. Contamination of the water by lead tetraethyl was not apparent even though boat traffic on the lake is quite heavy. More tests will need be made in order to insure more complete coverage of the lake.

It is highly probable that this type of instrument can be used to help establish the quality of drinking water supplies. Furthermore, since it is desirable that heavy metal ions not be discharged into ordinary sewage treatment plants, this instrument could be employed by industrial plants and public health personnel to check on the quality of plant effluents.

Study to be extended to oxidation ponds.

SUPPORTED BY University of Texas - Austin

2.0808, SIMULATION OF WATER QUALITY IN STREAMS AND CANALS
W.A. WHITE, Frank D. Masch & Associates, *Austin, Texas*

Objective: To develop a set of interrelated water quality models capable of routing the following water quality parameters through a branching stream or canal system: 1. Temperature 2. Biochemical Oxygen Demand/Dissolved Oxygen, and 3. Conservative Minerals.

Approach: A set of interrelated quality models is developed for the prediction of the temporal and spatial distribution of temperature, biochemical oxygen demand/dissolved oxygen, and conservative minerals within a river basin. The governing differential equation is solved by an implicit-finite-difference technique under the assumption that advection along the primary axis of flow (longitudinal axis of the stream reaches) is the primary mode of transport. The models are verified with field data from a portion of a river basin containing multiple headwater sources, waste loadings, and branching streams.

SUPPORTED BY Texas State Government - Austin

2.0809, APPLICATION OF STOCHASTIC TECHNIQUES TO WATER QUALITY DATA ANALYSIS
A.O. WEISS, State Water Development Board, *Austin, Texas* 78711

Objective: To evaluate the feasibility of using stochastic techniques for generating conservative water quality parameters for deterministic and stochastically generated streamflow sequences.

Approach: A random component will be added to deterministically computed conservative water quality parameters (dissolved solids, chloride, and sulfate) to simulate the randomness inherent in measured water quality data. This technique will be capable of generating water quality parameters to correspond to discharges generated by either deterministic and statistical streamflow simulation models. The primary simulation model will be a statistical fill-in procedure in which unfilled data sets (water quality) will be filled-in using a complete data set (discharges) as reference. The fill-in model will use available water quality data to establish the population statistics and then will extend the record to the length desired, maintaining these statistics during the extension.

SUPPORTED BY Texas State Government - Austin

2.0810, MULTI-BASIN WATER QUALITY SIMULATION
W.A. WHITE, State Water Development Board, *Austin, Texas* 78711

Objective: To develop a computerized simulation technique for application to the analysis of quality constituents (conservative materials) in transfer links of a system of reservoirs and interconnecting transfer canals and river reaches such as the Trans Texas Division of the proposed Texas Water System.

Approach: A conservative mineral routing model will be developed to interface with existing multi-basin planning model (SIM-III and SIMYLD- I) which simulates the hydraulics of an interconnected network of reservoirs, pump canals, and river reaches. Specific goals are to: (1) insure that the various plans analyzed by SIM-III and SIMYLD-I are capable of delivering water at quality levels suitable for all intended uses, (2) evaluate the effects that various prespecified quality standards have on the cost of the water delivered, and (3) evaluate the effects that urbanization and other land use changes have on the quality levels of the streams and of the reservoirs into which streams flow.

SUPPORTED BY Texas State Government - Austin

2.0811, URBAN HYDROLOGY STUDY - SAN ANTONIO, TEXAS
E.E. SCHROEDER, U.S. Dept. of the Interior, Geological Survey, *Austin, Texas* 78701

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Texas.

Purpose: To provide data for a logical approach to flood-zoning and flood-protection problems, and to analyze the effects of progressive urbanization on the runoff. Data will also be useful in design of storm sewers, culverts, and bridges.

Methods: An adequate sampling will be made of data with respect to flood discharge as affected by time, variations in rainfall through climatic cycles, size of area, and degree of urbanization of area. This sampling will be accomplished by installation of streamflow stations, crest-stage stations, and rain gages at appropriate locations. The instrumentation will be done on pairs of small drainage basins within the metropolitan area. One basin of a pair will be chosen to represent urbanized conditions, the other will represent the undeveloped conditions. In so far as possible, the pairs of basins will be chosen so that the other factors such as geology, topography, and size will be equal.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0812, LIMNOLOGICAL INVESTIGATIONS OF TEXAS IMPOUNDMENTS FOR WATER QUALITY MANAGEMENT PURPOSES
E.G. FRUH, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

The seasonal change in water quality parameters such as dissolved oxygen, pH, precipitates, nutrients, and microorganisms will be measured in seven sub-tropical impoundments within a 150 mile reach of the Lower Colorado near Austin. Field surveys will be conducted below the impoundments to determine the effect of releases on the water quality of the downstream impoundment. The data will serve as a model for future river systems which have been transformed from a free-flowing river to a series of slack-water pools with intermittent river reaches.

In the last year of the project, major emphasis will be placed on determining what effect additions of different quality waters

(through a diversion project or pollution) would have on the water quality of the impoundments. Various nutrient enrichment studies will be conducted under different temperature and light conditions. Carbon- 14 bioassay techniques will be utilized to determine limiting nutrient concentrations. Similar tests will be conducted using additions of river waters most likely to be diverted to the Texas Colorado River Basin in any future state water plan.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0813, MODEL RIVER SYSTEM STUDIES
E.F. GLOYNA, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

The objective of this project is to provide information concerning the behavior and effects of radionuclides released to aquatic systems during continuous low-level discharge conditions or accidental high- level spills from reactor, waste processing, or laboratory sites. This information will be used to develop a reliable mathematical model which, when given several factors easily measured in the systems, will facilitate an evaluation of the actual or potential impact of a particular facility on safety and public health. A model river system consisting of a flume 200 ft. long, 2.5 ft. wide and 2 ft. deep has been and is being used to isolate and study variables such as the change in transport of radionuclides as caused by induced pollutional loads, clay suspensions, pH variations, chemical concentrations, and the dynamics of radionuclide transfer from water to plants and sediments. Specific emphasis is given to determining the behavior of Co-58, Sr-85, Cs-137, Zn-65, and Cr-51. All flume experiments are preceded by detailed laboratory and aquaria investigations.

A series of experiments have been conducted to determine the delay in transport of radionuclides caused by the interaction between flowing water and bed sediments. The relative concentration of radionuclides on the surface of the bottom sediments to that in the bed sediment was found to be a function of the depth of bed sediment from the surface, diffusion coefficient in water and time after migration started. A computer program has been developed and tested through prediction of hydraulic dispersion uptake and release of radionuclides by bottom sediments and plants in a flowing flume, simulating river processes. This program is adapted for prediction of radionuclides transport in a real river.

SUPPORTED BY U.S. Atomic Energy Commission

2.0814, INSTRUMENTATION FOR ENGINEERING MANAGEMENT OF A MULTI-PURPOSE RIVER BASIN SYSTEM
E.F. GLOYNA, Univ. of Texas, Ctr. Res. in Water Resources, *Austin, Texas* 78712

The proposed research plan involves various conceptual interaction studies to determine the data acquisition and monitoring instrumentation system requirements on a major, multi-purpose river basin system in order to achieve the extremely high degree of water quality and water multi-use management which is envisaged for this engineering operation.

The specific area of the study is the Trinity River Canalization and tributary projects which are part of the comprehensive basin program.

The studies will evaluate the performance of specific water quality monitoring networks, the status of automation in data transmission recording, storage and retrieval and also sensing and detecting devices as applied to stream gaging, flood routing, navigation lockages, and water quality sampling. Hence, the studies will evaluate the major elements of information engineering with the view toward developing feasible applications for the efficient operation and management of comprehensive, multi-purpose water system.

These factors will be explored in detail, including the economics of the instrumentation system.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0815, PRECISION RATIO GAS-SOURCE MASS SPECTROMETER
W.R. MUEHLBERGER, Univ. of Texas, School of Arts, *Austin, Texas* 78712

The precision ratio gas-source mass spectrometer will be used in the determination of C13/C12,O18/O16 and D/H ratios in the following selected studies. D/H chemistry of natural waters and hydrated minerals as indicators of carbonate and silicate deposition and diagenesis, specifically: 1) D/H chemistry of bauxite minerals and its bearing on the origin of bauxites. 2) D/H chemistry of clays in Baffin Bay, Texas, a hypersaline lagoon, and its bearing on the recent history of the bay, and clay diagenesis. 3) Isotopic chemistry of selected organic compounds, Baffin Bay, Texas. Interaction of organic compounds, particularly fatty acids, and carbonate sediments, and diagenesis of organic compounds. 4) Carbon, oxygen, and hydrogen isotope studies of natural waters and recent carbonate and sulfate minerals from the Persian Gulf, and 5) Biogeochemistry of recent oysters, Texas coast, and determination of the history of sedimentation (including pollution) in Texas bays.

SUPPORTED BY U.S. National Science Foundation

2.0816, MACROBENTHOS AS INDICATORS OF ECOLOGICAL CHANGE
R.C. HARREL, Lamar State Coll. of Technol., School of Science, *Beaumont, Texas* 77704

The objective of this project is to correlate community structure of benthic macroinvertebrate with ecological changes in a 30 mile section of the lower Neches River.

The resulting information could be used to predict ecological effects of river basin development, and serve as a reference for future studies.

Physico-chemical conditions will be measured according to standard methods. Total oxygen demand will be made with an Ionic Total Oxygen Demand Analyzer by the Chemistry Department. Macrobenthos will be collected by dredge and artificial substrate samplers. Community structure will be determined in terms of numbers of species and individuals, indicator organisms, and diversity indices.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0817, THE MOLECULAR NATURE OF ORGANIC WASTE REMOVAL PATTERNS
W.B. DAVIS, Texas A & M University System, School of Engineering, *College Station, Texas* 77843

The objectives of this project are: 1. To investigate the behavior of organic compounds in activated sludge systems. 2. To investigate the use of analytical techniques including total organic carbon and gas chromatography in the characterization of natural waters with regard to identification of organic components.

In accordance with stated objectives, the behavior of representative organic chemicals will be investigated with regard to (a) rate and extent of removal from solution, (b) characterization of intermediate products in solution, (c) effects of molecular structure, and (d) interference effects in multi-component systems. All analytical data will be catalogued for reference value. Work will be oriented in the following direction: 1. Chemical: Development of analytical techniques and testing of substrate response in mixed culture batch reactors. 2. Engineering: Application of continuous treatment design innovations to multi-component systems of unusual response characteristics. 3. Microbiological: Isolation of species and relation of species predominance to substrate characteristics.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0818, ELECTRICAL LOGGING IN AQUATIC ENVIRONMENTS
W.E. SWEET, Texas A & M University System, Sea Grant Program Office, *College Station, Texas* 77843

2. WATER QUALITY

This project is designed to a) develop quantitative in situ and laboratory electrical logging hardware and technique, b) define the relationship between the electrical properties and the chemical, physical, and engineering properties of recent sediments, and c) result in computer models capable of reducing the electrical measurements to a variety of desired parameters. These techniques will provide a quick, accurate and inexpensive means of making sediment distribution and sediment property maps useful in pollution control work, offshore foundation work, and offshore mining. The costly and time consuming coring programs now used for such work can be vastly augmented and, in many cases, replaced by electrical logging.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0819, REMOTE SENSING - TEKTITE, VIRGIN ISLANDS

L.E. GARRISON, U.S. Dept. of the Interior, Geological Survey, *Corpus Christi, Texas* 78411

States to which project pertains: Puerto Rico - Virgin Islands.

The U. S. Geological Survey participated in the man-in-the-sea experiment Tektite I and anticipates participation in Tektite II during calendar year 1970. These experiments are conducted in tropical waters off St. John in the U.S. Virgin Islands. Inasmuch as they require a considerable amount of seafloor mapping, the experiments provide an excellent opportunity to combine observations from space with a man-in- the-sea program, and to evaluate the use of remote sensing in the study of the tropical reef environment.

The recent population explosion of 'Crown of Thorns' starfish and consequent rapid destruction of segments of reefs indicates the necessity of monitoring reef areas. Satellite observations spaced widely in time may provide early warning data on gross changes resulting from removal of beach and nearshore sand for building purposes, from pollution of nearshore waters or from basic changes in life forms.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0820, ION SELECTIVE ELECTROCHEMICAL SENSORS

I. TRACHTENBERG, Texas Instruments Incorporated, *Dallas, Texas* 75222

Continued investigations of ion-selective electrochemical sensors have demonstrated that several of these sensors can be used in continuous monitoring of a wide variety of polluted, saline, and brackish waters. The current investigation places particular emphasis on Ca, Mg, Fe(3), Mn and SO4 ions. New solid state sensors have been developed which show considerable promise for monitoring Ca, Mg, and Fe(3) ions. Emphasis is currently directed to novel material systems for use as ion-selective sensors. Nonoxide glasses with varying dopants have proved useful sensor material. Doped semiconductors have exhibited a variety of responses, but increased selectivity requires additional investigations of the kind and amount of dopant and the doping process used to make the material. Doped non-semiconductor single crystals will also be prepared and tested as sensor materials. Sensor materials will be used to construct sensors in electrode and/or membrane configuration. Sensors will be evaluated for selectivity and sensitivity, particularly in terms of interferences and limits of detectability.

SUPPORTED BY U.S. Dept. of Interior - Off. Saline Water

2.0821, VIRUSES IN SURFACE WATERS -DEVELOPMENT AND APPLICATION OF NEW CONCENTRATION METHODS

J.L. MELNICK, Baylor University, School of Medicine, *Houston, Texas*

The isolation of viruses from natural waters has been carried out usually with relatively crude and insensitive procedures (literature reviewed in Transmission of Viruses by the Water Route, edited by G. Berg, 1966). Recently this laboratory has developed new methods for detection of small amounts of virus in large volumes of sewage and other natural waters. These methods consist of the adsorption of viruses to and elution from (a) insoluble salts, (b) cellulose membranes, and (c) insoluble polyelectrolytes.

Under this grant, these studies will now be expanded toward development of field equipment for clarification of large volumes of surface waters prior to virus isolation, and for concentration of viruses in the field. This will avoid the receipt and handling of 100- gallon samples in the laboratory, permitting instead a very small and highly concentrated sample to be easily transported to a virus testing center to be assayed for its virus content. The methods developed will be applied in comparative testing for isolation of viruses such as polio viruses, echo viruses, and coxsackie viruses. Water purification steps in use or under consideration will be monitored as to their effectiveness in removing viruses that infect human beings.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0822, A MODEL RELATING WATER QUALITY VEGETATIONAL STRUCTURE AND URBANIZATION IN THE SAN JACINTO RIVER BASIN

D.L. JAMESON, Univ. of Houston, Graduate School, *Houston, Texas* 77004

We propose to analyze the correlation between vegetational structure, amount and kind of land utilization urbanization and the chemical and biological measures of water quality in the San Jacinto River Basin, Texas. The initial parameters will be obtained from government documents, reports already available or currently obtained (weather and hydrographic stations). These measures are assumed to be available to any metropolitan region which should give the model structural generality. Principal component analysis will be used for data reduction. Canonical correlation analysis will be used to obtain a preliminary estimate of the significant parameters. Multiple discriminant analysis will be used to identify the significant variables correlated with specific water quality stations. The data from these analyses will be used to construct a model which will characterize the present situation. The parameters of this model will then be manipulated with simulation programs in computers to attempt to predict the course and nature of water quality changes during the continued expansion of urbanization in the vicinity of Houston, Texas.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0823, STABLE ISOTOPE VARIATIONS IN BIOGEOCHEMICAL SYSTEMS

P.L. PARKER, Univ. of Texas, Graduate School, *Port Aransas, Texas* 78373

This is a continuation of NSF Grant GA-911 and it is planned to extend the research already done on ways to use measured variations in stable carbon and oxygen isotope ratios to solve problems concerning the flow of these elements in biogeochemical systems. These studies will be extended to stable nitrogen isotopes. Such biogeochemical systems will include rivers, lakes, marine bays and near-shore Gulf of Mexico, as well as single species of organisms, sewage systems and industrial plants.

The stable isotope ratios, especially of carbon, of the dissolved organic matter in natural and polluted systems will be studied as possible markers or tracers for both pollution and natural events.

The stable carbon isotope ratios of a large number of organic molecules isolated from living organisms and from recent and ancient sediments will be measured with the purpose of establishing chemical precursor-product relationships for these molecules.

Isotope fractionation in the biological cycle of oxygen will be investigated. These will include dissolved O2 as well as oxygen containing organic compounds.

SUPPORTED BY U.S. National Science Foundation

2.0824, DEVELOPMENT OF SAMPLE PREPARATION METHODS FOR ANALYSIS OF MARINE ORGANISMS

H.C. MCKEE, Southwest Research Institute, *San Antonio, Texas* 78228

In this program, methods of sample preparation will be developed for processing, extracting, purifying, and concentrating specific chemical pollutants absorbed and retained by marine organisms so that chemical analysis to measure contaminants can be carried out. These methods, in turn, will be useful in the development and application of new techniques for water quality monitoring based on the analysis of marine organisms.

It is known from previous work that many species of marine life absorb various impurities from the water in which they live. Marine specimens can then be analyzed to identify and measure contaminants, even though concentration of contaminants in the water may be below the limit of detection of even the most sensitive analytical methods. In some cases, the results of such analyses provide a more direct indication of the effects of contaminants on marine life than measurements performed on water samples, especially where cumulative effects may occur over a period of time.

This program is based on a background of experience in trace analysis which has been developed over a period of many years. Methods are now available to measure trace materials in the parts per million and parts per billion range using a great variety of samples. In specific instances, these techniques have been used to measure trace contaminants absorbed and concentrated by fish and other marine organisms. These methods will be modified as necessary to provide appropriate techniques for monitoring water quality by measuring absorbed contaminants in various types of marine life.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0825, CONSTRUCTION OF WASTE WATER SAMPLING AND ANALYTICAL EQUIPMENT
H.C. MCKEE, Southwest Research Institute, *San Antonio, Texas* 78228

No summary has been provided to the Science Information Exchange.

SUPPORTED BY No Formal Support Reported

2.0826, GEOCHEMISTRY OF WATERS OF THE HOG CREEK BASIN - HAMILTON, CORYELL, AND BOSQUE COUNTIES, TEXAS
T.H. MOORE, Baylor University, Graduate School, *Waco, Texas* 76703

The purpose of this study was to determine the change in water quality from the time it falls as rain near the headwaters of Hog Creek, Bosque County, until it becomes part of surface flow, about 19 miles downstream along the stream course of Hog Creek. Chemical tests were used to determine the quality of rainwater, spring water, and runoff. Special attention was given to waters which drain from farm lands, to determine if fertilizers have any effect on the quality of water in Hog Creek. Runoff water from each of the formations which crop out in the basin area was sampled to determine effect on the stream. The primary aquifer, the Edwards Limestone, was listed to determine chemical composition. A study of the structure of the Edwards Limestone was made to determine how large an area was drained by the aquifer to flow into Hog Creek as spring water. An effort was made to see if the length of time the water remained in the aquifer had any effect on the quality of water. The contributions of plants and other life on water quality were determined.

SUPPORTED BY Baylor University

2.0827, DEVELOPMENT OF NUCLEAR TECHNIQUES IN THE STUDY OF WATER POLLUTION PROBLEMS
G. EDEN, Water Pollution Research Lab., *Stevenage, England, United Kingdom*

Development of nuclear techniques in the study of water pollution problems (part of a coordinated programme of research on the study and improvement of biosphere resources).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.0828, LIMNOLOGY OF LAKE CHAMPLAIN
M. POTASH, Univ. of Vermont, State Resources Res. Center, *Burlington, Vermont* 05401

The objectives of the project are twofold; (1) to carry out field studies on Lake Champlain to determine, as far as possible, its physical, chemical, and biological characteristics; and (2) to continue long-term studies to determine whether these characteristics are being altered in any harmful way, or in any region of the lake, by the addition of pollutants.

Immediate research will concentrate on obtaining further descriptive information on such characteristics as temperature, light transparency, oxygen, pH, carbon dioxide, nutrients, currents and water flow, and bottom sediments. After the basic character of the lake had been described, continued research will be carried out to determine the biological character of the lake. As far as possible, research will emphasize the distribution and quantity of phytoplankton, zooplankton, benthic organisms, correlating their patterns with environmental data previously obtained.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0829, EVALUATION OF THE BIOLOGICAL AND PHYSICAL ENVIRONMENTAL PARAMETERS OF WATERSHEDS
S.H. KUNKLE, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Danville, Vermont* 05828 (SWC-027-ADA-4)

OBJECTIVE: Study concentrations, distributions, and migration of coliform, fecal coliform, and fecal streptococcus bacteria on a watershed; measure bacterial concentrations in streams in relation to chemical, physical, and hydrologic factors; investigate cycles of bacteria in streams, describe the migration of bacteria from watershed to stream, relate bacteria group to depth, physical characteristics, and soil moisture; and to evaluate bacteria populations in soils with reference to land use patterns.

APPROACH: Stream sampling stations will be established at several weirs along the main branch of the stream. Additional sites will be added as needed. Weekly samples will be collected from spring to autumn with additional sampling during major storm events. Soil samples from both forested and agricultural sites will be collected to evaluate concentrations and distribution of bacteria. Movement of bacteria from watershed to stream will be evaluated by plot irrigation and sampling of subsurface flows.

PROGRESS: Concentrations and cycles of two pollution-indicating bacterial groups were monitored in a small stream and on an adjacent runoff plot in Northeastern Vermont. The concentrations of these organisms in storm runoff from a partially grazed watershed rose to 50 or more times the usual non-storm values and were distinctly related to stream discharge. Total coliform concentrations in runoff from a non- grazed hay field were similar in magnitude to concentrations in the entire watershed's runoff. Results indicate that total coliform data are questionable as an indicator of pollution in rural watersheds. The fecal coliform density is a better indicator of pollution from animal waste

SUPPORTED BY U.S. Dept. of Agriculture

2.0830, RI - AN EVALUATION OF THE BOD TEST
E.M. JENNELLE, Virginia Polytechnic Institute, School of Engineering, *Blacksburg, Virginia* 24061

The research is directed towards improving one of the most serious shortcomings of any water pollution abatement program or water resource planning,i.e. a reliable means of measuring the strength of a wastewater or evaluating the efficiency of a wastewater treatment process. The biochemical oxygen demand (BOD) and the kinetics of the oxygen uptake will be evaluated and correlated with the change in total carbon, anthrone carbohydrate, protein and chemical oxygen demand.

Domestic sewage will be employed as substrate. Experiments will be conducted using sewage collected from each of the following stages of treatment. (1) raw sewage, (2) effluent from primary sedimentation, and (3) effluent from secondary sedimentation. It is proposed that the nature and composition of the organic con-

stituents of the sewage change during the treatment process, and that the biochemical oxygen demand test as it is currently employed is not a satisfactory measure of the treatment process nor is it a suitable parameter for use in establishing effluent standards.

SUPPORTED BY U.S. National Science Foundation

2.0831, WATER POLLUTION
R.G. KRUTCHKOFF, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0200176)

OBJECTIVE: Extend the work done on pollution in streams to estuaries.

APPROACH: Find a theoretical stochastic model for pollution in estuaries and check out the model with actual data.

PROGRESS: Work completed this year: a) A Program Extension to Pollution in Streams, b) A Stochastic Model for Biological Oxygen Demand and Dissolved Oxygen in Estuaries. Work Continuing: a) Estimating the Parameter delta For the Stochastic Model for Pollution in Streams.

SUPPORTED BY Virginia State Government

2.0832, WATER COLUMN TESTING OF FERTILIZERS
N.S. PROSSER, State Comm. of Game Inl. Fish., *Richmond, Virginia*

Water columns will be randomly paired and treated with various combinations of commercially marketed fish pond fertilizer. Elemental additives will also be applied if water analyses indicate a particular element may be present in such low quantities as to restrict primary productivity. Periodic estimates of gross photosynthesis will be made on a specificed sampling schedule during each 10 day test period. Upon initiation of each sampling period, gross photosynthesis will be measured on the 3rd, 5th, 10th and 17th days. In the beginning, 2 techniques will be employed for the measurement of gross photosynthesis; a light and dark bottle method and a diel oxygen curve method. Later on, the technique yielding the least reliable data will be eliminated.

Information will be evaluated at the end of each 10 day interval. Additives or fertilizers exhibiting little beneficial results will be discontinued in the succeeding 10 day testing period, being replaced by untested materials. Aaterials substantially increasing productivity, when opposed to controls, will again be replicated. Testing will be terminated when surface water temperatures of the lake approach a 70 degree F temperature.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0833, BOTTOM FAUNA COMPOSITION STUDIES
E.W. SURBER, State Comm. of Game Inl. Fish., *Richmond, Virginia*

Project Objective: To determine if eutrophication of the Shenandoah River is taking place, to what extent if any, and to determine if eggs, fry and young of smallmouth bass are being affected; also, to determine species of bottom fauna inhabiting the river.

Job Objective: To identify the species of bottom animals that occur in the Shenandoah River and to relate this information to available life history information.

Procedures: Many bottom fauna samples are on hand and a series of preserved specimens will be selected from the samples for the purpose of species identification. Adult and sub-imagos of mayflies will be collected at intervals throughout the year so that these stages can be associated with the nymphal forms found in the river. Certain species of Cheumatopsyche are often the most abundant caddisflies in zones of the river and rearing of these species to identifiable forms will be required. Cages will be placed in the river at convenient points. Larvae of midgeflies will be brought into the labororatory for rearing in order that identifications can be made from adult forms. Lights will be used to attract and collect insects emerging after dark at selected stations along the river. Collections will be made on a seasonal basis. Photographs of nymph, larvae and adult stages of insects will be taken using microscope attachments and camera extension tubes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0834, A PRE-IMPOUNDMENT ECOLOGICAL STUDY OF THE BOTTOM FAUNA AND WATER QUALITY IN THE NORTH ANNA RIVER
G.M. SIMMONS, Virginia Commonwealth Univ., Graduate School, *Richmond, Virginia* 23219

This proposed research problem is directed toward evaluating the composition of bottom fauna and water quality in a river which will soon be dammed and used as a coolant for nuclear reactors. The main approach of this investigation will be to establish baselines of existing water quality (biological, chemical, and radiochemical) in order to evaluate future effects of nuclear power operation on the aquatic environment receiving the thermal effluent and possible radionuclides.

Field investigations will employ the following methods: 1. Collecting existing bottom fauna in river by qualitative and quantitative means. 2. Establishing artificial substrates, if necessary, to facilitate qualitative collecting. 3. Evaluating the physical properties of existing stream flow conditions.

Laboratory investigations would employ the following methods: 1. Rearing necessary organisms for species determination. 2. Analyses of bacteriological, chemical, and radiochemical properties of water.

The data collected from this study will be correlated with ecological data obtained after the river is impounded to assist responsible personnel in water resource management.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0835, DETECTION OF PATHOGENS IN WATER
G.J. BURNS, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Gig Harbor, Washington* 98335

Investigations of the effects of procedural variations on the efficiency of methods for the recovery of 'Salmonella', 'Shigella' and the Arizona group from water are being continued. The most promising methodology variations will be incorporated into a comparative study involving various types of natural fresh and estuarine waters.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0836, DEVELOPMENT OF METHODS FOR ISOLATION AND ENUMERATION OF VIRUS FROM WATER
W. JAKUBOWSKI, U.S. Environ. Protection Agcy., Northwestern Water Hyg. Lab., *Gig Harbor, Washington* 98335

The objective of this project is the development of methods for concentrating and enumerating human enteric viruses in drinking and recreational waters. Studies on the efficiency of poliovirus removal and recovery from water by adsorption to iron oxide, charcoal and a polyelectrolyte (PE60) will be continued. The methods in use will be scaled up to process tap and estuarine water volumes on the order of 50 to 100 gallons. Virus multiplicities to be tested will be at least as low as 1 PFU/gallon. Optimum conditions of adsorbent load, filtration pressure and flow rate will be investigated. Further studies will be conducted on factors affecting elution of adsorbed virus.

Continuous flow centrifugation will be examined as a method for concentration of viruses from turbid waters. Kaolin, bentonite and precipitated aluminum hydroxide will be added to water samples of up to 10 gal. and compared for efficiency of virus removal and recovery. The effects of centrifugation speed, flow rates and adsorbent concentration will be determined.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0837, DETECTION AND SIGNIFICANCE OF KLEBSIELLA IN WATER
G.J. VASCONCELOS, U.S. Environ. Protection Agcy., Northwestern Water Hyg. Lab., *Gig Harbor, Washington* 98335

The objective of this project is to determine whether high numbers of Klebsiella in water competitively suppress the growth of recognized coliform indicator groups during enumeration by the membrane filter method. Since coliforms are often used assessing the bacterial quality of recreational and potable waters,

the inhibitory influence of so- called nuisance organisms must be considered in the final sanitary evaluation of any body of water. Methodology will be established for the quantitative differentiation of Klebsiella from coliform and other related Enterobacteriaceae. Differentiation will be accomplished by observation of morphological features and reactions on various biochemical media designed to elucidate specific phenotypic characteristics. Once methodology has been established, the recovery rates of low densities of coliform (Escherichia coli and Aerobacter aerogenes) from water containing high concentrations of Klebsiella (10 to the 4th power or more) will be compared with samples containing similar numbers of coliforms but no Klebsiella. The study will involve both fresh and estuarine waters. Comparisons will be made of numbers of coliforms recovered versus number of Klebsiella present. Studies will include field investigations of waters where high levels of Klebsiella are thought to be present.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0838, TESTS OF EFFICIENCY OF CHANGES IN FILTER DESIGN AND FILTER MEDIA
R.E. BURROWS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Longview, Washington* 98632

Objective: To test efficacy of upflow filter as compared to the conventional downflow biological filter and artificial media as compared to sharp rock for the removal of ammonia in reuse systems.

Procedure: To test both the upflow filter and artificial media, a 20-foot, circular, fish rearing tank will be assembled, 2-4x20 upflow filters constructed, and pumps, piping, and aeration tank installed. One filter will have 320 cu. ft. of Koroseal plus 80 cu. ft. of oyster shell to provide 11,840 sq. ft. of area in the Koroseal. The second filter will have 320 cu. ft. of fiber glass and 80 cu. ft. of oyster shell to provide 25,280 sq. ft. of area in the fiber glass. The flow through both filters will be 300 gpm or slightly less than 2 gpm. per square foot of area. Supplemental water will be added to the circulating flow at the rate of 10 percent. Tests will be conducted under conditions with normal fish loads to determine if the area per cubic foot of artificial media is a factor in denitrification. If the fiber glass filter does not prove to be more efficient than the Koroseal it will be dismantled and sharp rock substituted. During operation, chemical tests will be conducted to determine the quality of both the overflow and backwash water for comparison with the conventional reuse system.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0839, DEVELOPMENT OF AN IN SITU MARINE BIOASSAY WITH CLAMS
C.E. WOELKE, State Dept. of Fisheries, *Olympia, Washington* 98501

The basic objective of this study is to develop a bioassay of Pacific Coast estuarine water with embryos of indigenous species of clams and demonstrate its use to detect, monitor, and biologically quantify the effects of pollutants in the natural environment.

To achieve this goal the seasonal reproductive cycles of seven major species of clams, as determined from histological examination of adult clam gonads, will be related to those environmental factors which might be expected to affect their spawning. The results of this phase of the study will be employed in developing techniques for controlling gonadal maturation and spawning of as many species of clams as possible. Fertilized embryos from controlled spawnings will then be used to bioassay known toxicants and marine water samples under controlled laboratory conditions.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0840, CORRELATED STUDIES OF VANCOUVER LAKE--WATER QUALITY PREDICTION STUDY
S.K. BHAGAT, Washington State University, School of Engineering, *Pullman, Washington* 99163

Vancouver Lake, Washington, in its present state is shallow and polluted but it has the potential of becoming a valuable water resource. The lake is connected with the Columbia River on its north end and it is the only water access to the lake. There are plans to dredge the lake to a depth of 10-15 feet as well as connect the lake on its south end with the Columbia River.

The primary object of this study is to predict the effect of the planned changes on the water quality of the lake and to see if the usefulness of the lake can be improved by these changes.

The plan of operation includes determination of the existing water quality of both the Columbia River and the Vancouver Lake; predictions of obtainable water quality in the lake based on the considerations of channeled flow from the Columbia River, changes in the lake depth, improvements in present pollutional loadings and the removal of organics and nutrients in present bottom sediments. Residence times and flow patterns will be obtained from the hydraulic model study being conducted by the Albrook Hydraulic Laboratory of this university.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0841, THE PREDICTION OF WATER QUALITY ASPECTS OF THE WENATCHEE RIVER
H.D. COPP, Washington State University, School of Engineering, *Pullman, Washington* 99163

A pumped-storage hydroelectric power development has been proposed by the Sponsor on the Wenatchee River, a mountain stream in north central Washington State. Since this river is an important fish spawning stream, tributary to the Columbia River, and since recreation activity is increasing in the watershed, influences of the proposed power project on existing water quality need to be predicted.

Simulation techniques by digital computer are being developed for prediction purposes. Weather phenomena, system hydrology, heat transfer, principles and mixing processes have been programmed for both reservoir and stream waters to compute temperatures and oxygen and nitrogen contents in these waters. A program is operable and is quite general, i.e., it is not tied to the system under consideration. At present, July 1967, program optimization, process simulation mechanics, and logic continuity are under critical review.

SUPPORTED BY Chelan County Government - Washington

2.0842, ADVANCE WARNING OF GROUND-WATER POLLUTION HAZARDS, WITH SPECIAL REFERENCE TO AQUIFERS IN GLACIAL OUTWASH
J.W. CROSBY, Washington State University, State Water Research Center, *Pullman, Washington* 99163

It is proposed to study methods of providing advance warnings of pollution build-up so that public health hazards can be avoided. The research is to be done on the Spokane Valley aquifer where conditions now exist which are conducive to contamination of the Spokane water supply. Geoelectrical methods, utilizing both standard and specially designed probes, will be investigated and comparison drawn between electrical properties of the groundwater and water quality analyses. The desirable end result of the project would be to establish rapid, routine methods of identifying polluted zones in stratified groundwaters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0843, SURVIVAL OF INTESTINAL BACTERIA IN PRISTINE WATERS
D.L. JOHNSTONE, Washington State University, School of Engineering, *Pullman, Washington* 99163

A comparison of regrowth and die-off rates of pathogenic and non- pathogenic bacteria of intestinal origin will be studied in pristine waters. The recreation potential of our pristine waters are being developed to their fullest. With this increase in pressure on these types of waters the possibility of fecal contamination is a very real threat. However, there is no data available on the comparative survival of intestinal bacteria in high quality waters. Without such comparison we can determine the necessary degree of treatment of wastes nor the health hazard associated with pristine waters even though they may be routinely tested for coliforms.

2. WATER QUALITY

Samples will be collected from pristine streams, only recently accessible, over a period of two years to encompass the annual water cycle. Initially the samples will be characterized bacteriologically and chemically. After the initial profile is established, samples will be either filtered or used raw and innoculated with known numbers of the organism to be tested. Kinetics of survival will be ascertained under aerated and static conditions at selected low temperatures over extended time periods.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0844, GEOCHEMICAL OCEAN SECTION STUDY

R.W. PERKINS, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

GEOSECS is designed to perform a systematic world survey of the chemical and radiochemical components of the ocean. Where appropriate and practical, measurements of these components in the overlying air and underlying sediments will be included. This investigation includes trace element studies, natural and artificial radionuclide measurements, and a Be-7 air to sea exchange study. Trace element measurements for 10 to 12 ocean water constituents can be made by direct counting of neutron activated seawater. Samples collected on each of the depth profile samples will be analyzed for this element group. An additional group of some 20 elements requires group or specific separations and will be measured on selected depth profiles. Some 15 to 20 natural and artificial radionuclides will be measured on the various depth profiles. It is planned that the natural radionuclides U-238, Th-234, Ra-228, Ra- 226, Pb-210, and Be-7 will be measured. Concentrations of the airborne radionuclides will be monitored continuously during the sampling program to provide a basis for defining the rate of air to sea transfer. Surface layers of the ocean bottom sediments will be obtained at each collection site to permit an estimate of the sedimentation rates from the overlying water columns.

Results: Seawater samples collected during a pre-GEOSECS testing cruise at 16 depths between the surface and 4000 meters in 30-liter modified Niskin bottles were analyzed for their trace element content. The samples are providing information needed to determine the optimum sampling and storage methods to be used. Analysis consists of neutron activation and direct gamma-ray spectrometry utilizing multidimensional and GE (Li) analyzers. Preliminary analysis of the seawater samples indicates that the method of storing the samples is a critical factor.

SUPPORTED BY U.S. Atomic Energy Commission

2.0845, TESTING METHODS FOR EVALUATION OF BOTH EFFECTIVENESS AND TOXICITY TO AQUATIC LIFE OF VARIOUS TREATING MATERIALS

P.C. WALKUP, Battelle Memorial Institute, *Richland, Washington* 99352

Current methods for evaluating the effectiveness and toxicity of oil spill treating agents (dispersants, sorbents, burning agents, biological degrading agents, sinking agents, and beach cleaners) were evaluated. No method of effectiveness testing is totally applicable. Recommended tests were based on refinement and development of procedures given in MIL-S-22864A (Ships). Methods of toxicity determination, with the exception of BOD measurement, are generally adequate. However, shortcut methods of measurement of sublethal toxicity, better selection of test organisms, and correlation between laboratory and field observations are needed.

SUPPORTED BY Amer. Petroleum Institute

2.0846, RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION

A.J. NOVOTNY, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Seattle, Washington* 98102

This program seeks to develop a self-sustained, mobile field laboratory, designed for maximum flexibility, which will provide a working base for unlimited aquatic environmental studies in navigable impoundments, and eventually in marine bays and estuaries. Primary emphasis is being placed on studies related to changes in the environment induced directly or indirectly by human activities and the effects of these environmental changes on salmon. These studies will include on-site experimental control of water quality to determine the feasibility of 'carrying' salmon through critical phases of their life cycle in river-run impoundments. Parameters of control include temperature, filtration, sterilization, dissolved gases, and waste products.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0847, ORGANIC-MATTER BUDGET FOR PUGET SOUND

K. BANSE, Univ. of Washington, School of Arts, *Seattle, Washington* 98105

Decisions on multiple use of the nearshore environment should be based, as nearly as possible, on the evaluation of quantifiable alternatives. Decisions on uses that affect the biota would benefit greatly from a numerical understanding of the major pathways of organic matter, be it alive or dead, and the rates of change in the water and on the bottom. This year, it will be most advantageous to apply existing analytical models of plankton production of the Steele-Riley approach to the very large body of phytoplankton data in hand, in order to sort the material and learn whether the existing information on parts of Puget Sound can be used for checking a larger model. This will thereby tie together data on hydrography and water exchange, nutrient concentrations and primary productivity. By the latter part of the year a consideration of the zooplankton and the losses of organic matter to, and regeneration of nutrient salts by, the seabed will begin. Biomass data from two time series stations will be used for the zooplankton. Further, a current sampling program will also include larger pelagic organisms like euphausiid shrimps and small fishes which are mostly links in the food chain to large fishes. Information should be available at that time on the distribution of communities, including the biomass. The same information on species occurrence and abundance will be usable for studies of flatfish food and as indicators for long-term pollution effects away from the shore.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0848, LAKE NUTRIENT STUDY

W.T. EDMONDSON, Univ. of Washington, Graduate School, *Seattle, Washington* 98105

For a long time, Lake Washington received increasing amounts of treated sewage, and responded rather promptly to each major change. As late as 1950, it could still be regarded as relatively unproductive, and certainly was not producing nuisance conditions. By 1955 it was unmistakably deteriorating; it was clear that Lake Washington, like many before it, was showing increased productivity as a result of enrichment with nutrient-rich sewage effluent. In 1958 a major sewage revision was decided by public vote. Diversion started in 1963 and was completed in 1968. The lake has responded promptly and sensitively to the progressive decrease in nutrition with reduced production of algae and many other changes related to the change in productivity.

The sediments show a record of the changing productive status of the lake both in the chemical composition and the content of microfossils.

Thus Lake Washington has been an extremely suitable object for a study of the relation between nutrient income and population productivity and abundance. In addition to the scientific value of the limnological study, the results have been useful locally in making decisions about how to handle the pollution problem, and are beneficial in helping to understand eutrophication in general. Research will be continued on Lake Washington as it reverts to a less productive condition.

SUPPORTED BY U.S. National Science Foundation

2.0849, GEOSECS - C14 FACILITY AND ANALYSIS OF OCEAN WATER SAMPLES

M. STUIVER, Univ. of Washington, Graduate School, *Seattle, Washington* 98105

Considering the ocean as a source of food, a disposal area for nuclear and industrial waste products, and a controlling factor in the earth's climatic regime, our ultimate use of the sea is critically dependent on a detailed understanding of processes presently understood in only the vaguest and most qualitative way. These are the stirring and mixing processes in the deep sea, the interchange of material between deep and surface water, the variation of organic productivity throughout the ocean and the exchange of water and gases with the atmosphere. The GEOSECS program will measure in detail the oceanic constituents along Arctic to Antarctic sections at all depths, to provide, for the first time, a set of physical and chemical parameters measured on the same water samples. These data will provide the input for quantitative studies of oceanic mixing and organic productivity, and, at the same time, serve as a base-line for the levels of pollutants and of fission and waste products being added to the sea. Stuiver will concentrate on C14. If measurements are made with higher precision than currently available, C14 holds the greatest wealth of information as the most important oceanic radio tracer because it is involved in both the inorganic-organic carbon cycle and the general circulation problem. The investment in electronics, shielding, counters, and vacuum equipment is justified by the need for a large number of highly precise (plus or minus 4 per mil) and reliable results.

SUPPORTED BY U.S. National Science Foundation

2.0850, BIOLOGICAL STREAM SURVEILLANCE
R. MENENDEZ, State Div. of Wildlife Resour., *Charleston, West Virginia* 25305

Objectives: To establish a biological surveillance network on selected high quality streams to determine present biological conditions and to monitor any changes resulting from new industrial activities.

Procedures: Benthic samples will be collected quarterly from selected high quality streams on which new industrial activities are planned. Sampling stations will be strategically located so as to effectively monitor any stream changes and will include stations above, below, and at the point of origin of the new industrial activity. Samples will be collected with a Surber square foot sampler and with an artificial substrate sampler. A minimum of three samples will be collected from each station at various points across the stream. The artificial substrate samplers, as described by Hester and Dendy (1962), will be anchored to the stream bottom at the various stations and serviced quarterly. When collecting samples, the sampler will be enclosed in a small plastic bag before removal from the water to prevent loss of organisms. Samplers will be transported to the laboratory in this manner where they can be dismantled and all organisms removed and preserved for identification. A sufficient supply of samplers will be maintained so that when one is removed from the stream, another can be returned in its place.

All organisms will be identified to genus and species when possible and classed as to their tolerance to pollution. Use will be made of all pertinent literature to aid in determining tolerance levels.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0851, IDENTIFICATION AND CONTROL OF PETROCHEMICAL POLLUTANTS INHIBITORY TO ANAEROBIC TREATMENT
R.A. CONWAY, Union Carbide Corporation, *Charleston, West Virginia* 25303

This eighteen-month investigation will serve to complement the earlier FWPCA Grant, 12020-DIS, 'Anaerobic Treatment of Synthetic Organic Wastes,' by identifying chemicals common to many petrochemical wastes which are inhibitory to anaerobic biological treatment.

The initial phase will involve the identification of chemicals and the levels of these chemicals which are acutely inhibitory to anaerobic biodegradation processes, while subsequent studies will deal with the control of the toxicity of these materials through acclimation and through dilution techniques. Emphasis will be placed on alpha-beta- unsaturated carbonyl compounds, sulfates, and aromatic structures. Parameters such as gas production and organic carbon reduction will be used to determine the effect of the chemical on the anaerobic test system.

A second phase of the project will include the study and use of an anaerobic photosynthetic bacterial-algal culture to control sulfide toxicity in a lagoon-type system. These tests will be conducted in twin units under a variety of operating conditions while monitoring gas production, organic carbon reduction and sulfur balances.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0852, CHEMICAL CHARACTERISTICS OF WATERS IN FLOODED BITUMINOUS-COAL MINESHAFTS
R.G. CORBETT, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

We shall determine quantitatively the major chemical components of waters from various levels in flooded bituminous-coal mineshafts. We shall attempt to measure Eh and pH of samples without altering the values in the process of sampling. These data may aid in better understanding the mechanism of pyrite alteration in the mine environment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0853, NUTRITIONAL ECOLOGY AND COMMUNITY STRUCTURE OF THE PHYTOPLANKTON OF GREEN BAY
P.F. SAGER, Univ. of Wisconsin, Graduate School, *Green Bay, Wisconsin* 54302

The proposed research involves investigations on the relationship between phytoplankton community structure and nutrient availability. Previous studies have indicated an inverse relationship between species diversity and nutrient availability in the water. In this study, equal emphasis will be placed on the algal cell content of the important plant nutrients, nitrogen and phosphorous. Techniques to be utilized will determine the limiting or non-limiting nature of these nutrients in the algal material itself. The question to be answered is how is nutrient availability reflected in the structure of the community.

The phytoplankton community existing along the nutrient gradients in the bay resulting from pollution inputs provides a large experimental system in which this question can be explored. At selected sampling stations, seasonal estimates of community structure will be made from species-abundance enumerations and the subsequent calculation of a species diversity index. Pigment extraction will also be utilized for the estimation of community structure and standing crop. Several physico-chemical variables will be measured concurrently. The data will be examined in a framework which will lead to a better understanding of the factors that regulate structure and metabolism in the phytoplankton community in the face of an ecological disturbance (water pollution).

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0854, WATER QUALITY MONITORING STUDIES
J.W. MASON, State Dept. of Nat. Resources, *Madison, Wisconsin* 53701

A statewide program is under way to detect and document changes in water quality which may occur in various lakes and streams as a result of changing use patterns (shoreline development, recreational development, dam construction, dredging, ditching, irrigation, etc.). In the waters selected for monitoring, the following parameters are measured four times yearly: temperature and oxygen profiles, pH, alkalinity, water clarity, resistivity, nutrient concentrations, and other elements. Biota changes, if any, are noted (fish populations, vegetation, etc.). Streams are also being monitored for any chemical changes that may occur, and in addition continuous temperature recordings are being made. In situations where fish populations are suspected to be affected by development they are studied intensively (dam constructing, ditching, irrigation, land cover changes). Lakes and streams which man-made changes are not expected to affect are being monitored as 'bench mark' waters.

SUPPORTED BY Wisconsin State Government - Madison

2.0855, A COMPARISON OF TOTAL COLIFORM AND FECAL COLIFORM COUNTS IN STREAM POLLUTION SURVEYS

D.H. SCHUETTPELZ, State Div. of Env. Protection, *Madison, Wisconsin* 53701

The study consists of a literature review and limited field sampling to determine if the fecal coliform, rather than the total coliform count, would be a better indicator of bacterial contamination of surface waters. This study will determine whether the fecal coliform organism will be used in routine stream pollution surveys conducted by the sponsoring department. The field sampling is being conducted below a sewage treatment plant and will provide die-off rates and correlation of the coliform strains in the stream.

All bacterial counts are performed by the membrane filter technique and are accepted as being representative (equivalent to MPN) of the true fecal and total coliform populations. Analyses are performed in accordance with Standard Methods for the Examination of Water and Wastewater (12th ed.) at the Wisconsin State Laboratory of Hygiene.

SUPPORTED BY Wisconsin State Government - Madison

2.0856, WATER REOURCES OF SOUTHEASTERN WISCONSIN - RACINE AND KENOSHA COUNTIES

R.D. HUTCHINSON, U.S. Dept. of the Interior, Geological Survey, *Madison, Wisconsin* 53706

This research is part of the program of water resources investigation conducted by the U. S. Geological Survey in cooperation with the State of Wisconsin.

Purpose - To determine the quantity and quality of the ground water resources available for the expanding population and increasing industrialization in southeastern Wisconsin.

Methods - Daily and periodic water-level measurements will be made to supplement current records and gages to record pumpage will be installed on selected wells. Hydrographs of wells will be used to determine the effects of recharge and discharge. Areas of recharge and discharge and the direction of groundwater movement will be determined. Quality of water data will be correlated with geologic information to map the geographic and stratigraphic distribution of chemical constituents that occur in critical quantities.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0857, APPLICATION OF REMOTE SENSING TO THE DETERMINATION OF WATER QUALITY

M.S. ADAMS, Univ. of Wisconsin, Inst. of Environmental Studies, *Madison, Wisconsin* 53706

Abstract: This research is directed towards the establishment of correlations between aerial remote sensing responses and water pollution parameters. Once established, these correlations would be a valuable tool in both the enforcement of water pollution legislation and in the overall planning of a given watershed. A study of the spectral reflectance and radiant emission properties, as measured in the laboratory using Gamma Scientific and Isco Spectro-radiometers, will be conducted for samples containing known chemical, physical and biological characteristics. The reflectance and emission properties will be correlated with specific water pollutants and the relative magnitude of these radiant emission properties of water will be conducted in situ through radiometric measurements. The correlation between these two properties in specific water pollutants and secondary pollutional indicators will be established. Based on both laboratory and field measurements, aerial remote sensing responses will be interpreted and appropriate wavelengths and/or wavelength combinations will be established for specific pollutional parameters. In coordination with Wisconsin state agencies, spectral bands will be prescribed, and data handling and analysis techniques will be developed so that the research findings can be used as a practical tool for water pollution control.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0858, INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES

G. CHESTERS, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

Detailed Objectives: a. To determine the extent of adsorption of certain insecticides by intact and fractionated lake sediments and the bonding mechanisms involved. b. To relate adsorption to a characterization and classification of lake sediments. c. To ascertain the effect of adsorption on chemical and biochemical degradability.

The extent of insecticide adsorption will be evaluated by equilibration and chromatographic techniques utilizing gas chromatographic and radioisotopic methods for insecticide determination. Properties of the insecticides and the sediments controlling the extent of adsorption will be ascertained. The effect of adsorption on the chemical and biochemical degradability will be determined by comparison of degradation rates in the presence and absence of adsorbents. Properties of sediments will also be related to their origin, environment of deposition and location to obtain a classification useful for prediction of the extent of insecticide accumulation in lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0859, TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS

G.C. GERLOFF, Univ. of Wisconsin, School of Letters, *Madison, Wisconsin* 53706

The primary goals of this project are: (1) To develop the tissue analysis technique as a simple and reliable procedure for evaluating the adequacy of nutrient supplies in lakes and streams for the growth of nuisance producing angiosperm aquatic plants (macrophytes). This includes determining if the supply of any essential mineral element becomes limiting for the growth of the aquatic plants during the summer months in representative Wisconsin lakes. (2) To establish procedures for the successful culture of angiosperm aquatic plants in synthetic nutrient media and to study in detail the nutritional requirements of several of the most troublesome species. Nutritional factors which might be of specific importance in explaining the distribution and abundance of the plants under field conditions will be of particular interest.

The tissue analysis technique and the information gained on this project should be very useful in programs being developed by sanitary engineers and chemists to reduce nuisance plant growths by removal of growth-limiting essential mineral elements from pollution sources.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0860, ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY

W.L. HILSENHOFF, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The effectiveness and limitations of an artificial substrate sampler under a variety of conditions will be statistically evaluated. Replicated tests will be conducted to determine the rate of colonization at different temperatures, the effect of periphyton on the rate of colonization, the relationship of current velocity to debris accumulation and the rate and degree of colonization, the suitability of various substrates for use in samplers, and the effect of the height of the sampler above the stream bottom, its position in the stream, shade and sunlight, and surrounding substrate on the degree and type of colonization.

The effectiveness of different types of artificial substrate samplers will be compared, and the efficiency of removing insects by agitation will be evaluated. Samplers will be placed above, below and far downstream from known sources of various types of pollution to demonstrate the ability of samplers to detect pollution and the role of various species of insects as indicator organisms.

This project was initiated in June 1968 and will be completed in January 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0861, APPLICATION OF REMOTE SENSING TO THE DETERMINATION OF MIXING ZONE FOR WASTE EFFLUENTS DISCHARGED INTO STREAMS OR RIVERS
J.A. HOOPES, Univ. of Wisconsin, Inst. of Environmental Studies, *Madison, Wisconsin* 53706

Abstract: The basic objective of this project is to develop a relationship for the extent of the mixing zone in terms of the characteristics of the outfall, effluent, and water body. Using this definition of a mixing zone, government agencies could establish a reasonable sampling and regulation program for waste effluent discharges. Through an extensive literature search a working hypothesis for the extent of the mixing zone as a function of outfall, effluent and water body characteristics has been developed. This literature search will be continued and expanded to include additional laboratory and field studies. Using laboratory flumes and tanks to simulate 'idealized' river and lake environments, rates of dilution or mixing of tracers will be measured. Mathematical models will be developed along the lines of the classical jet and plume analysis subject to the constraints of the type and location of the outfall and the environment. Intensive aerial remote sensing, coupled with detailed ground measurements of waste effluent concentration distribution temperatures and velocities will be undertaken along the lower Fox River, the western shoreline of Lake Michigan, the Madison lakes, and the Wisconsin River (Wausau to Pentwell Reservoir). The observed 'mixing zones' will be compared to the predicted ones using the functional relation developed.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0862, TOXIC ELEMENT CONTAMINATION OF WATERS AND RELATED ENVIRONMENT
D.R. KEENEY, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The ultimate objective is to evaluate the current magnitude and future hazards of contamination of water and food by Be, Cd, Ni and As.

Detailed objectives are 1) to elucidate the amounts and forms of Be, Cd, Ni and As in soils, plants and surface waters from direct addition from industrial wastes, the atmosphere, and other man-derived sources, and 2) to evaluate the uptake of Be, Cd, Ni and As by plants and the transport of these elements through soils into groundwater.

The extent of contamination of water and related environments by Be, Cd, Ni and As in dustfall, precipitation, soils, waters and lake and river sediments at locations varying in population density and industrial activity will be elucidated. The conditions affecting the rate and extent of Be, Cd, Ni and As uptake by plants, and the critical factors governing the entry of these elements into water and food supplies will be evaluted. The ultimate aim of the investigation is to provide information needed to evaluate present and future deleterious effects of Be, Cd, Ni and As on water and related environments.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0863, GEO-ENVIRONMENTAL AND MINERAL RESOURCES PROGRAM
R.A. RAGOTZKIE, Univ. of Wisconsin, School of Letters, *Madison, Wisconsin* 53706

Research in minerals will concentrate on three major areas of investigation: Green Bay Manganese, Marine Mineral Placers, and Minerals Law.

The Manganese investigation will consider two main aspects: inshore acoustic profiling and charting of pollutant muds and analysis and charting of manganese and other elements, including possible pollutant sources. The prime objective is to determine the mode of origin and distribution of the pellets and use such information as a guide for further exploration of the Great Lakes and elsewhere.

Marine Mineral Placer investigations will consist of field and laboratory studies of heavy mineral dispersal origin and the limits of marine placers. The major objective is to establish exploration guides for locating placers of economic value.

To provide guidance for program investigators as well as industry, information on permits and exploration rules also will be assembled. Present laws and regulations covering marine and Great Lakes mining will be included in the collection.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0864, APPLICATION OF REMOTE SENSING TO SURFACE PARAMETERS OF LARGE WATER BODIES
R.A. RAGOTZKIE, Univ. of Wisconsin, Inst. of Environmental Studies, *Madison, Wisconsin* 53706

Abstract: This research is centered around the detection and monitoring of oil and thermal pollution as well as the determination of near-shore circulation patterns. An attempt is being made to find a remote sensor which will suitably detect an oil slick from an aircraft or satellite platform. Current research dictates that instruments operating in the UV or microwave portions of the spectrum will be useful. The spectral responses of oil samples in the visible spectrum will be determined with a spectrophotometer. This will reveal any possibility of utilizing a particular film filter combination or show a need for a UV scanner. A literature search will be made to determine the possibility of using an instrument operating in the microwave region. Infrared radiometers will be used initially to monitor thermal plumes from nuclear power plant discharges, with infrared scanners being used later. Seasonal changes in the thermal structure of the receiving water will be investigated. Airborne infrared radiometry will be used for the detection and monitoring of near-shore circulation patterns because these patterns are associated with substantial horizontal temperature gradients, normal to the direction of flow.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0865, EVALUATION OF THE PROVISIONAL ALGAL ASSAY PROCEDURE
G.A. ROHLICH, Univ. of Wisconsin, Water Resources Center, *Madison, Wisconsin*

This project consists of a laboratory evaluation of two bioassay techniques, batch and continuous culture, for investigating algal growth-nutrient concentration relationships in natural and enriched waters. The project is part of a cooperative effort sponsored by the Joint Industry/Government Task Force on Eutrophication to develop a reliable and reproducible assay procedure which can be employed universally.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0866, APPLICATION OF REMOTE SENSING TO HYDROGEOLOGY
D.A. STEPHENSON, Univ. of Wisconsin, School of Natural Sciences, *Madison, Wisconsin* 53706

Abstract: The purpose of this research is to investigate the application of remote sensing to: a) define ground water influx points to surface water bodies; b) determine patterns of distribution for pollutants entering surface water bodies; c) establish lateral and/or abnormal temperature gradients within soils associated with ground water flow systems; and d) determine patterns of pollutant distribution within shallow ground water flow systems. All of the above are currently under investigation using conventional ground based techniques. The sites currently under investigation are: a) City of Madison Truax Field Sanitary Landfill Site; b) City of Madison Dane County Coliseum Sanitary Landfill Site, and c) Sulfite Liquor Disposal at the Badger Paper Company, Peshtigo, Wisconsin. During the first phase of this study, appropriate portions of the reflectance and emission spectrum would be imaged and coordinated with simultaneous ground truth. The second phase of the study will consist of qualifying the remote sensed imagery with available ground truth. The third phase will consist of applying the qualified remote sensed imagery to the investigation of the ground water flow system. The application of remote sensing to these investigations would provide

meaningful data for basin-wide water resource planning, pollution migration control, and ground water-surface water relationship studies.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.0867, ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER
C.O. HUBER, Univ. of Wisconsin, Graduate School, *Milwaukee, Wisconsin*

The initial aim is to determine phosphate in natural and waste waters by atomic absorption with high sensitivity, speed and specificity. The linear absorbance decrease for metals due to flame compound formation will be observed quantitatively. The investigation will necessarily include studies of flame reaction stoichiometries and rates and should provide improved understanding of compound formation in flames. This will be used to establish a specific determination for the various phosphates as well as for other non metallic anions. The extension of the advantages of atomic absorption to analysis of many anions at concentrations present in natural waters is the final objective.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr Qua. Adm.

2.0868, ECOLOGICAL STUDIES OF THE SURFACE WATERS OF THE WHITEWATER CREEK WATERSHED, WALWORTH, ROCK, AND JEFFERSON COUNTIES, WISCONSIN
S.G. SMITH, Univ. of Wisconsin, Graduate School, *Whitewater, Wisconsin* 53190

Distribution and relative abundance of selected plants and animals will be correlated with physical and chemical features of the surface waters of the Whitewater Creek watershed. Although primary emphasis will be placed on the streams, preliminary studies will be made of the lakes which have been formed by the damming of the streams. Detailed studies will be primarily concerned with vascular plants, fishes and selected algae. Although the primary objective of the project is to initiate a long-range interdisciplinary research program, certain specific problems will also be investigated, i.e. 1) the movements of selected species of fish within the stream system, and 2) the genecology of hybridizing or otherwise genetically variable populations of the round-stemmed bulrushes (Scirpus spp.) and possibly Potamogeton in relation to habitat disturbance and other ecological factors. Organisms studied will be evaluated as to their usefulness as indicators of water quality and other environmental conditions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0869, AERATION OF LAGOONS IN RIGOROUS CLIMATE AREAS
R.L. CHAMPLIN, Univ. of Wyoming, School of Engineering, *Laramie, Wyoming* 82070

Demonstration Grant: Two Parts. Part I. A water balance for the City of Laramie, Wyoming is being measured. This includes measuring all incoming flow (municipal, surface and ground water) and all outgoing flow (storm drainage, sewage flow, ground water and streams). Part II. Aeration of a pilot lagoon is being investigated. Due to the rigorous climate, treatment of sewage by the lagoon system is inadequate during much of the year. The parameters being investigated are: amount of air, loading and detention time, and temperature effects. The effect of present treatment on the Laramie River is being monitored.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

C. WATER TREATMENT

Physical Management Or Treatment Applied to Poor Quality Water Before Utilization. Includes Chlorination for Potable Water and Related Sanitation Measures.

2.0870, TREATMENT OF WATER-PLANT SLUDGES
J.F. JUDKINS, Auburn University, School of Engineering, *Auburn, Alabama* 36830

The objectives of the proposed research are to investigate the crystal seeding process as a means of improving the filterability of water treatment plant sludge. The process will be investigated for its applicability to both coagulant sludges and lime-softening sludges. Variables of interest will include crystal seed dosage, mixing rate and the concentrations of impurities in the water. Studies will be conducted on laboratory samples prepared by the addition of typical concentrations of turbidity, hardness and alkalinity to distilled water.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0871, THE EFFECTIVENESS OF CONTACT FILTER FOR THE REMOVAL OF IRON FROM GROUND WATER
W. KIM, Univ. of Alaska, Inst. of Water Resources, *College, Alaska* 99735

The objective of the proposed study is to explore the applicability of the contact filter in the removal of iron from ground water. A contact filter process developed by Minz in Russia consists of a deep sand bed (six feet) through which the coagulated suspension is passed in upward direction. Theoretically this process should perform better than conventional sand filters due to the decreasing grain size of filter media in the direction of flow, and due to the greater depth effective in the filtration. Iron removal from ground water requires the oxidation of ferrous iron, and flocculation and separation of ferric precipitate. The contact filter may promote not only flocculation and separation steps but also the oxidation of ferric ion due to the intimate contact of iron-coated filter media with the incoming water.

The relative effectiveness of the contact filter and conventional sand filters and the optimum media characteristics will be determined by running pilot filter tests under controlled conditions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0872, WATER PURIFICATION BY LARGE-SCALE ELECTROPHORESIS
M. BIER, U.S. Veterans Administration, Hospital, *Tucson, Arizona* 85713

In prior years, this work has been always fully supported by extramural grants. Because of lack of current support, no experimental work has been carried on in the past year. It is the intent of the principal investigator to seek new support to reactivate this project.

Nevertheless, there remains widespread interest in the principal investigator's prior work in this field. For instance, he was invited a. to present a paper on Water Treatment by Electrophoresis at the Annual Meeting of the Institute of Electrical and Electronics Engineers, Detroit, Mich., October 12-16, 1969. This paper had to be read by title only as travel funds were not made available. b. to organize a Symposium on Membrane Processes for Industry and Biomedicine, for the American Chemical Society. The Symposium was be held at the Annual Meeting in Chicago, Sept. 1970, and the Proceedings were published by Plenum Press, in early 1971. His own contribution is entitled Electrokinetic Membrane Processes. c. to participate in the Symposium on Recent Advances in Separation Techniques, at the Annual Meeting of the AmericanInstitute of Chemical Engineers, Houston, Spring 1971. The paper, entitled: Electrophoresis as an Industrial Process will be included in the Symposium Proceedings.

SUPPORTED BY U.S. Veterans Administration

2.0873, INVESTIGATION INTO THE POSSIBLE AGRICULTURAL USE OF RECONDITIONED WATER FROM THE PROPOSED SOUTH-EASTERN PURIFICATION PLANT
A.W. BIRD, Victoria Rivers & Water Comm., *Armadale, Victoria, Australia*

Part of a project investigating possibility of using water from Purification Plant for agricultural and other purposes.

General investigations proceeding, pilot field tests completed.

SUPPORTED BY Australian National University

2.0874, FLOC STRENGTH AND FILTERABILITY OF PRE-TREATED WATER
H.F. LUDWIG, Ludwig Engin. & Sci. Res., *Arcadia, California* 91006

This study is primarily concerned with the effect of floc characteristics on the performance of rapid sand filters. Floc strength is to be investigated as a measure of floc characteristics. Floc strength will be measured by the degree of floc breakdown after being exposed to a velocity gradient producing shear stress.

The filterability of pretreated water is to be measured by the Silting Index utilizing a membrane filter, by Boucher's Index, and by floc retention capacity of a rapid sand filter.

The effect of pH, alum dosage, coagulant aids, mixing conditions, and lime addition on floc strength will be investigated; their effects on filter performance, expressed by filterability indices, will be studied in pilot plant operation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0875, ORTHOKINETIC FLOCCULATION OF HETERODISPERSED SYSTEMS
W.J. KAUFMAN, Univ. of California, School of Engineering, *Berkeley, California* 94720

The broad aim of the proposed research continues to be the elucidation of the relationships of the rate of orthokinetic flocculation to the hydrodynamic parameters describing turbulence in stirred reactors. In the present proposal, theoretical formulae are presented that relate the rate of flocculation to the rate of energy dissipation and the turbulence spectrum, and the rate of deflocculation, or breakup, to similar turbulence parameters and floc strength. It is expected that the establishment of these relationships will lead to the more rational design and operation of the flocculation and precipitation systems employed in water and waste treatment. The principal aim of the proposed research will be to validate these expressions experimentally or to modify them as appropriate to describe the flocculation process under steady-state conditions in stirred reactors. Recognizing that improved flocculator performance may accompany increased rates of energy dissipation only if the flocs are sufficiently strong to resist breakup, a secondary objective will be the investigation of floc strength and particularly those chemical physical factors that may increase the resistance of floc to the shearing forces of turbulence. One of the limited aims of this phase of the research will be the development of a suitable device to measure or provide an index of floc strength.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0876, DILUTE SOLUTION REACTIONS OF NITRATE ION AS APPLIED TO WATER RECLAMATION
F.C. GUNDERLOY, North Amer. Rockwell Corp., *Canoga Park, California* 91304

1. Undertake a literature search of dilute solution reactions of the nitrate ion. Two groups of reactions are expected to be useful: Reduction of nitrate to nitrite, and deamination to nitrogen.

2. Carry out a testing program using the most promising chemical systems to determine feasibility of chemically decomposing nitrate ion.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0877, PHOTOCHEMICAL METHODS FOR PURIFYING WATER
J.M. SMITH, Univ. of California, School of Engineering, *Davis, California* 95616

The primary objective is to evaluate photochemical processing as a means of tertiary water treatment. The first phase is to establish the most promising operating conditions (lamp-reactor geometry, residence time, light intensity, oxidizing agent, sensitizer, etc.) for a continuous flow process. These data would be obtained in a small, pilot-plant reactor, feed for which would be secondary effluents from Sacramento-area wastewater treatment plants. Preliminary runs with water from the Northeast Area Treatment Plant of the Sacramento County Sanitation District have indicated a reduction in COD of 25-50% without sensitizer of supplementary oxidant. When Fe ion was added as a sensitizer, the reduction was greater, but not markedly so. These initial results, admittedly not at optimum conditions, indicate that the photochemical method is a promising one. Of particular importance is the possibility of a process not using a sensitizer.

As a secondary objective, and with time permitting, studies would be made to evaluate photochemical decomposition as a process for removing resistant pesticides from water, especially wastewater.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0878, HYDROLOGY OF CACHUMA RESERVOIR
E.R. HEDMAN, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

The objective of this project is to evaluate proposed air-injection systems to minimize thermal stratification in large reservoirs in order to (1) increase the dissolved oxygen content of the deep water, (2) prevent the development of dissolved hydrogen sulfide and other sources of bad taste and odor, and (3) reduce the concentration of phytoplankton populations in water to be withdrawn and treated for domestic use. The chemical and biological effects of air injection in lake water will be studied. Field and laboratory experiments will be conducted to study the effects of air injection in a controlled environment. The changes in phytoplankton populations, water quality, and temperature will be studied with varied thermal stratification.

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of California.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0879, TREATMENT OF MUNICIPAL SECONDARY EFFLUENT BY REVERSE OSMOSIS
A.N. MASSE, Los Angeles Co. San. Dist. 21, *Pomona, California*

Reverse osmosis through a cellulose acetate membrane is being investigated as a process for removing dissolved inorganic and refractory organic materials from a municpal secondary effluent. A 5000 gpd unit, using the spiral membrane configuration, manufactured by the General Atomic Division of General Dynamics Corporation has been run at 400 psi on secondary effluent passed through a 10-micron filter and on secondary effluent passed through a column of granular carbon for removal of dissolved organic mterial. The secondary effluent receiving only a filtration pretreatment both fouled and plugged the membranes and the feed channels. Considerably more success was obtained when the unit was fed carbon-treated secondary effluent. Over 80 per cent of the 4000 gpd feed is recovered as product having a TDS of less than 50 ppm, and a COD of less than 5 ppm. A similar study is in progress on a fiber-glass tube unit spplied by Havens Industries. The results are similar but troubles have been encountered because of tube rupture.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0880, BACKFLOW PREVENTION DEVICES FOR POTABLE WATER SYSTEMS AT NAVAL SHORE FACILITIES
R.N. BIBBENS, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Technical Objective: Provide current, detailed information and a state-of-the-art report relating to the testing, certification and maintenance requirements for backflow prevention devices at Naval shore facilities.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0881, INFLUENCE OF SEDIMENTATION UPON THE PRODUCTION OF GAME FISHES
R.E. VINCENT, Colorado State University, State Coop. Fishery Unit, *Fort Collins, Colorado* 80521

2. WATER QUALITY

A pre-treatment population inventory was made of all species of fishes in Blue Water Creek in 1963. Sections of the watershed were then treated to reduce the amount of sediment in the watershed. Post treatment inventory will then be made of all fish species with emphasis upon species composition, numbers and age class, standing crop and productivity. Fish population information can be correlated with the changes in sediment discharge and attendent changes in water temperatures, food organisms, etc.

The project is being conducted in Blue Water Creek in south-central Montana.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0882, SELF-ADJUSTING AND SELF-CLEANING FILTER FEASIBILITY STUDY
J.D. BANE, Hercules Incorporated, *Wilmington, Delaware* 19899

This six-month program will determine the feasibility of a unique self-adjusting and self-cleaning filtration system for reducing water pollution from combined sewer systems during storm runoff conditions. The new concept is based on the expansion and leakage characteristics of Hercules' filament-wound, resin-bonded Spiralloy structures-used successfully in a number of missile motors and commercial applications. Basically, the Spiralloy filter will be designed and fabricated to expand at low pressures to yield numerous micron-size openings. During stormflow, the filter will expand in proportion to the hydraulic head and permit leakage of filtered water to a separate chamber for subsequent chlorination before final water-way discharge. The suspended and settleable solids will be retained by the filter and transported to a sewage treatment plant. Self-cleaning will be accomplished by the interior surface condition and a centerbody to impart high shear velocities along the filter wall. This approach offers an economical solution to the combined sewer pollution problem.

This program is being performed at Allegany Ballistics Laboratory (ABL), Box 210, Cumberland, Maryland. ABL is a government-owned laboratory managed by Hercules Incorporated, Chemical Propulsion Division.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0883, ON-SITE PURIFICATION OF GROUND WATER AND DOMESTIC SEWAGE BY AEROBIC MICRO-FAUNA
R.P. ECKELS, Unknown Inst. Or Indiv. Grant, *Florida*

Approximately 1/3 of all Americans obtain their drinking water raw from private wells or from untreated public sources, and approximately as many dispose of household wastes at the site, in privies, cesspools, septic tanks, etc. For most of these citizens, full, municipal-type treatment of either water or sewage is a remote and impossible dream.

We utilize the conventional concrete septic tank (500-1000 gal. capacity) as the structural framework for a simple device. With structural modifications and additions and a colony of aerobic micro- fauna, the concrete box is used to purify either raw water or domestic sewage. Both processes could be carried on side by side. The process is odorless and without insect or other nuisance, and requires only minute amounts of either mechanical or electrical power. No process chemicals are required or necessary.

The final effluent is potable: clear, colorless, tasteless, odorless, substantially free of microbial and suspended solids, completely non-pathogenic. It is equally utilizable for generation of hydroelectric power, for agricultural irrigation, spraying or flooding; for recreation (boating, swimming, fishing); for recharging underground aquifers or for direct addition to a supply of potable water.

SUPPORTED BY No Formal Support Reported

2.0884, EFFECTIVENESS OF IODINE FOR DISINFECTION OF PUBLIC WATER SUPPLIES & TO DETERMINE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION
A.P. BLACK, Univ. of Florida, Graduate School, *Gainesville, Florida* 32601

This project is to demonstrate the effectiveness of iodine for the disinfection of polluted water supplies and to evaluate the several variables affecting such procedures to demonstrate the physiological effects, if any, on a significant number of consumers over an extended period of time. The water supplies of three state institutions will be disinfected with iodine and every sixth person of more than 600 inmates will be selected for intensive medical evaluation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0885, WATER POLLUTION CONTROL BY THE SECLAR METHOD
UNKNOWN, Sogreah, *Grenoble, France*

Research and experimentation on the Seclar water pollution control method to produce potable water, and develop prototypes of 5.5 cubic meters/per hr.

SUPPORTED BY Aquaval Society - France

2.0886, PHYSICAL-CHEMICAL PHENOMENA ASSOCIATED WITH ORGANO-COLLOIDAL SURFACE INTERACTIONS
G.W. BAILEY, U.S. Dept. of the Interior, Federal Water Quality Admin., *Athens, Georgia* 30601

Investigation is concerned with the elucidation of the nature of interactions between organic compounds and colloidal surface, particularly with regard to sorption, degradation and/or decomposition. It will be possible with such information to predict the behavior of a given organic in, through, and/or off soil surfaces and thus predict the possibility of such a compound entering water courses and causing a water pollution problem. With such information, it will be possible to predict the mechanism of pollutant transportation in water courses.

Three sorption parameters are being investigated: (1) Molecular orientation (by means of X-ray diffraction); (2) Bonding type (spectrophotometrically); (3) Thermodynamic properties (by means of calorimetry and/or appropriate thermodynamic relationships).

Adsorption isotherms will be run in addition to supplement the above parameters in formulating mechanism(s) of adsorption.

The applicability of the above findings to improving existing water and waste treatment processes will be tested.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0887, EVALUATION OF MEDIA FOR RAPID FILTRATION OF WATER
T.F. CRAFT, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332

Sand, anthracite, and mixed media are being evaluated in pilot filters. To ensure direct application of the results to full-scale operations, the filters are installed at a municipal water treatment plant where a continuous supply of coagulated and settled water is available. Head loss and turbidity are the major parameters being measured. Variables of the media to be investigated include particle size, particle size distribution, combinations of more than one material, and the manner of grading. One of the filters is designed so that reverse grading can be achieved. The filters are operated in parallel so that conditions in the water during a run are identical. Findings to date verify that head loss increases more slowly with reverse graded than with normally graded sand.

SUPPORTED BY Georgia Institute of Technology

2.0888, RADIOTRACER STUDIES ON RAPID SAND FILTRATION
G.G. EICHHOLZ, Georgia Inst. of Technology, Water Resources Center, *Atlanta, Georgia* 30332

This project continues a current research project aimed at determining the distribution and dynamics of fine particles of given sizes in rapid sand or anthracite filters of controlled composition and size distribution. The effect of surface condition, flow rate, bed composition, and chemical exchange on primary deposition and subsequent elution of suspended matter in the

filter is being studied by means of radiotracers. Continuous readings on deposition curves and detailed analysis of succeeding layers of the filter as well as the collection of dissolved tracer ions are employed to observe the behavior of the test filter under representative conditions. Analysis of the filtration curves makes it possible to evaluate appropriate kinetic coefficients for the adsorption and exchange mechanisms.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0889, BUFFER CAPACITY IN AQUATIC ECOSYSTEMS
F.G. POHLAND, Georgia Inst. of Technology, Environmental Resources Center, *Atlanta, Georgia* 30332

The proposed research will investigate the use of buffer capacity for evaluation of pH changes resulting from the influx of pollutants into aquatic ecosystems. The study will be divided into three phases: (1) Development of a mathematical model for buffer capacity; (2) Experimental verification of the model with laboratory analyses and simulations; (3) Elaboration of the application of buffer capacity for analysis of the quality and ultimate use of natural waters.

The model for buffer capacity will be developed by identifying the types and relative concentrations of various acids and bases indigenous to or discharged into the aquatic ecosystem. Analytical solutions to expressions describing the component buffer systems will be simplified by defining limits of application, introducing appropriate approximations and programming for computer analysis. Total species concentration will also be described on the basis of alkalinity and/or acidity measurements in order to facilitate application of the method in terms of routine analytical parameters.

Biological processes will be simulated in the laboratory and used to provide verification of the model for buffer capacity and to help establish limits of application. These results will then be extrapolated to natural water systems and techniques will be proposed for the use of buffer capacity in water quality control and treatment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0890, SALT-WATER ENCROACHMENT IN THE BRUNSWICK AREA, GEORGIA
D.O. GREGG, U.S. Dept. of the Interior, Geological Survey, *Atlanta, Georgia* 30309

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0891, EFFICIENCY OF FIBROUS BED COALESCERS
W.M. LANGDON, Illinois Inst. of Technology, School of Engineering, *Chicago, Illinois* 60616

The object of the one year program is to produce a design for a complete coalescer unit. This design will be used to construct and test a small scale demonstration unit which will be operated on an actual industrial pollutant stream. The program will consist of the preparation of general plans, specifications, explanations, cost estimates, and a discussion of the anticipated performance in recovering finely-divided, insoluble liquid pollutants from the selected industrial source. The design must not only be effective and economical but also capable of adaption to the many different types of pollutants and conditions that may arise.

Project will begin June 1, 1970 and approximately May 31, 1971 it will end.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0892, NITRIFICATION--DISSOLVED OXYGEN RELATIONSHIPS
T.A. BUTTS, State Water Survey, *Urbana, Illinois* 61801

Earlier investigations have emphasized the importance of nitrification as a major sink on dissolved oxygen resources in several sectors of the Illinois River. Conventional secondary treatment implemented along the river may not maintain adequate DO levels commensurate with current water quality criteria. Assessments will be made of existing ammonia loadings on the river, and alternatives, including in-stream aeration, will be investigated.

SUPPORTED BY Illinois State Government - Springfield

2.0893, FACTORS INFLUENCING FREE-LIVING NEMATODES IN WATER SUPPLIES
R.S. ENGELBRECHT, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

It has been observed that nematodes can be removed effectively by rapid sand filtration if their motility can be reduced. The use of various chemical agents, e.g., chlorine, bromine, copper sulfate and silver nitrate, on nematode motility is being evaluated in terms of nematode removal by subsequent water treatment processes. Results indicate that 3mg/l of free available residual chlorine, prior to coagulation, sedimentation and filtration, can eliminate more than 99 percent of the nematodes in the finished water as compared to about 66 percent in systems without chlorine. Copper sulfate was effective only when the hardness of water was low. Studies are being continued, using tap water, sewage treatment effluent, and stream water to determine the efficiency of different chemicals under various conditions, e.g., pH, organic and inorganic composition of the water.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0894, NITRATE REDUCTION IN THE VICINITY OF TILE DRAINS
B.A. JONES, Univ. of Illinois, School of Agriculture, *Urbana, Illinois* 61801

Various oxidizable substrate that can be used as filters for a tile drain will be studied in the laboratory to determine the potential of utilizing the biological denitrification process to reduce nitrates in the drain effluent.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0895, WATER SUPPLIES
E.R. BAUMANN, Iowa State University, School of Engineering, *Ames, Iowa* 50010

Methods are being developed for protecting individual water supplies and improving the chemical and physical quality of these waters. Methods that have been successful for treating municipal water supplies are usually not directly applicable or practical for individual systems. Among the methods studied is superchlorination-dechlorination for disinfection and sand filtration for iron and turbidity removal.

In studies of farm water supplies, techniques are being developed to measure chlorine, removal properties of activated carbon. Adsorption phenomena and chlorine removal characteristics of several types of carbon have been operated in the laboratory for removal of chlorine and precipitated iron to evaluate their combined effects on filter life.

In studies of small water supplies, laboratory water testing techniques are being developed to predict the life of precoat carbon filters in small water supply installtions. A laboratory test has been developed for measuring cake resistance of the suspended solids. A theoretical equation and computer program have also been developed for predicting filter life on the basis of the measured cake resistance.

Other physical properties of the powdered activated carbon used in precoat carbon filters are also being determined. These properties include surface area, particle size distribution, bulk density, and specific gravity. The relationships between these properties and the performance of the activated carbon are being evaluated. The objective of the research is to provide the basis for a specification for purchasing activated carbon to be used in precoat carbon filters.

An associated study concerns removal of iodine-131 from water using precoat carbon filters. This study is providing a basis for future investigation concerning the removal of pesticides using the precoat carbon filters; the pesticides used in these studies will be tagged with radionuclides.

2. WATER QUALITY

SUPPORTED BY Iowa State University

2.0896, DESIGN REQUIREMENTS FOR MUNICIPAL DIATOMITE FILTERS
P.E. MORGAN, Iowa State University, School of Engineering, *Ames, Iowa* 50010

This study was undertaken to determine the characteristics of municipal applications in which diatomite filters may be used successfully, to study the effect of various variables on filtration economy and effectiveness, and to outline a procedure for designing a plant to operate with maximum economy. A theory of diatomite filtration has been proposed and verified for use in designing plants for the filtration of raw and chemically treated water. In the current work, a computer program is being developed that will be used for determining the characteristics of a filter to operate at lowest cost. A truck mounted diatomite water treatment plant is being operated in the field to gather design data for typical municipal water applications: iron removal, surface water filtration, coagulated water filtration, and filtration of limesoda-ash softened water. These data will be fed into a computer to determine the economics of filtering such waters with diatomite filters.

Laboratory studies are being made to determine the hydraulic characteristics of filter cakes used in the removal of kaolin, montmorillonite, and other clays from water. The evaluation of coagulant and polyelectrolyte coatings for filter aids will be extended to determine the effects of pH and other factors on their removal of biological organisms and turbidity and on their hydraulic characteristics.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0897, A NEW TYPE OF DISINFECTANT FOR WATER SUPPLIES
J.L. LAMBERT, Kansas State University, School of Arts, *Manhattan, Kansas* 66502

The research will consist of the study of a safe, convenient new type of disinfectant for water supplies. The compounds to be studied are of the water-insoluble ion association type, containing a polyhalide ion of iodine, bromine or chlorine in combination with a quaternary ammonium anion exchange resin. The polyhalide ion would react on a demand basis with organic contaminants in the water, and release only the harmless halide ion into solution. Virtually complete kills have been attained from overloads of 10 to the 5th power to 10 to the 6th power of E. coli per ml on passage through a column of a triodide-resin combination. The effect on other enterobacteria and certain fecal streptococci are currently being studied. If desired, the halide ion released after bacterial reduction of the polyhalide ion could be retained downstream on another portion of anion exchange resin in the chloride or sulfate form.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0898, THE REMOVAL OF EXCESS NITRATES AND NITRITES FROM POLLUTED WATER
C.E. MELOAN, Kansas State University, Kansas Water Resou. Res. Inst., *Manhattan, Kansas* 66502

It is proposed to synthesize a modified nitron compound so it can be pearl polymerized. This material should be highly selective for removing nitrate and nitrite from water resources. The saturated bead is to be regenerated with NH4OH producing NH4NO3 which is of commercial value. Four other materials, Di(-Methyl-Naphthylamine), Cinchonamine, N-Diethyl Benzohydrylamine, and -Phenyl- - Diethyl Amino Ethyl-P-Nitro Benzoate will also be investigated.

In an attempt to understand the mechanism of the nitrate specificity, 4H-1,2,4-Triazole-3-Anilino-4,5-Diphenyl and 1,2,4-Triazolidine-1, 4-Diphenyl-2-Phenylimino will be investigated if the money holds out.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0899, FOAM SEPARATION FLOTATION OF COLLOID ORGANIC SYSTEMS
R.B. GRIEVES, Univ. of Kentucky, School of Engineering, *Lexington, Kentucky* 40506

The overall objective of this investigation is the establishment of definite design criteria for specific, continuous foam separation processes. The processes will include the foam fractionation-flotation of colloidal and soluble iron from water supplies, the ion flotation of hexavalent chromium from plating wastes, the foam fractionation of sulfate, sulfite, and lignin-containing wastes from pulp and paper mills, the ion flotation of free and complexed cyanide, and several additional processes, involving specific industrial waste constituents. The processes will be conducted on a batch and on a continuous-flow basis, establishing the efficiencies on the basis of effluent contaminant concentration, and on the quantity of influent lost into the foam stream. For each process an economic evaluation will be carried out, and definite recommendations on the applicability of each process will be made.

Based on previous work and on work currently being conducted, foam separation processes can become a vital part of industrial waste treatment systems. They have excellent potential for water clarification and for iron and manganese removal. This research will enable the design of full-scale processes for specific contaminants.

An additional phase of the investigation will be a feasibility study of the addition of low concentrations of colloidal particulates to wastewaters to enable the foam separation of weakly-surface-active organics.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0900, EFFECTS OF CHEMICAL IONS ON VIRUS INACTIVATION
O.J. SPROUL, Univ. of Maine, School of Engineering, *Orono, Maine* 04473

This project would determine the influence of chemical ions on virus inactivation in certain water and wastewater treatment systems and dieoff in natural water systems. The processes to be investigated would be ion exchange, phosphate removal from a secondary effluent and inactivation under high and low pH conditions.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0901, LIVESTOCK FARMSTEAD WATER SYSTEMS
E.E. JONES, U.S. Dept. of Agriculture, Agricultural Engin. Res. Div., *Beltsville, Maryland* 20705 (313-012-B602)

OBJECTIVE: Develop design recommendations for farmstead water systems which will provide sanitary protection, efficient labor and water utilization and first-aid fire protection.

APPROACH: Develop water system design criteria which will provide uncontaminated water. These studies will include an investigation of methods and equipment for protection of the source of supply, provision of adequate sanitary protection, and the elimination of backsiphoning and cross-connection hazards. Develop design criteria to improve the first-aid fire fighting potential of the farmstead water system. This study will include the development of design recommendations which will allow local fire departments to use the farmstead system as a source of water in combating fires. Develop methods and equipment for efficient use of water and labor for cleaning livestock and dairy facilities. This study will include an investigation of such factors as surface configuration, pen shape, nozzle design and pressures.

PROGRESS: Further analysis of farmstead water use data indicates that desirable system capacity can be estimated with sufficient accuracy using demand factors of 100%, 50%, and 25%. Limited field progress was made in improving water utilization efficiency in livestock sanitation. Literature review has confirmed initial field and theoretical evaluations and strengthened mathematical models for rational analysis. Above bottom velocities of 3 fps, depth of flow to waste depth and duration of flow, are major factors determining average solids loading and effectiveness of

cleaning. The uncertainty of animal response to a given surface configuration makes full scale system evaluation necessary. Wells lacking adequate sanitary protection and serving as unauthorized uncontrolled recharge points cannot be disinfected by a disinfectant dosage based on bore volume only. Disinfectant must be forced into formation in sufficient concentration to disinfect the contaminated formation. Measurement of disinfectant residual on pumping after specified contact time is necessary to determine adequacy of disinfection.

SUPPORTED BY U.S. Dept. of Agriculture

2.0902, IMPROVEMENT OF ANALYTIC AND FEEDING METHODS FOR FLUORIDES
E. BELLACK, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Bethesda, Maryland*

The main objectives are to develop continuous feeding and analytic methods that will permit accurate administration of fluorides to domestic drinking water supplies. Other methods will also be refined to defluoridate high fluoride water.

There will be an opportunity to test various methods at the several rural school sites where the PHS Dental Division is checking the influence of high fluoride water used in the school.

Some effort will be made to refine the specific ion probes now used for continuous plant measurements as well as for laboratory purposes.

This has been a continuing project of many years and will continue to respond to technology problems in fluoridation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0903, LONG TERM EFFECTS OF WATER FLUORIDATION IN GRAND RAPIDS, MICHIGAN
E. SCHIFFMANN, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

The objective of this report is to determine long term effects of fluoridation by histological and chemical examination of rib, vertebra, and aorta of individuals residing for at least 20 years in a fluoridated area. These were compared with specimens from individuals resident in non-fluoridated areas. The project is now complete. The findings are that increased fluoride uptake occurred in both osseous and non-osseous calcified specimens from the fluoridated area compared to the non- fluoridated areas. Also there was no noticeable relationship between incidence of pathology and exposure to fluoride. Finally it appeared that exposure to fluoride produced no long deleterious effects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0904, MECHANISM OF ORGANIC ADSORPTION ON ACTIVATED CARBON
J.T. COOKSON, Univ. of Maryland, School of Engineering, *College Park, Maryland*

Activated carbon is extensively employed for removal of dissolved organic substances from water, such as color, taste and odor compounds. The research objective of this project is to evaluate surface groups that exist on activated carbon for adsorption of these organics.

Activated carbon will be chemically treated to methylate and hydrolyze select surface oxides. The significance of these surface oxides as active sites will be determined by the capacity and adsorption rate of organic substances on treated and untreated carbons. The effect of variables such as pH and ionic strength will also be determined. This information will be analyzed to provide the mechanism for adsorption of color and odor substances on carbon, and the physicochemical nature of the active sites.

There is a need to continue research on the physicochemical nature of the surface of activated carbon, but of equal importance and the aim of this project is to determine the functional groups that act as sites for removal of most natural organic substances from water. The capacity of activated carbon can possibly be increased and maintained by regeneration practices if they conform to activation methods that establish surface groups responsible for adsorption.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0905, IMPROVEMENT OF QUALITY OF WATER RESOURCES BY A THREE-FOLD ATTACK - ADSORPTION, SEDIMENTATION AND MIXING
W.A. WOCKENFUSS, Univ. of Maryland, School of Engineering, *College Park, Maryland*

The proposal is an effort to get to the general problem of water purification through a three-fold attack. (1) Chemically, we would investigate a method to remove water pollutants by adsorption. (2) Through thermodynamics and study of flow conditions, we would investigate a method of preventing destruction of aquatic life and make a significant contribution to an area of investigation which has had little or no attention given to it as indicated by a lack of publications. (3) Through an investigation of settling velocities and settling characteristics of flocculent and nonflocculent materials, we would evolve design criteria for new improved sedimentation tanks.

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SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0906, ASSESSMENT OF CHEMICAL POLLUTANTS IN UNDERWATER EXHAUST OF WATERCRAFT ENGINEERING
L.N. KUZMINSKI, Univ. of Massachusetts, School of Engineering, *Amherst, Massachusetts* 01002

There is need for the establishment of public policy to guide the growth of recreational boating and to protect all legitimate uses of the water resource. The overall objective of this project is to develop criteria to be used in establishing public policy on restriction of watercraft use in inland waters.

The research proposed herein will address itself initially to the problem of chemical substances in watercraft exhaust discharged under water. A first step is to determine the amount of such pollution disseminated as a function of watercraft horsepower and use. Subsequent laboratory work calls for the evaluation of removal efficiency by water treatment processes and toxicity testing. Field studies will be then carried out to correlate stress exerted on the water with pollutant build-up.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0907, STUDY ON FLUORIDE CONCENTRATIONS IN TOOTH ENAMEL
F. BRUDEVOLD, Forsyth Dental Infirm. for Ch., *Boston, Massachusetts* 02115 (NIH-70-2244)

Determine whether differences in dental caries experience in groups of adolescents native to communities with approximately 1 ppm fluoride and fluoride-deficient communal water supplies are related to the concentration of fluoride in the outermost surface of the enamel of permanent teeth.

Determine whether the differences in caries experience and any of the differences in enamel fluoride concentrations are associated with traces of molybdenum, vanadium, titranium, aluminum, zinc, copper, and iron in the water supplies.

Clinical dental examinations shall be conducted on approximately 150 Caucasian adolescents, aged 13 and 14 years, in each of 4 cities. The subjects shall be chosen from fluoridated Charlotte, North Carolina, and Danvers, Massachusetts, and from fluoride-deficient Rockford, Illinois, and Boston, Massachusetts. Children will be selected randomly from all the 13 and 14 year olds in Junior High Schools located in upper middle-class neighborhoods.

At the time of the clinical examinations, enamel biopsies shall be performed on the labial surfaces of the upper right central incisor of each child. The analyses will be done at pH 5.5 with and without addition of citrate, in order to determine presence of F complexers in the enamel.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0908, EFFECTS OF INTERACTIONS OF CHEMICALS FOR WATER TREATMENT
J.J. COCHRANE, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

Aluminum sulfate, chlorine, activated carbon and potassium permanganate are the common treatment chemicals for removal of turbidity, organics, ions and bacteria from a water supply. This investigation sought to determine the effects of order, method and time for addition of combinations of these chemicals. It was discovered that considerable savings in cost and improved efficiency can be accomplished by proper sequence of additions.

SUPPORTED BY No Formal Support Reported

2.0909, KINETICS OF DISINFECTION WITH CHLORINE
W.R. DOMEY, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

Studies are being conducted to determine the relative effectiveness of disinfection of wastewater with chlorine gas versus hypochlorites with respect to chlorine residual, bacteriological effect and destruction of organic matter. Another study is being performed to determine those factors which affect the deterioration of a breakpoint in the chlorination of natural waters.

SUPPORTED BY Northeastern University

2.0910, STUDIES TO PROVIDE DATA CONCERNING THE EFFECTIVENESS STABILITY AND RELIABILITY OF GERMICIDAL COMPOUNDS
A.M. KAPLAN, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Technical Objective: Determine the reliability and stability of emergency water purification and germicidal compounds to provide germicidal formulations, with optimal performance and storage stability characteristics, for Army use.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0911, BASIC SALINOGEN ION EXCHANGE RESINS FOR SELECTIVE NITRATE REMOVAL FROM POTABLE AND EFFLUENT WATER
E. SAUNDERS, Tyco Laboratories Incorporated, *Waltham, Massachusetts* 02154

This program has as its primary objective development of specific anion exchange resins for removal of nitrate from water at influent levels of 20-100 ppm. The contractor will supply the necessary personnel, materials and facilities, and will perform the research and development studies necessary to establish the technical and economic feasibility of nitrate removal by the method proposed. His best efforts will be exerted to develop practical syntheses for the most effective resins and to evaluate their capacity, specificity, and service life characteristics.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0912, EFFECTS OF ENVIRONMENTAL CHANGES ON BLUE-GREEN ALGAE
M.M. ALLEN, Wellesley College, Graduate School, *Wellesley, Massachusetts* 02181

Changes in evironment will be used to study the structure and function of the subcellular components of the blue-green algal cell, in an effort both to isolate and identify the components chemically and ultrastructurally, and to discover their functions in the cell in different physiological states. The primary experimental objects will be two axenic unicellular species, Anacystis nidulans and Gleocapsa alpicola, whose growth conditions are well defined. Pigment ratios, fine structure, granule formation and composition, and chemical composition of control cells grown under optimal laboratory conditions will be compared with those of cells grown or treated with variations in concentration of required inorganic nutrients, in light quality and intensity, and with mutagens. Such basic physiological information is necessary for application in the control of algal blooms in water supplies.

The localization of pigment molecules in the cell, and the pathway and control of pigment synthesis, will be studied by pigment analyses and electron microscopy of cells containing varying ratios of pigments. Efforts will be made to prepare pigment mutants to complement and enlarge the information obtained.

Of the many unidentified types of granules found in cells of blue- green algae, two specific forms which are observed in large quantities in cells grown under particular ecologically important conditions will be characterized in this study.

SUPPORTED BY U.S. National Science Foundation

2.0913, SAND FILTRATION OF DISCRETE SUSPENSIONS
J.A. BORCHARDT, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

This research is a continuation of a laboratory study on sand filtration. New techniques have been developed for media placement which have resulted in extremely reproducible head loss values under similar flow and impurity levels. This had made possible the extension of our work into regions of low turbidity.

The magnitude of the surface charge effects can now be separated from other gross bed response factors and hopefully a better insight into the filtration mechanism will result.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0914, ADSORPTION FROM AQUEOUS SOLUTION
W.J. WEBER, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

The broad objective of the research is the definition and description of adsorption phenomena associated with the uptake of organic pollutants from waters and wastewaters by active carbon, and the delineation of factors which govern rates and equilibria of adsorption from aqueous solution.

The studies include a detailed investigation of the adsorption process and of the mass-transfer properties of different adsorption systems, and a detailed comparison of various conditions of operation from the points of view of efficiency and effectiveness of removal of persistent organic pollutants.

The factors of 'selectivity' of active carbon for certain types of organic solutes and of 'competition' for adsorption among the various solutes of a multi-component solution are of major concern for the present studies. In addition, and related both to the selectivity and to competitive effects, the nature and role of surface functional groups in adsorption are to be studied in detail.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0915, DEVELOPMENT NEUTRON ACTIVATION TECHNIQUES FOR INVESTIGATION OF WATER CLARIFICATION
L. HEMPHILL, Univ. of Missouri, School of Engineering, *Columbia, Missouri* 65202

A program of study, designed to investigate the course, nature and extent of clay mineral coagulation-flocculation by lime-alum reagent has been proposed. It is the object of this experimental study to determine colloidal clay material per se in solution using neutron activated clay. Direct measurement of clay mineral turbidity will provide new methods for determining turbidity in natural waters, calibration of filter efficiency and comprehensive evaluation of organic reagents (coagulation and filter aids) for water treatment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0916, OXYGENATION OF AQUEOUS BODIES USING LIQUID OXYGEN
W. GARNER, Midwest Research Institute, *Kansas City, Missouri* 64110

This is a proposed study of the parameters controlling the transfer of liquid oxygen (i.e., LOX) to dilute aqueous solutions. The study would include measurements of the oxygen transfer coefficient, design of suitable oxygenation equipment, development of application techniques, and process-cost calculations;

this last item would, in turn, permit accurate comparisons of the costs of accomplishing various levels of oxygen enrichment with LOX vs. mechanical aeration or compressed gaseous oxygen.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0917, BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS
W.A. SCHELLER, Univ. of Nebraska, School of Engineering, *Lincoln, Nebraska* 68508

Purification of brackish water containing 1000-5000 ppm of salts by electrodialysis appears to be more economical than any of the present day distillation techniques, but it is still expensive. A reduction in the water costs might be realized if a useful byproduct were produced in the water purification process.

The primary objective of the proposed research is to investigate the possibility of using an electrodialysis cell for brackish water purification in conjunction with a biological fuel cell powered by microorganisms capable of living in the brine effluent from the electrodialysis unit, feeding on cellulose containing materials such as hay, corn stalks, etc. and suitable for processing into cattle feed or feed supplement. Furthermore it is planned to investigate the effect of operating variables on the performance of the electrodialysis unit within the range of voltage-current-power capabilities of a battery of biological fuel cells. Finally, using the experimental results as a basis, economic evaluations will be made in order to determine the economic optimum arrangement of electrodialysis units and biological fuel cells. This is a five year program from fiscal 1966 through fiscal 1970.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0918, PURIFICATION OF LOW QUALITY WATERS BY FOAM SEPARATION
T.E. WILSON, Rutgers the State University, School of Engineering, *New Brunswick, New Jersey* 08903

The proposed research will involve laboratory scale experiments of both the batch and continuous type. Removal of turbidity, color and bacteria will be studied using both natural and lab-prepared water. Kinetic data from the batch studies will be used to develop a suitable continuous flow system. The constituents of the raw water will be varied and their effect, as well as the effect of air bubble size will be studied.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0919, THE EFFECT OF CHLORINATION ON TREATED ORGANIC CHEMICALS
E.L. BARNHART, Hydroscience Incorporated, *Westwood, New Jersey* 07675

It is proposed to conduct a study to determine any adverse effects that might result from the chlorination of certain industrial chemicals either before or after biological treatment.

Present Objectives: 1. To determine the effect of selected organic chemicals and their degradation products on chlorine demand and disinfection efficiency. 2. To determine, for selected chemicals, in which cases it is possible to form chlorinated compounds during disinfection of the treated effluent. 3. To determine the physical properties and degradation rate of any chlorinated compounds found. 4. To determine the influence of persistent chlorinated compounds on the stream biota. Several levels of life forms will be considered.

The study will be conducted in three phases: Phase I will mix selected compounds before and after biological treatment with chlorine and measure chlorine demand and disinfection efficiency; Phase II will collate persistent chlorinated organics and describe their properties; Phase III will determine the impact of persistent chlorinated organics on the receiving environment.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0920, EVALUATION OF PUMPING EFFECTS IN MALAGA BEND AREA, NEW MEXICO
J.S. HAVENS, U.S. Dept. of the Interior, Geological Survey, *Albuquerque, New Mexico* 87106

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with state and local agencies in New Mexico.

Purpose: To determine the improvement of the quality of water in the Pecos River as the result of lowering the head of the brine aquifer discharging a saturated brine into it and to determine if the pumped brine is confined within the disposal area.

Methods: Observation wells completed in the brine aquifer and in shallower aquifers are used to monitor water-level fluctuations and quality of water changes. Seepage runs are made to monitor the quality of water in the Pecos River.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0921, CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION
V.H. EDWARDS, Cornell University, School of Chemical Engineering, *Ithaca, New York* 14850

This research seeks to determine whether ultrafiltration or reverse osmosis can be used effectively to concentrate aqueous solutions and suspensions of pesticides and other biologically and chemically recalcitrant organic molecules for purposes of more accurate and sensitive sampling and analysis of water supplies. A second objective will be the development of a prototype design for a field sampling device based upon the principles developed in this research.

Principal elements in this research will include: 1. Screening of various commercial ultrafiltration membranes for suitability in concetration of selected test pesticides. 2. Study of the influence of pertinent variables (such as pH, temperature, pesticide concentration, and mineral and sediment content and compostion) on ultrafiltration flux rates and rejection efficiency of memoranes for selected pesticides. 3. Implementation of these results into the preliminary design of a prototype field sampling device. (Subsequent research based upon this work will be directed towards construction and field evaluation of this device and technique.)

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0922, ARTIFICIAL RECHARGE OF TREATED SEWAGE WATER AT BAY PARK, NEW YORK
G.D. BENNETT, U.S. Dept. of the Interior, Geological Survey, *Mineola, New York* 11501

The objective is to evaluate the feasibility of and develop optimum methods for injecting water from highly treated sewage-plant effluent into deep artesian sand aquifers of the Magothy(?) Formation (Upper Cretaceous) of Long Island. This formation, which is the principal source of the water supplies for Nassau and western Suffolk Counties, is being pumped intensively and locally is being invaded by salty water. Extensive artificial recharge through injection wells with reclaimed waste water may be needed for water conservation and to create fresh- water pressure ridges to retard sea water.

Water from sewage-plant effluent will be further treated to a potable quality and then injected under pressure through specially designed wells (with fiberglass casings) under various experimental conditions. Data on hydraulic and geochemical results of the injection will be collected using observation wells and special in-situ geochemical sensors.

This research is part of the program of water resources investigations being carried on in cooperation with the County of Nassau, N.Y.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0923, MASS TRANSFER ANALYSIS IN REVERSE OSMOSIS OPERATION
C. TIEN, Syracuse University, Research Institute, *Syracuse, New York* 13210

The main objectives of this work are: (1) To obtain analytical expressions for the rate of production of pure water from waste water by reverse osmosis operation in terms of operating variables under turbulent flow conditions. (2) To study the effect of natural convection on a reverse osmosis system. (3) To determine the most promising geometrical configurations of the system and the most optimal operating conditions.

2. WATER QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0924, REUSE OF PLANT EFFLUENT AND COOLING WATER BLOWDOWN AS PROCESS WATER
W.J. DAY, Fiber Industries Incorporated, *Charlotte, North Carolina* 28201

An existing facility provides treatment for the combined sanitary and equalized chemical process waste waters from a synthetic fiber manufacturing plant. Treatment facilities consist of extended activated sludge aeration basins, clarifier, polishing ponds, and aerobic sludge digestion basin, and a sludge holding pond.

The project will evaluate treatability of this waste in a plastic media trickling filter, feasibility of algae removal from the polishing pond effluent by use of microscreen filters, feasibility of BOD, COD, color, odor and taste reduction in the final effluent by use of powdered carbon for the purpose of ultimate reuse of the effluent as process makeup water, and chromate reduction of cooling tower blow-down to permit treatment in the waste treatment plant.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0925, EVALUATION OF FIELD WATER PURIFICATION SYSTEMS
N.S. HURST, U.S. Navy, Medical Field Res. Lab., *Jacksonville, North Carolina* 28542

Technical Objective: Evaluate methods of water purification suitable for use by individual Marine troops in the field and improve the taste of purified water.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0926, WATER QUALITY IMPROVEMENT - KINETICS AND MECHANISM OF THE CHLORINATION-DEGRADATION OF UREA AND URIC ACID
F.H. RATHMANN, North Dakota State University, School of Chemistry, *Fargo, North Dakota* 58102

The objective of this project is to determine the mechanism and chlorination-degradion of urea and uric acid and the intermediate products formed prior to eventual conversion to harmless and non-noxious substances. Aqueous solutions of pure urea and pure uric acid will be made up and mixed with solutions of Cl2, HOCl, and NaCl. Intermediate products formed by the reactions will be determined by oxidation, by ultraviolet and visible spectroscopy, by adsorption chromatography, by polarography, and by diminuation and disappearance of the tests used for the initial materials. The course of the reactions will be followed mainly by changes in the ultraviolet spectra and in the pH of the solutions. Urea will be determined by direct oxidation or by the xanthydrol method. Uric acid will be determined by ultraviolet spectroscopy, or by the phosphomolybdate and other methods.

Samples of water taken weekly from swimming pools in the Fargo- Moorhead area will be analyzed by standard methods to determine the levels of urea, uric acid, and of the intermediate chloro-urea and chloro-uric acid degradation products in those waters. The course of reactions will be followed by the same methods used for the ideal solutions of pure urea and uric acid.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0927, REMOVAL OF ORGANIC CONTAMINANTS
P.W. BUELOW, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Cincinnati, Ohio* 45213

The primary objective of this project is to field test monitoring techniques and evaluate full-scale plant testing of treatment processes for removal of organics and in water supplies. For the present, this study will be confined to helping local waterworks officials and State Health Department people evaluate the efficacy of activated carbon monitor units for detecting organic removal and to concurrently study the various full-scale methods for reducing organics from surface water such as replacing the sand in filters with granular activated carbon.

This has been a continuing project since 1967 and will have to continue indefinitely.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0928, BEHAVIOR AND CONTROL OF CONTAMINANTS IN SURFACE WATERS
J.K. CARSWELL, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Cincinnati, Ohio* 45213

This project is designed to determine the behavior of contaminants of public health importance in surface water used as a raw water source for municipal drinking water and to develop engineering techniques for controlling these contaminants. Laboratory-, pilot-, and field experiments will be carried out, to accomplish the above-mentioned long- range objectives. Behavior of water quality parameters will be studied in controlled laboratory experiments under conditions typical of those found in nature. The findings of these experiments will be confirmed in large-scale experiments and in the field. Engineering techniques for control of water quality will be investigated in small- and large-scale field studies. Early studies will be concerned with the behavior of indicator organisms in thermally stratified reservoirs and the usefulness of artificial destratification to the water supply industry as a means of raw water quality control. This project was started in October 1967 and is a continuing project.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0929, STUDIES CONCERNING THE EFFECTIVENESS, STABILITY AND RELIABILITY OF GERMICIDAL COMPOUNDS
G. BERG, U.S. Dept. of the Interior, *Cincinnati, Ohio* 45244

Technical Objective: Determine the effectiveness, reliability, and stability of emergency water purification and germicidal compounds for Army use.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0930, DESTRUCTION OF INFECTIOUS VIRAL NUCLEIC ACID BY IODINE
G. BERG, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

It has been reported that iodine destroys viruses by reaction with the protein coat, and that it does not react with viral nucleic acids. Since iodine is used as a water disinfectant, we have undertaken to determine whether viral nucleic acid, imprisoned in an inactivated shell, presents a hazard in disinfected wastewaters and renovated waters.

Polio virus 1 (Mahoney) has been concentrated by ultracentrifugation. The viral RNA has been extracted with phenol from the intact virus, and purified by precipitation with salt-saturated ethanol. We have shown that the viral RNA is much more resistant to the disinfecting action of iodine than the parent virus from which the RNA was obtained.

A large volume of coxsackievirus A9 has been concentrated by ultracentrifugation, and its RNA will be extracted and tested for sensitivity to iodine.

Polio virus RNA and coxsackievirus RNA will be tested for sensitivity to other halogens, also.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0931, DISINFECTION OF RENOVATED WASTEWATER
R.L. BUNCH, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

In some areas the treatment of municipal wastewater for direct reuse is inevitable. Recreational use of renovated wastewater will also increase in areas which lack surface water. Regardless of the use of reclaimed water, the health needs for sewage purification and disinfection must be met at all times.

The primary objective of this project is development of methodology to produce a pathogen-free effluent from waste treatment processes. This process must be economically feasible, yield an effluent free of hazardous toxic components and as far as possible yield an effluent that does not introduce factors undesirable to aquatic environments.

The merits of chlorination, ozonation, C102-process, and any other promising and practical disinfection process will be evaluted in terms of efficacy, economy, practicability and relative freedom from undesirable after-effects.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0932, BIBLIOGRAPHY ON FLUORIDATION OF PUBLIC WATER SUPPLIES
I.R. CAMPBELL, Univ. of Cincinnati, School of Medicine, *Cincinnati, Ohio* 45221

The purpose of this project is a continuing survey of the worldwide literature concerning the occurrence and biological effects of the inorganic fluorides and of all aspects of fluoridation of water supplies, and alternative methods of caries prevention with fluorides. The main objective is the preparation of informative abstracts of publications of major interest, i.e, those applying to dental and general health, so as to provide as complete as possible a record of the pertinent fluoride literature, equipped with detailed indexes. These abstracts are made available at nominal cost or gratis to interested libraries and scientists in universities and other research organizations as an aid in keeping up with the rapidly growing and widely scattered literature.

The overall product of this work serves as the basis for the publication of state-of-the-art reviews with the assistance of an Advisory Editoral Board, to provide reliable information for dentists, physicians, community leaders, and others concerned with the welfare of their community on the safety, effectiveness and significance of fluoridation of public water supplies and on the role of fluoride in general health. The availability of the abstracts has materially assisted authorities in the field to prepare critical reviews on this subject.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0933, CONCENTRATION OF CHEMICALS BY FLOC FORMING ORGANISMS
P.R. DUGAN, Ohio State University, Graduate School, *Columbus, Ohio* 43210

This study is an investigation of the metabolic activities of floc forming organisms with regard to their ability to lower biochemical oxygen demand (BOD) and to remove toxic metal ions from solution in relation to aerobic waste treatment processes. This may have particular relevance to specialized waste treatment situations such as those encountered in milk processing wastes and metal processing wastes. It is planned to examine the relative importance of the floc matrix (zoogleal material), compared to the same microbial cells not in zoogleal form, to the aerobic treatment process.

The influence of environmental variables in the floc forming process is also being studied.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0934, FORMATION OF DENSE SETTLED SLUDGE BY LIME - TREATMENT OF SYNTHETIC ACID MINE DRAINAGE
K. SVANKS, Ohio State University, School of Engineering, *Columbus, Ohio* 43212

The voluminous sludges obtained in current methods of lime neutralization and iron removal in the treatment of acid mine drainages constitute one of the major drawbacks to this process. The objectives of this research are to investigate means of obtaining dense sludges when acid mine drainages are treated with lime. Initial laboratory investigations have shown that with proper preadjustment of the ferric- ferrous ion ratio, lime neutralization can lead to the formation of FE3O4 or FeOOH, depending on pH control and on the concentration of aluminum in the drainage. It appears probable that dense sludges can be obtained in both cases. Sludge quality and iron removal will be studied as a function of total iron and acidity, ferric-ferrous ratio prior to neutralization, pH control during neutralization, and aluminum content. Due to the extremely slow rate of oxidation of ferrous ion by oxygen under acid conditions, organisms of the Ferrobacillus- Thiobacillus group will be utilized to catalyze the rate of ferrous ion oxidation in the preneutralization adjustment of the ferric-ferrous ratio.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0935, TERTIARY TREATMENT BY FLOCCULATION AND RAPID SAND FILTRATION
D.F. TOSSEY, Dayton Department of Water, *Dayton, Ohio* 45402

The purpose of this project is to demonstrate the feasibility of tertiary treatment at a municipal trickling filter plant. Coagulation, flocculation, sedimentation and filtration principles will be applied to trickling filter effluent and final plant effluent utilizing an existing scale model unit. Tests will be conducted both with and without the use of chemicals. Various filter media and flow rates will be studied.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0936, EFFECT OF SURFACE GROUPS ON ADSORPTION OF POLLUTANTS
R.W. COUGHLIN, Lehigh University, School of Engineering, *Bethlehem, Pennsylvania* 18015

Activated carbon is the most promising material which has been investigated for adsorbing biologically undergradable organic compounds from waters and waste waters. Of the many different commercially available carbons which have been used for these studies, some have shown markedly higher adsorptive capacities than others (two to three times on a per-gram basis). Presumably, these differences are due to varying specific surface areas, variable types of surfaces and different functional groups on the solid surfaces. It is proposed herein to investigate the influence of type of surface and nature of functional groups on the surfaces as they affect the adsorption of typical biologically undergradable organic compounds on activated carbon and on other promising adsorbents. The utimate goal of this research will be to identify those functional groups and surfaces which are most efficacious for adsorbing specific compounds. This information will indicate how better materials can be designed for specific adsorption tasks, provide expanded and better means of surface regeneration and establish guides for selecting solid adsorbents to achieve a particular adsorption goal.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0937, TREATMENT OF COAL MINE WATERS TO MEET CURRENT COMMONWEALTH WATER DISCHARGE REQUIREMENTS
H.L. LOVELL, Penn. State University, Graduate School, *University Park, Pennsylvania* 16802

The detailed engineering design and plans are complete. Construction for phase 1, excavation and construction of lagoons at the site near Hollywood, Clearfield County, Pennsylvania is essentially completed.

Phases 2,3,4, and 5 (the installation of unit operations and instrumentation) have been bid and work will proceed shortly. Completion of construction is anticipated by spring 1969.

The plant will encompass a highly instrumented series of unit operations so designed that it will be capable of functioning through at least six different flow sheets. Emphasis is being placed on solid- fluid separations which comprise the highest cost operations, both capital and operating, and which offer the most difficult technical and engineering problems.

SUPPORTED BY Pennsylvania State Government

2.0938, FACTORS AFFECTING MINE DRAINAGE AND THE GROUND WATER INTERACTIONS IN SELECTED AREAS OF WESTERN PENNSYLVANIA (PART 2)
R.R. PARIZEK, Penn. State University, Graduate School, *University Park, Pennsylvania* 16802

As shown by a previous study, a stratification of ground water flow in the strip-mined bituminous coal field of Pennsylvania may exist that may effectively divert acid mine drainage pollution to deep ground water reservoirs. Further, opportunities

for neutralization were shown to exist. These considerations may lead to the establishment of a potable ground water supply in an area afflicted with surface acid mine drainage. To test these hypotheses a specialized water monitoring system was installed to accurately evaluate the aquifer characteristics, to determine the aquitards in the area and to sample ground water by chemical analyses to determine the extent and effect of acid mine drainage pollution.

A related study will investigate the field conditions under which pyrite remains stable and does not decompose to produce acid mine drainage. Samples of iron disulfide from an area containing strip mines yielding alkaline drainates will be analyzed to determine the reason for the stability; hence, gain an insight to acid mine drainage abatement.

SUPPORTED BY Pennsylvania State Government

2.0939, CARTRIDGE FILTRATION FOR IRON AND MANGANESE REMOVAL

F.J. DELUISE, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

The primary aim of this project is the development of a practical, effective cartridge-type filter system for the removal of iron and manganese from ground water supplies. Bench-type laboratory studies have indicated that such a system should be possible. This study will employ a flow system in which a feed pump, dosing pump, contact coil and cartridge filter are the principal elements. Various chemicals will be used to oxidize the iron and manganese. The proper combination of system elements, sizes and conditions will be sought to provide both an acceptable effluent and a minimum pressure drop across the filter.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0940, DIRECT METHODS FOR THE ENUMERATION OF SALMONELLA IN WATER

V.J. CABELLI, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

A series of laboratory and field studies will be performed towards developing and evaluating a membrane filter method for the enumeration of Salmonella species in marine and fresh waters. This method is needed for the conduct of investigations relating the sanitary quality of marine and fresh recreational waters to enteric disease in the swimmers. It also is needed as another means of monitoring (potable waters) and their sources.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0941, EFFECT OF CHLORINATION ON HUMAN ENTERIC VIRUSES

O.C. LIU, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

The effect of chlorination on viruses has been repeatedly investigated in the past two decades. The weaknesses of these studies are: (a) the number of viruses examined was very small as compared with the available viruses isolated from human feces, thus generalization of this limited information may be hazardous. (b) the most unfavorable conditions for the virus existing in nature have never been taken into consideration. Under any or a combination of these conditions, a virus could be much more resistant to this treatment than has been demonstrated in the laboratory. This project is undertaken at the request of the Army Corps of Engineers as a part of the feasibility study of the supplementary supplies for Washington, D.C. area in the year 2000. The major objective for this project is to compare the resistance of 35 strains of human enteric viruses to chlorine.

Two types of water will be used as the suspending media for all viruses: the conductivity water (chlorine demand free) and the Potomac estuarine water (coagulated and filtered in the Washington, D.C. water treatment plant). Water samples will be characterized for chlorine- demand, chlorine content, total solid, pH, turbidity, COD, and the like. Immediately before each experiment, all aliquots of each water sample will be adjusted to pH 7.8. Half of the aliquots will be kept at 22 degrees C and the other half at 2 degrees C. Each virus strain will be added to the water samples to achieve a concentration of approximately 10,000 infectious doses/ml. The treatment of the virus-laded water samples will consist of 0.5 and 1.5 mg/l of chlorine for two hours. The rates of viral devitalization will be determined in appropriate assay systems and the free residual chlorine read by an amperometric titrator.

Initially six representative virus strains will be tested parallelly in both the conductivity and the Potomac estuarine waters. The chlorine effect on these viruses in two waters will be critically compared and evaluated. From this analysis, the procedures for testing the remaining viruses will be determined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0942, EFFECT OF CHLORINATION ON HUMAN ENTERIC VIRUSES

H.R. SERAICHEKAS, U.S. Environ. Protection Agcy., Northeastern Water Hyg. Lab., *Narragansett, Rhode Island* 02882

The objective of this project is to determine and compare the resistance of human enteric viruses to free chlorine in drinking water. This information will furnish the basis for guidelines for disinfection of water supplies and safeguarding the supplies from transmission of human enteric viruses.

Accomplishment in FY-71: During the past 18 months, 25 strains of human enteric viruses were tested for their relative resistance to 0.5 mg/l of free chlorine under identical experimental conditions: suspending in partially purified Potomac River water adjusted to pH 7.8 and incubated at 2 degrees C. A wide range of resistance to the chlorine treatment was detected among the tested viruses. For instance, 2.7 min. were required to kill 99.99% of a reovirus under these conditions, whereas 43.7 min. were required to kill the same amount of a coxsackievirus (A6). The resistance of the remaining viruses fall between these two extremes. Thus it is clear from these data that the degree of chlorine resistance of any virus is entirely unpredictable.

Plans for FY-72: It is planned to test an additional 20 strains of virus for the resistance to chlorine. Further, it became apparent that chlorine resistance of the naturally occurring virus may be substantially different from those grown and prepared in the laboratory. As a preliminary study, the chlorine resistance of several types of poliovirus from human feces will be determined under controlled conditions and compared with the same types of virus prepared in the lab. These results should shed more light on the problems encountered in the field.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0943, KINETICS OF BIOLOGICAL FILTERS

J.F. ANDREWS, Clemson University, School of Engineering, *Clemson, South Carolina* 29631

Since the trickling filter is an aerobic biological treatment process which depends upon the action of attached microorganisms for the removal of organic waste products, the overall process may be represented by the simplified reaction equation: organisms plus substrate plus oxygen yields new cells plus metabolic waste products.

It is the objective of this research project to study the kinetics of biological filters by observing the influence of the three reactants on the rate of removal of organic products by attached microorganisms and use this data to evaluate a proposed mathematical model for trickling filters. In view of the fact that the microbial population of a trickling filter is responsible for the removal of organic waste products, it should be possible to express this removal in terms of microbial growth kinetics.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0944, THE REMOVAL OF IMPURITIES IN TRICKLING FILTER EFFLUENTS

T.M. KEINATH, Clemson University, School of Engineering, *Clemson, South Carolina* 29631

Over the past ten years application of electrophoretic mobility measurements in control of water treatment processes has been investigated by Black and associates and Riddick, primarily, under various conditions using natural or synthetic waters. It is

considered to be materially effective in improving efficiency of the removal of impurities in both secondary and tertiary waste treatment.

It is planned, as a first step, to examine the colloidal properties of the particulates in a trickling filter effluent, using the effluent from Clemson University waste treatment plant, both before and after passage through the final clarifier. This plant discharges to a large impoundment which is used for water supply and recreation. Investigation of the chemical properties of the waste from the sampling points will be a necessary adjunct to the electrophoretic mobility measurements and microscopic examination of the particulates. Initial work will be extended to include treatment of the trickling filter effluent using coagulants, such as ferric sulfate, and further investigation of the colloidal properties, to obtain information on the conditions for optimum removal of impurities, along with the use of zeta potential as a control process in treatment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0945, THE VORTEX CHAMBER AS A GRIT REMOVAL DEVICE FOR WATER TREATMENT
P B. ZIELINSKI, Clemson University, School of Engineering, *Clemson, South Carolina* 29631

The objective of this study is to determine the efficiency of the free surface vortex chamber as a grit removal device for treatment of waste or supply water. This study also includes a consideration of the effectiveness of this flow to retain the lighter organic particles in suspension and be retained in the flow through the chamber for conventional treatment.

The measured parameters will include the variables necessary to define adequately the vortex flow according to existing methods, which include a measure of the total head, flow rate, circulation, and physical properties of the fluid. Measured batch quantities of a known size gradation of light particles in the form of wax and plastic spheres and organic media along with inorganic particles will be combined with the flow at various rates prior to the entrance into the vortex chamber. Quantities of collected or settled particles will be measured. Particular attention will be directed toward the effectiveness of grit removal over a wide range of variation of flow rates, a condition of operation which is normally found in treatment plants.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0946, VIRUS REMOVAL-WATER AND WASTEWATER
W.A. DREWRY, Univ. of Tennessee, School of Engineering, *Knoxville, Tennessee* 37916

The proposed research project involves laboratory studies of virus removal by several conventional water treatment processes that also are or can be used as wastewater treatment processes. Processes studied will include flocculation, chlorination, activated carbon adsorption and ion exchange. The virus used will be f2 bacteriophage which is effective against E. coli.

It is proposed to use a single virus, a single assay technique and well defined experimental procedures in order to provide a valid basis for determination of the relative effectiveness of the various treatment processes.

Laboratory studies on three different waters will include: 1. Flocculation studies (Jar Tests) using several commonly used chemical coagulants and a representative cross section of approved coagulant aids. 2. Concentration effect and rate of kill chlorination studies. 3. Activated carbon adsorption studies both on a batch (Jar Test) and continuous flow column basis. 4. Ion exchange removal studies using continuous flow columns.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0947, REFRACTORY ADSORPTION ON CHEMCOKE
G.T. FISHER, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

The adsorption properties of chemcoke, an apparent competitive material for activated carbon, will be examined for refractory materials.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0948, ELECTROPHORETIC CLARIFICATION OF WATER
E.A. HILER, Texas A & M University System, School of Agriculture, *College Station, Texas* 77843

This research involves a study of the utilization of the electrophoretic method for pollutant removal from natural waters. Electrophoretic clarification is effected by removal of charged colloidal particles from water as the suspension is passed through a dc electric field.

The purpose of this research is to investigate the removal of colloidal clay, bacterial and pesticidal pollutants from water by the electrophoretic method. The objectives are as follows: (1) development of an optimal electrode arrangement based on results of theoretical and basic experimental research; (2) characterization of various contaminants present in typical natural waters; and (3) evaluation of the efficiency of removal of these pollutants by the electrophoretic method.

This study will provide a critical evaluation of the feasibility of the electrophoretic method of water clarification.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0949, ADSORPTION OF ORGANIC COMPOUNDS ONTO SOLIDS FROM AQUEOUS SOLUTIONS
J.P. WIGHTMAN, Virginia Polytechnic Institute, Graduate School, *Blacksburg, Virginia* 24061

The proposed research involves a study of factors effecting adsorption of organic compounds from aqueous solution. The compounds selected for study contain functional groups representative of water contaminants. Several solids of different surface energy will be studied.

The surface area, surface constituents, and structural elements of each solid will be established. The measurement of the amount of organic compound adsorbed and the heat of adsorption is proposed.

The results should ultimately support a model for solution adsorption by which predictions concerning the selectivity of adsorption of a given compound in water by a given solid could be made.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0950, ELECTROCHEMICAL ACTIVATION AND REGENERATION OF CARBON SURFACES FOR TERTIARY WATER TREATMENT
G.B. WILLS, Virginia Polytechnic Institute, School of Engineering, *Blacksburg, Virginia* 24061

Proposed is a study of a novel electrochemical carbon activation process in which the surface adsorptivity of carbon anodes can be increased by several orders of magnitude by an electrochemical etching procedure. Carbon surfaces so prepared are to be tested for effectiveness in the tertiary treatment of waste water to remove refractory organics. Also, the regeneration of loaded carbon surfaces is to be attempted by simple electrode polarization or by electrolytic oxidation of the adsorbed pollutants in situ.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0951, SUPPORT ENGINEERING TESTS/SERVICE TESTS OF MOBILE ION EXCHANGE UNIT BY TECOM
R.J. GAINEY, U.S. Army, Engineer Research & Dev. Labs., *Fort Belvoir, Virginia* 22060

Technical Objective: Support combined engineer tests and service tests of the ion exchange unit, mobile; 3000 GPH conducted by the test and evaluation command.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Defense - Army

2.0952, HIGH FLUX RO MEMBRANE WITH SALT REJECTION PROPERTIES
J.E. JONES, U.S. Army, Mobility Eqp. Res. & Dev. Ctr., *Fort Belvoir, Virginia* 22060

Technical Objective: Study potential membrane materials exhibiting high flux and salt rejection characteristics. Determine flux decline slopes and salt permeation constants and optimize material best adapted to military field intended use.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0953, DETERMINE FEASIBILITY CHARACTERISTICS OF TUBULAR RO PROCESS
D.C. LINDSTEN, U.S. Army, Mobility Eqp. Res. & Dev. Ctr., *Fort Belvoir, Virginia* 22060

Technical Objective: Conduct exploratory investigation of the various tubular configurations to determine the technical feasibility of the various geometrical tubular modules and select the most optimum arrangement for the multi-purpose military water purification requirements.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0954, DEVELOPMENT OF METHODOLOGY FOR ISOLATION OF VIRUSES FROM WATER
W. JAKUBOWSKI, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Gig Harbor, Washington* 98335

The efficiency of poliovirus removal from water by adsorption to iron oxide, kaolin, bentonite and a polyelectrolyte (PE60- an insoluble cross-linked copolymer of maleic anhydride) will be determined. The adsorbents will be tested under varying conditions of pH, ionic strength and nonviral protein level. A centrifugation procedure will be used to separate the virus-adsorbent complexes from the reaction mixtures. The percentage recovery of virus from adsorbent will also be determined. The adsorbents will be compared for efficiency of removal and recovery of low polio-virus levels from large volumes of freshwater and seawater. The adsorbent-virus complexes will be removed from suspension by filtration through fiberglass prefilter pads. Investigations will also be conducted on filtration of virus suspensions through layers of adsorbent preformed on the surface of the filter pad. Parameters to be studied include flow rate and adsorbent bed depth.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.0955, PROVIDE A COMPENDIUM OF OIL SPILL TREATING AGENTS COVERING ABSORBENTS, DISPERSANTS, SINKING AGENTS, COMBUSTION PROMOTERS, GELLING AGENTS, ETC
P.C. WALKUP, Battelle Memorial Institute, *Richland, Washington* 99352

Manufacturers' information and documented field experience on the use of various types of treatment agents were compiled. About 100 commercially available products were included and the information on each includes chemical and physical characteristics, effectiveness, limitations, and toxicity.

SUPPORTED BY Amer. Petroleum Institute

2.0956, NITROGEN REMOVAL AND IDENTIFICATION FOR WATER QUALITY CONTROL
D.A. CARLSON, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

The specific research objectives are to use a biological denitrification system to (1) define a theoretical kinetic model for denitrification based on information from pure culture studies using Ps aeruginosa, (2) establishing an emperical equation for denitrification in mixed cultures based on the pure culture research and mixed culture pilot studies, and (3) development of analytical techniques for measuring nitrogens and other water quality parameters using modern optical, acoustical and microwave techniques.

Laboratory and pilot studies will be used and instrumentation developed to apply equations and mechanisms to field studies for continuous monitoring.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0957, THE USE OF PULP MILL SLUDGES AS EXTENDERS FOR CORRUGATING MEDIUM
L. LENEY, Univ. of Washington, School of Forestry, *Seattle, Washington* 98105

The objectives are to enhance reduction of stream pollution by the development of a technical basis for economic utilization of pulp and paper mill sludge. Sludges of various mills which represent sludge types will be mixed as extenders in varying proportions with semi- chemical pulps. Hand sheets of corrugating medium will be made and tested according to TAPPI standards. The characteristics of the corrugating medium will be determined by all feasible means to understand how the sludge influences the sheet properties. From this it may be possible to predict the best mix for any sludge of known composition thus encouraging its utilization in a marketable product.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

D. WATER MANAGEMENT AND POLLUTANT DISPERSAL

Dispersal of Effluents, Hydrologic Mixing, Disposal on Soil Waste Fields, Dilution of Pollutants, Assimilative Capacity, Ocean Dispersion, Self-purification. Includes Management of Polluted Natural Waters to Improve Quality.

2.0958, CONSERVATION OF WATER AND REDUCTION OF POLLUTION BY USE OF SOLVENT SYSTEMS FOR COLORING TEXTILE MATERIALS
W.S. PERKINS, Auburn University, School of Engineering, *Auburn, Alabama* 36830

The purpose is to study organic solvent systems for coloring of textile materials for the purposes of conservation of water supply, reduction of effluents, and improvement in quality of dyed textiles.

In Fiscal Year 1971 solvents for selected disperse dyes will be screened. Selected dyes will be applied to polyester substrates from selected solvents by batch dyeing procedures. Dyed substrates will be tested for appearance, fastness, and handle.

The kinetics and thermodynamics of the dyeing process will be evaluated as they are related to the economics of the process.

In Fiscal Year 1972 the study will be extended to direct dyes on cellulosic substrates.

Consultations regarding the construction of facilities for application of dyes from solvents and for solvent recovery are within the scope of the project.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0959, STUDY OF ASSIMILATIVE CAPACITY OF ARCTIC AND SUB-ARCTIC STREAMS
P.J. FREY, U.S. Dept. of the Interior, Federal Water Quality Admin., *College, Alaska* 99701

Information on the effects of extreme environments (have periods of darkness or of light, total ice cover for nine months of the year, low maximum water temperature) on a river's capacity to assimilate pollution, and on the organisms which inhabit the streams and are responsible for the degradation of pollution will be obtained so that it will be possible to predict and evaluate the effects of pollution on these streams.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0960, THE EFFECTS OF SUSPENDED SILTS AND CLAYS ON SELF-PURIFICATION IN NATURAL WATERS
A.P. MILLER, Univ. of Alaska, Inst. of Water Resources, *College, Alaska* 99735

The proposed research plan involved laboratory investigations using natural and synthesized sediment laden waters to determine their effects upon the self-purification process in rivers and streams. The primary hypothesis to be tested will be whether

adsorption of particulate contaminants and bacteria upon the sediment particles will enhance the biodegradation of these materials requiring extracellular enzyme production. Effects of temperature will be studied once the adsorptive capacities for the bacteria and organic substances are known. Biological activity will be determined by respiration rates measured under various conditions of known adsorptive capacity, bacterial population, and substrate concentrations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0961, LIMNOLOGY--NUTRIENT-BIOTIC RELATIONSHIPS IN THE UPLAKE REGION OF BEAVER RESERVOIR
L.R. AGGUS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Fayetteville, Arkansas* 72701

Preliminary limnological studies in the extreme upper reaches of Beaver Reservoir suggest a level of biological activity much higher in the remainder of the impoundment. Waste materials after secondary treatment enter the reservoir via the White River. The long theoretical detention time of Beaver Reservoir (1.3 years) permits ample time for considerable nutrient assimilation in the extreme uplake region. Attempts will be made to correlate standing crops of bacteria, plankton, benthos and shad with several physical-chemical parameters. Nitrogen- phosphorus uptake by these organisms will be estimated.

Appropriate sampling methods will be used to estimate desired parameters from five stations in the uplake region of Beaver Reservoir. Sampling will be conducted biweekly from June through the period of fall overturn. Monthly or bimonthly sampling may then be conducted until thermal stratification occurs in the spring.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0962, REHABILITATION OF A BRINE-POLLUTED AQUIFER
R.C. SMITH, State Soil & Water Cons. Comm., *Little Rock, Arkansas*

The project is expected to rehabilitate a brine-polluted aquifer. The aquifer is used to supply domestic and irrigation water and has been polluted by oil field brine water. The project is located near Garland City, Miller County, Arkansas.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.0963, DECISION PROCESSES IN WATER QUALITY MANAGEMENT
R.M. MALES, Engineering Science Inc., *Arcadia, California* 91006 (C-1736)

This study will evaluate, using dynamic simulation techniques, the decision-making processes at both the agency and group or individual levels in the multi-agency system of water quality management. Both existing and hypothetical organizational schemes will be considered in terms of their management functions as they relate to objective implementation interrelationships. Techniques and tasks which can be used to evaluate and improve the decision-making process of groups and individuals will be developed.

The results of this study will have broad applications in all sectors of the water quality management field.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0964, MIXING PROCESSES IN ESTUARIES
H.B. FISCHER, Univ. of California, School of Engineering, *Berkeley, California* 94720

This research will study the underlying procesees which cause mixing amid dispersion in estuaries through a re-examination of the fundamental mixing and transport processes. A laboratory flume will be used to study the effect of partial stratification on turbulent mixing, both in the vertical and transverse to the main flow direction. In addition, the convective patterns in a simplified model estuary will be observed in detail, in an attempt to combine knowledge of turbulent mixing and convective patterns to predict the overall dispersive pattern. Methods will be sought to predict the values of transfer coefficients in real estuaries, and to show the effect on these coefficients of engineering modifications to the estuary. Results of these studies will be used to improve present methods for forecasting pollutant dispersion.

SUPPORTED BY U.S. National Science Foundation

2.0965, MIXING PROCESSES IN SATURATED AND UNSATURATED SOIL-WATER SYSTEMS IN RELATION TO POLLUTION
J.W. BIGGAR, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D0-WSE-2451-SG)

OBJECTIVE: Analyze the transient nature of the mixing of dissolved organic and inorganic ions in water flowing through saturated and unsaturated soils. Impose the presence of thermal gradients and analyze the transient nature of the mixing of two fluids at two different temperatures for similar and dissimilar salt concentrations. Ascertain the nature of the porous material by comparison of mixing of thermally different solutions with chemically dissimilar solutions.

APPROACH: Attempt to describe the system by means of thermodynamic and hydrodynamic models with the aid of computer analysis. Particular attention will be given to the physical properties of the fluids used. This project will augment previous and present work conducted under Regional Projects W-68 and W-82. Experimental laboratory work to test theory and provide ranges of values for parameters will be obtained.

PROGRESS: Studies of the mixing of thermally different fluids in porous medium has been completed. Although the analogies exist between the mixing of chemically and thermally different fluids in porous media, the conditions are sufficiently different to provide additional knowledge of the mixing phenomenon. Axial thermal conductivities may have significant effect on the overall heat transferred at slow velocities. The ratio of kz to kr (longitudinal to radial thermal conductivity, respectively) remained constant at (1.1) for all flow velocities and for all soils. Heat transfer by mass flow was the dominant mechanism and the different fluid mixing patterns account for the behavior of the apparent thermal conductivities. Miscible displacement of Cl and HTO through soil at different flow rates and total salt concentration has been used to test a new model for dispersion based on mobile and immobile salt and water zones in the soil. The new model appears to be a big advancement in dispersion theory.

SUPPORTED BY U.S. Dept. of Agriculture

2.0966, FEASIBILITY ANALYSIS OF INCINERATOR SYSTEMS FOR RESTORATION OF OIL CONTAMINATED BEACHES
R.M. ROBERTS, Aerojet General Corporation, *El Monte, California* 91734

The purpose of this program is to establish if combustive systems can find effective application in the restoration of shore areas that have been despoiled by large oil spills. Included in the study is the establishment of the physical and thermodynamic properties of contaminated shore material and the design of conceptual incineration systems which would be economically feasible in renovating such material. All types of beaches and various configurations of combustors are being considered in this analysis. Appropriate testing will be performed to verify conclusions derived from theoretical premises. Contingent upon the feasibility established for the approach, the system selected as optimum in cost-effectiveness will be reduced to preliminary design drawings. This work was initiated in and will be completed in fiscal year 1969-1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0967, SOCIO-ECONOMIC STUDY OF MULTIPLE USE WATER SUPPLY RESERVOIRS
R. STONE, Ralph Stone & Company, *Los Angeles, California* 90025 (C-1633)

The research objective is to determine and evaluate the social and economic costs and benefit associated with varying degrees of recreational use of water-supply reservoirs while main-

taining safe potable water quality standards. Representative examples of four classes of reservoir will be studied in depth to define the socio economic cost-benefits of multi-versus single-purpose reservoir use to the community, region, and nation, and the relationship of incremental water treatment requirements to the individual water consumer. The interrelationships between water quality standards, treatment costs, community recreation and water needs, alternative recreational reservoir use, economic activity generated, and projected pollution loads and demographic change will be defined to develop general principles for optimum water-supply reservoir management. Formulation of a DARE Algorithm, mathematical model, and computer program will ensure maximum applicability of the principles developed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0968, CHEMISTRY OF HYDROSOLIC METALS IN NATURAL WATER

J.D. HEM, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

Certain metallic elements readily precipitate as oxides or hydroxides at the pH and redox potential normally occurring in aerated natural water. The most common of these elements, iron, manganese, and aluminum are being studied under this project.

One aim of the research project has been to provide a more complete understanding of the factors affecting solubility of iron and manganese in natural water so that the problems of removal from water supplies can be approached more logically.

Phases 1 and 2 of this project, the study of iron and manganese chemistry respectively, have been completed. Phase 3, concerned with aluminum chemistry, is in progress.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0969, HYDROUS METAL OXIDES - THEIR GEOCHEMISTRY AND EFFECT ON WATER QUALITY

E.A. JENNE, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

As the use and reuse of water increases and hence the degree of pollution increases, it becomes increasingly important to understand the processes controlling the concentration of trace metals in waters, as recent medical findings show that the trace metal concentration of water has pronounced effects on human health.

Previous studies have indicated that hydrous oxides of iron and maganese are the principal control on the concentrations of many of the trace metals in fresh waters and soil solutions. Current studies show: 1) that hydrous microcrystalline manganese dioxide can sorb certain metals very rapidly; and 2) provide a chemical means of determining the amount of the various oxides in sediments.

Determination of the time-capacity of stream sediments and water impoundment sediments for trace metal sorption and relationship of these data to the hydrous oxides present will be studied. Evaluation of the relative importance of organic matter in trace metal fixation will be determined.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0970, SAN FRANCISCO BAY

D. MCCULLOCH, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

State(s) to which the work listed herein pertains: California.

The principle objectives of this combined geologic and hydrologic study of the San Francisco Bay estuary are: to describe the past and present geologic framework of the bay, including the three dimensions of its bedrock basin and sediment fill and its tectonic and sedimentation history; to describe the physical, chemical, and in part, biological properties of the water mass; and to evaluate the relation between these geologic, hydrologic and geochemical factors and the physiography, bathymetry, quality of water and biota of this complex estuary.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0971, BIODETERIORATION OF NAVY INSECTICIDES IN THE OCEAN

H.P. VIND, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Technical Objective: Determine the relative rates at which various insecticides used by Navy pest control operators are detoxified in sea water. Isolate microorganisms which will degrade DDT, obtain a biodegradable substitute for DDT.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0972, A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN

R.A. SCHWARTZLOSE, Univ. of California, Graduate School, *San Diego, California* 92038 (AT(11-1)-34,)

Knowledge of the deep near-bottom ecology and the ocean circulation is important to the basic understanding of the heat and energy exchange between the deep and upper layers, the nature and behavior of the organisms living in darkness and under high pressures, the factors involved in disposal of radioactive waste, and the conditions of the operation of deep submergence vehicles and other deep-sea floor developments of many kinds, etc. Also, the low level of understanding and quantification of organic productivity in the volume of the ocean is a vital defect in our basic grasp of the total biological process in the sea, and this deficiency may be alleviated through our approaches.

We plan to continue to photograph deep near and bottom animal communities and measure currents near the deep bottom. The measurements will be carried out during cruises that lend themselves to the use of autonomous vehicles. At present there are plans for measurements in the deep basins on the continental borderland off Southern California, the region between New Zealand and the Antarctic and in the western Indian Ocean near the Comoro Islands.

RESULTS: Over 200 deep current measurements have been made in areas from the north Central Pacific at 43 degrees N to south of South America at 63 degrees S. The measurements in general are beginning to show a pattern of the movement of deep bottom water from the central South Pacific entering the North Pacific through a narrow channel north of Samoa about 300-400 miles. Under the California Current the deep flow appears to be generally southeastward. The average speeds are 2-4 cm/sec. The deep benthic fish populations photographed by our baited camera continue to show fish populations much larger than anticipated. The deeper the photographs, the variation in species becomes less and less with the Grenadier being the predominate fish below 2000 m.

SUPPORTED BY U.S. Atomic Energy Commission

2.0973, TECHNICAL FEASIBILITY AND ANALYSIS OF COSTS AND EFFECTIVENESS OF BULK TRANSPORT OF SEWAGE TREATMENT PLANT SLUDGE AND DREDGING SPOILS

E.J. WASP, Bechtel Corporation, *San Francisco, California* 94119

This project is concerned mainly with the development of regional land and ocean pipeline disposal systems for digested sewage sludge and maintenance dredgings. Two study cases are presented, namely, a land disposal system for Northeast Ohio (Cleveland-Canton) and an ocean disposal system for the Baltimore-Washington region. A systems approach is used, in which collection, transportation, and disposal aspects are examined in light of technical, economic and social requirements. Various transport modes are compared, including pipeline, ocean tankers, railroads, and trucks

To a lesser extent, the study also considers the expansion of such systems to include fly ash and water treatment plant sludge. Present methods and costs of disposal for all four wastes are reviewed. Environmental criteria is presented for examining both land and ocean sludge disposal alternatives in terms of a general solution for two broad metropolitan regions, namely, the Great Lakes region from Buffalo to Milwaukee and the Atlantic Coast region from Boston to Norfolk.

Results of a loop test program utilizing 12" and 16" pipe for pumping digested sludge fly ash, and sludge-fly ash slurries are included, as well as corresponding rheological tests with a 1/2" small tube viscometer and a rotational lab viscometer. A procedure for predicting head losses is given, as well as a review of the state of the art of pipelining of waste materals.

Project began in fiscal 1968 and will end in fiscal 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0974, ANALYSIS OF MOUND GEOMETRY UNDER A RECHARGE BASIN

R. SINGH, San Jose State College, School of Engineering, *San Jose, California* 95114

The central aim of this research is to predict analytically the changing positions of the water table over a region during the artificial recharge of excess rain or waste water.

For unconfined aquifers the Dupuit-Forchheimer assumptions may lead to large errors. For recharge problems the delayed dewatering may be relatively unimportant, but the vertical component of the velocity cannot be neglected. Hence the formulations of the recharge problems would be made following the Boulton's approach in such a way that the vertical component of the velocity would be accounted for. The following two cases will be investigated: (i) Unsteady recharge from a long pit, and (ii) Unsteady recharge from a circular pond.

SUPPORTED BY U.S. National Science Foundation

2.0975, LAKE CURRENTS AND DIFFUSION PROCESSES

R.K. LANE, Canadian Cen. for Inland Water, *Burlington, Ontario, Canada*

Studies of lake currents and diffusion processes related to transport and dispersion of pollutants, including diffusion of thermal pollution and movements of materials such as oil on lakes.

SUPPORTED BY Rhodesian Govt. - Salisbury, Rhodesia

2.0976, THE RELATIVE MERITS OF DISPERSION TECHNIQUES

P.G. SLY, Canadian Cen. for Inland Water, *Burlington, Ontario, Canada*

Studies on the relative merits of dispersion techniques using ultrasonic probes, chemical dispersants, and different liquid media.

SUPPORTED BY Canadian Government - Ottawa

2.0977, INVESTIGATIONS OF ALGAE INHIBITING MATERIALS

T.R. BARTLEY, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Attached aquatic organisms seriously reduce the carrying capacity of irrigation and water distribution structures. Laboratory and field studies show that by coating these structures with appropriate materials containing toxicants the organisms will not develop on the coated area. Coatings under study include antifouling paints, direct metal coatings to concentrate incorporation of toxicants in the concrete surface, and various other materials applied to the surface of the submerged concrete. The most promising results to date indicate that certain antifouling paints, a vinyl-resin system of cuprous oxide or tributyl tin oxide, applied to submerged concrete will provide long-term inhibition of algae attachment. The present program has progressed sufficiently to provide recommendations for routine field use of specified materials on submerged concrete structures. These antifoulifg coatings are presently limited to small areas, such as concrete weirs and flumes, because of cost.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0978, RIVER BASINS - SOUTH FORK DAM

D.A. HOFFMAN, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Two Forks Reservoir will be constructed on the South Fork Platte River to impound water for flood control, M&I, fish and recreational uses. The dam and reservoir will be key elements in a complex of reservoirs and streams going from mountain parks downstream through a large metropolitan area. There is a great need for background information in order to make recommendations for construction and operation to protect and enhance environmental objectives. A small study will be initiated to develop the data needs for a management model of the South Platte River from its head waters through Antero, Eleven Mile Canyon, and Cheesman Reservoirs, the connecting mainstream through the city of Denver, and on through a highly irrigated farm area to the Colorado-Nebraska stateline. The model will be used to develop a management program which will include Two Forks and Narrows Reservoirs and Chatfield Dam. The operation of Two Forks for water quality, fish and recreational benefits in Denver will be included. The study will be contracted with a resource organization.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0979, WATER QUALITY CONTROL BY SELECTIVE WITHDRAWAL AND REAERATION

D.L. KING, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Purpose: To investigate by means of physical and mathematical models and prototype measurements the movements of water through reservoirs and to investigate new and existing methods for reaction of streams and reservoirs.

The growing demand for sediment-free water and water at controlled temperatures and/or dissolved oxygen content requires a knowledge of the movement of water through reservoirs. Studies will be made to determine the effects of reservoir geometry and tributary waters on temperature stratification, to develop selective withdrawal techniques, and to develop methods of reoxygenation of rivers downstream from dams.

A general purpose research facility is being used to study the basic principles of temperature stratification, density currents, and patterns of flow approaching outlets at different levels.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0980, RESEARCH INTO THE ECOLOGICAL ASPECTS OF PRECIPITATION MANAGEMENT

H.L. TELLER, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Development of a plan for the systematic study of the effects a precipitation management plan may have upon the ecology of the San Juan Mountains area of Colorado.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0981, ECONOMIC AND INSTITUTIONAL ANALYSIS OF WATER QUALITY STANDARDS AND MANAGEMENT

K.C. NOBE, Colorado State University, Environmental Resources Center, *Fort Collins, Colorado* 80521

This research project will study in depth several agricultural pollution situations in Colorado and will identify for particular reaches of streams, economic optimum methods and levels of water quality management, including consideration of identifiable externalities involved and alternative means of pollution control. Comparison of the implicit optimum quality standard for the various pollution parameters investigated will indicate the extent to which adopted standards are compatible with efficiency criteria and will provide valuable information to state and federal water pollution control agencies in future reviews of existing water quality criteria.

Paralleling investigation of the economics of water quality standards will be an examination of the effectiveness of institutions and arrangements for administering and enforcing the Water Pollution Control Program. This examination will describe the legal basis for pollution control; appraise the adequacy of state statutes; assess coordination between units of federal, state and local government; judge the adequacy of the pollution monitoring system and its adaptability to emerging problems; analyze the procedures for enforcement; and assess the administrative

costs of the program. Identification of strengths and weaknesses should reveal desirable modifications for more effectively managing water quality in the state.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0982, WIND EFFECTS ON THE DISPERSION OF PARTICULATE POLLUTANTS IN TURBULENT OPEN-CHANNEL FLOW

E.J. PLATO, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

This is a study of the dispersion of solid particles in a liquid stream. The flow in the stream is turbulent with a free surface. Air is blown across the free surface in such a manner as to create waves in the water and thus to stimulate the turbulence generated by wind over streams. A quantitative understanding is sought through experimentation for the effect of wind on the diffusion of particles in the water.

The results should lead to data which can be used in the solution of the diffusion aquation in open channel flow with and without wind. A measure of the increase due to wind in diffusivity can be obtained in this way. The effect of wind on oxygen absorption in the stream is also to be investigated.

SUPPORTED BY U.S. National Science Foundation

2.0983, REAERATION IN OPEN CHANNEL FLOW

R. RATHBUN, Colorado State University, U.S.D.I. Geological Survey, *Fort Collins, Colorado* 80521

The capacity of a body of flowing water for assimilating biodegradable wastes depends heavily on the supply of dissolved oxygen which is required for the decomposition of organic material by bacteria. The amount of oxygen available for this purpose in turn depends on a complex balance among a number of processes which include various sources and sinks, and also the inflow and outflow of dissolved oxygen by convection. The principal sources augmenting the dissolved oxygen supply are atmospheric reaeration, and photosynthetic production by aquatic organisms, mainly green plants. Typical sinks depleting the supply, some of which are due to man-made pollution, are respiration of bacteria and algae, benthal deposits, and chemical oxidation.

The oxygen balance can be described qualitatively by a fundamental continuity equation. Before this equation can be used with confidence for predictive purposes, however, much remains to be learned about the source and sink processes, how they relate to one another, and how they relate to measurable physical and biochemical characteristics of a stream system.

This project is concerned with investigating the reaeration process in open channel flow, with particular emphasis on natural surface reaeration. Although no fundamental research on the biochemical processes involved in the oxygen balance is contemplated, they must be accounted for.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0984, SEDIMENTATION AND CONTAMINANT CRITERIA FOR WATER RESOURCES PLANNING AND MANAGEMENT

H.W. SHEN, Colorado State University, Environmental Resources Center, *Fort Collins, Colorado* 80521

To study the effect of vegetation on flow rate, sediment yield and dispersion of pollutant in watershed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0985, GRAND VALLEY SALINITY CONTROL

G.V. SKOBERBOE, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00031)

OBJECTIVE: Demonstrate that the mineral quality of the Colorado River can be improved by lining irrigation canals and other water conveyance channels. Evaluate the effectiveness and general applicability of this method of salinity control.

APPROACH: In three selected study areas, irrigation canals and other water conveyance channels will be lined to control the major source of recharge to the near-surface aquifers; thereby minimizing the quantity of flow through mineral yielding geological formations and reducing the gradient which forces saline water into the Colorado River. Detailed field observations and measurements will be made to evaluate the effectiveness of lining in preventing seepage and the reduction in salinity to the Colorado River.

PROGRESS:

SUPPORTED BY Colorado State Government

2.0986, FLOW IN POROUS MEDIA IN RELATION TO DRAINAGE DESIGN AND DISPOSAL OF POLLUTANTS

H.R. DUKE, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Fort Collins, Colorado* 87101 (SWC-020-DFC-5)

OBJECTIVE: Investigate the hydraulic properties of porous media as related to design of drainage systems and the disposal of agricultural pollutants based upon suitable mathematical description of relationships among pertinent variables; and reduce to field practice, theories, principles and concepts developed.

APPROACH: Investigations will be conducted in the laboratory and field. The portion dealing with drainage design criteria involves use of laboratory flumes and models to stuudy functional relationships between permeability and soil water content or fluid pressure. Existing drainage equations will be examined for adequacy in accounting for saturated and unsaturated flow where possible; ways and means will be developed to reduce drainage theories and concepts to field practice. Field investigations concerning movement of agricultural pollutants in water, under both unsaturated and saturated conditions, will also be conducted, cooperating with other scientists.

PROGRESS: No significant findings - Porous media flume was utilized by graduate student for basic studies relating to the infiltration process.

SUPPORTED BY U.S. Dept. of Agriculture

2.0987, ECOLOGICAL EVALUATION OF MULTIUSE WATERS RECEIVING PRIMARY TREATMENT EFFLUENT PRIOR TO A MAJOR FLOW INCREASE

J.D. BUCK, Univ. of Connecticut, Marine Sciences Institute, *Groton, Connecticut* 06340

The research will involve a biological and chemical evaluation of an estuary which currently serves multiuse, i.e., recreation, aesthetics and disposal of effluent from a primary sewage treatment plant. Updating of the plant to secondary treatment and chlorination within 2 years will increase effluent flow 10-20 fold. This extra load of fresh water and inorganic enrichment may produce serious ecologic inbalance of the cove such that none of the above uses will be appropriate for these waters. An adjacent cove which receives no gross input of sewage effluent will be used as a control. This comparative before hand survey will allow an assessment of the the present status of macro-and micro- organism populations in the 2 areas and may provide information on the use of various components of the ecosystem as indicators of the presence of effluent or early stages of eutrophication.

Field studies will include biweekly sampling of water and sediment and determination of temperature, salinity, pH and dissolved oxygen. Various groups of bacteria, phytoplankton and bottom invertebrates will be enumerated. Nitrate, phosphate and BOD values will be determined also.

Based on the present biological, chemical and physical status of the cove, some assessment will be made of the ability of these waters to receive and assimilate or transport a significant increase in effluent without initiation of eutrophy and subsequent loss of multiuse value.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0988, WASTE WATER RENOVATION POTENTIAL OF FOREST SOILS PREDICTED BY THEIR CHEMICAL AND PHYSICAL PROPERTIES

D.E. HILL, Conn. Agric. Expt. Station, *New Haven, Connecticut* 06504 (CONH00415)

OBJECTIVE: Measure removal of substances from percolating waste water by exemplary forest soils. Relate removal to CEC observed in test tube or to distribution of clay and organic matter--and hence CEC--in the profile.

APPROACH: Synthetic sewage will be percolated through 1x3 foot undisturbed cores of upland, terrace and alluvial soils of varied texture and fragipans. Removal of ions by cores will be compared to CEC of bulk samples. Failing to observe simple relation, scientist will observe heterogeneity of CEC and water paths in cores and seek means of predicting renovation potential of soil profiles.

PROGRESS: Six undisturbed forest soil cores of widely varying physical and chemical properties continue to be leached with a synthetic sewage effluent that contains Ca, Mg, Na, K, NO(3), Cl, SO(4), PO(4) and HCO(3). After leaching 6 months with 52 one-inch increments, renovation capacity of all soils decreased but differed between soils. All soils removed virtually all PO(4) and K, while NO(3) and Cl leached through, except in the Cheshire soil which still removed 90 per cent of the NO(3) added. Up to 90 per cent SO(4) was removed by Paxton and Cheshire soils; little SO(4) was removed by the others. Up to 35 per cent Na was removed by Paxton and Stockbridge soils; little Na was removed by the others. About 80 per cent Ca and Mg were removed in early leachings by all soils; removal remained high in Cheshire and Buxton, but in others, removal decreased. In the Stockbridge soil formed on Mg-rich dolomitic glacial till, the leachate was rich in Mg. Earlier, electron microprobe analysis of thin sections of soils indicated that the loci of cesium exchange were heterogeneously distributed in clay varves and coatings and in weathered biotite grains. The microprobe also indicated that weathered biotite grains sorbed as much Ca per unit volume as clay.

SUPPORTED BY U.S. Dept. of Agriculture

2.0989, OXYGEN STATUS OF SOIL AIR AND SOIL WATER AS INFLUENCED BY OXYGEN TRANSFER THROUGH THE SOIL PROFILE

R.W. WENGEL, Univ. of Connecticut, School of Agriculture, *Storrs, Connecticut* 06268

The purpose of this research will be to investigate and define those factors affecting the diffusion and mass transfer of oxygen through the soil profile with particular emphasis on the resultant oxygen status of water moving laterally or downward toward the ground water system.

The factors to be investigated are: soil air-space porosity distribution over the soil moisture release characteristic, oxygen sink sources within the soil profile and their relative importance in oxygen consumption, and the mass transport of oxygen during infiltration.

Soil porosity and soil water will be determined using standard pressure plate and pressure membrane technique. Gaseous oxygen in the profile will be determined from diffusion chamber samples by gas chromatography. Dissolved oxygen will be determined by polarographic techniques on soil water samples during periods of saturation and by oxygen solubility calculations based on gas-liquid phase equilibria during periods of unsaturation.

The quantitative measurement of oxygen transfer and utilization in soil will have application in studies of: oxidation-reduction reactions in the lower soil profile, potential conditions for biological oxidation of soluble organic contaminants in soil water, and soil oxygen supply characteristics for subsurface oxidation of organic wastes such as those from small septic systems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0990, THREE DIMENSIONAL DISPERSION FROM POINT SOURCES OF CHEMICAL OR THERMAL POLLUTION IN OPEN CHANNELS

M.R. SAMUELS, Univ. of Delaware, School of Engineering, *Newark, Delaware* 19711

The proposed research plan involves an experimental and numerical study of three dimensional dispersion from point sources in open channels.

The experimental studies will include measurement of: 1. Turbulent velocity, intensity and scale measurements, in open rectangular channels: 2. Pollutant (salt) concentration fields as functions of both time and position downstream from the injection of a saline solution into the channel. Both continuous and lumped injections will be studied.

The numerical studies will be centered around development and use of a suitable computational model for describing three-dimensional dispersion of the pollutants introduced at point sources. Once the program is complete the turbulence measurements from the experimental studies will be used to predict (via analogy expressions) turbulent dispersion coefficients. Numerical calculations based on these coefficients will then be compared with the experimental results. If satisfactory agreement is not obtained, then the dispersion coefficients will be varied until reasonable agreement is obtained. The dispersion coefficients so obtained will be correlated against the turbulent properties of the fluid flow.

The sensitivity of the calculated pollutant concentrations to changes in the various dispersion coefficients and velocity profile will also be examined to determine which if any of these terms may be neglected, or simplified in future dispersion models.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0991, CORROSION AND ENCRUSTATION MECHANISMS IN WATER SUPPLIES

F.E. CLARKE, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

A variety of physical, chemical, and biological processes determine tendencies of water supplies to cause objectionable corrosion problems in wells and other water handling equipment. Knowledge of these mechanisms is necessary for proper prediction of effects and proper control. Quality characteristics of well water supplies are determined by field studies and the data are analyzed thermodynamically for evidence of potential encrustation and corrosion reactions. The work to date in deep well fields of Egypt, Nigeria, and West Pakistan has revealed that the oxidation reduction potential - pH relationship - is very important in determining magnitude of corrosion damage. Chemical equilibrium studies appear to indicate that degree of saturation with calcium carbonate and ferric hydroxide are major factors in determining the nature and intensity of corrosion. Encrustation with ferrous carbonate, a common problem, appears to be independent of the concentration of this mineral in the well water and to depend primarily on kinetic factors, such as flow rate. Effective control measures are being devised on the basis of these studies.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0992, EVALUATION OF C-14 DATING OF GROUND WATER

B.B. HANSHAW, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

Technical objective: To improve the method of carbon-14 dating of ground water and to evaluate its application in a wide range of geochemical systems. The Army has direct interest in water contamination problems in the field by radioactive matter and the field disposal of radioactive wastes. To make practical solutions possible, it is necessary to be able to determine the age of ground water. The age indicates the degree of mobility of such water from high mobility to near-immobility. Therefore, it has a direct bearing upon the problem of quickly finding water-bearing layers (aquifers) at depths not easily and quickly contaminated by atomic warfare. The techniques of C-14 dating which have been developed are also relevant to Army studies of glacier ice in Greenland and the Antarctic.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0993, DISSIPATION AND DIFFUSION OF HEAT IN STREAMS AND LAKES

N. YOTSUKURA, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

Purpose: To develop a method for prediction of the temperature variation in streams and lakes which are subjected to thermal loading.

2. WATER QUALITY

Methods: The energy budget method of temperature prediction assumes uniform distribution of heat within a cross section of a flowing water and accounts for heat exchanges at the boundaries of the water body. It has been indicated theoretically that inclusion of longitudinal dispersion coefficients in a heat balance equation would materially affect the distribution of temperature along the length of a stream. This project will initially emphasize a basic study of the effect of heat diffusion or of non-uniform distribution of heat within the body of water on the ultimate dissipation of heat. The effect of stratification of flows, especially in estuaries, on heat dissipation will also be investigated.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0994, LAND DISPOSAL OF DAIRY FARM WASTE
A.R. OVERMAN, Univ. of Florida, School of Agriculture, *Gainesville, Florida* 32601

The proposed research seeks to determine feasible loading rates of dairy waste on sandy soils to avoid pollution of underground water supplies. Field studies on the fate of nitrogen and phosphorus will be conducted. Manure slurry from the milking barn will be applied at various rates by sprinkler irrigation. Chemical and physical analysis will be carried out to determine nutrient movement through the soil profile.

Chemical measurements would include: 1. COD (Chemical Oxygen Demand). 2. BOD (biochemical oxygen demand). 3. Total N, NO-3, and NH 4 plus. 4. Total P and orthophosphate. 5. CU, Mn, Ni, Mg, Zn and B. 6. pH. 7. Organic matter in soil. Physical measurements would include: 1. Water - holding capacity of soil. 2. Hydraulic conductivity. 3. Application rates of slurry. 4. Ground water table. 5. Surface runoff.

Correlations are to be obtained between nutrient input, percolation losses, storage in the soils, and uptake by plants growing in the soil.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0995, AEROBIC, HETEROTROPIC BACTERIA IN ESTUARIES
M.E. TYLER, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-BC-01429)

OBJECTIVE: Characterize, systematically, the major bacterial types in estuaries, with particular attention to their biochemical activities and potential roles in turnover of organic matter.

APPROACH: About 60 characters of each of 2000 isolates from an unpolluted and a polluted estuary have been determined; nearly 500 pure cultures are maintained. Major taxa will be discriminated among the 2000 isolates by numerical taxonomy. About 150 features of each of the nearly 500 isolates will be determined, including the mole-ratio of guanine and cytosine in DNA; these data will permit speciation by conventional and taxonometric methods. Attempts will be made to assess potentials for organic turnover by, e.g., measuring turnover of fatty acids and ATP.

PROGRESS: Two groups of estuarine bacteria have been characterized by morphology, physiology, and DNA base-ratio. One group of nine isolates constitutes a previously undescribed species of the genus Vibrio, producing an indigoidin-like pigment. The other group is difficult to place taxonomically: the isolates produce violacein, like Chromobacterium, but resemble Vibrio in several characteristics, including DNA base ratio. One anaerobic, methanogenic isolate from the Waccasassa estuary has been purified and characterized, and two other isolates are being processed.

SUPPORTED BY Florida State Government - Tallahassee

2.0996, USE OF THE BOULDER ZONE FOR WATER STORAGE AND/OR FOR WASTE DISPOSAL
R.O. VERNON, State Bur. of Geology, *Tallahassee, Florida* 32302

Approximately along the contact of the fresh water with the salt water of the Floridan artesian aquifer there occurs an extremely pervious zone which the well drillers have called the 'Boulder Zone'. This zone apparently represents some subsurface formation that has been easily dissolved and has been removed. Or it represents a solution zone that has formed along the contact of fresh and salt water in the artesian system. The dynamics of this flow are not fully understood and it is hoped that further study of the zone, both the hydrology and the geology will provide sufficient knowledge to allow its safe usage for storage of fresh water in the distal end of Florida where the artesian water is brackish or to use this zone for waste disposal after the waste has been treated to some extent and reduced to sludges.

SUPPORTED BY Florida State Government - Tallahassee

2.0997, STUDIES ON SOUTHEASTERN AQUATIC INSECTS
J.B. WALLACE, Univ. of Georgia, School of Agriculture, *Athens, Georgia* 30601

The overall objective will be to develop a background of knowledge in the scientific literature that will permit identification of the aquatic insect species of the southeast as they are influenced by and relate to water quality. The basic objective is to provide adequate species characterization of the immature stages. The order Trichoptera will receive most attention during the initial phases of the study with additional information gathered on the orders Ephemeroptera and Plecoptera. Field collecting will be followed by laboratory and field rearing in order to associate juvenile forms with proper adult species. Ecological and water quality parameters will be assembled for individual species during this study. The role of aquatic insects in breaking down detritus is also being evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0998, CHARACTERIZATION OF STREAM REAERATION CAPACITY
E.C. TSIVOGLOU, Georgia Inst. of Technology, School of Civil Engineering, *Atlanta, Georgia* 30332

The broad objective of this reseach is to fully develop techniques for the accurate evaluation of waste treatment needs and associated costs in specific situations, as currently used procedures are not adequate. The principal source of difficulty and large error has been our inability to accurately evaluate the reaeration capacity of natural streams. Research begun by the Administration three years ago has been successful in providing a direct field technique for the accurate determination of stream reaeration capacity. This technique now forms the necessary basis for providing water pollution control agencies and industry with the means for accurate evaluation of and prediction of waste treatment requirements and costs.

The specific objectives of this research, briefly stated, are to apply the gaseous tracer method developed by the Administration to: evaluate the range of error normally associated with the various available mathematical models for predicting reaeration capacity (O'Connor-Dobbins, Churchill, etc.); on the basis of direct field observations of reaeration capacity, to develop the necessary modified and/or additional models for this purpose; and, to develop a standardized laboratory procedure for evaluating the effects of various kinds of water pollutant on the reaeration capacity of river water.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.0999, SYMPOSIUM PRESENTATION OF RESEARCH FINDINGS ON THE REAERATION CAPACITY OF STREAMS AND ESTUARIES
E.C. TSIVOGLOU, Georgia Inst. of Technology, School of Civil Engineering, *Atlanta, Georgia* 30332

This symposium is to present results of current research in the area of application of radioactive tracer techniques to gas transfer kinetics, in particular measurement of reaeration of natural streams. National interest in the results of this research on the reaeration capacity of natural streams is very high, as evidenced by numerous requests for information and studies elsewhere, both in natural streams and in estuaries. Interest has been shown not only in the direct measurement of reaeration capacity, but also in the derivation of information regarding mixing and dispersion

characteristics of such natural water courses. The importance of oxygen transfer in pollution control and abatement is such that immediate dissemination of the results of these studies is recommended. The presentation will include experimental techniques, results from several rivers, and a field demonstration of the tracer technique on a local stream.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1000, ESTUARINE HYDROGRAPHY AND ITS ROLE IN TRANSPORT OF NATURALLY PRODUCED FOODS AND POLLUTANTS

F.C. MARLAND, Univ. of Georgia, Marine Institute, *Sapelo Island, Georgia* 31327

The major objective of the program is to conduct a hydrographic study of the three representative types of estuaries that are found in Georgia. The estuaries of Georgia, as well as those of the entire United States, are being destroyed at an accelerated rate. Research is needed to provide basic information concerning estuaries to serve as a guide in formulation of The National Estuary Policy. Through studies of; (1) water mass movements, (2) seasonal temperature, salinity and oxygen patterns, (4) seasonal import of organic/inorganic materials, and (5) seasonal current patterns, a better understanding of the role of hydrographic factors in the distribution of nutrients and pollutants into and throughout the estuaries.

The estuaries of Georgia exist in a relatively undisturbed condition. This study will provide basic information concerning the conditions that are fairly close to the natural state before man-made manipulations occur, and may thus explain some of the causes of the high productive capacity of estuaries. With increases in population and industry the estuaries will be subject to greater pollution pressure. The hydrographic characteristics of estuaries must be known and understood in order to predict the amounts and kinds of effluents that estuaries can receive and their ultimate distribution after entry.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1001, TERRESTRIAL ECOLOGY

J. KLINE, Argonne National Laboratory, *Argonne, Illinois* 60439
(W-31-109-ENG-38)

Tritium Studies. The objective of the tritium studies is to analyze the physical and biological behavior of tritium upon release in a terrestrial environment. Physical and biological studies are carried out simultaneously with the intention of developing a multi-compartment model for tritium dynamics in an ecological system. Physical studies are devoted largely to behavior of tritiated water in soils of a grassland. Injections and surface spray applications of tritiated water are utilized to determine rates of flow of tritiated water, distribution of soils and mean residence times in soils. Mass flow of soil water is monitored using lysimeters placed at several different depths in the soil as water collectors. Biological tritium studies are devoted to field work on the use of tritiated water to measure transpiration by trees and to laboratory work on the incorporation of tritium into the organisms from a tritiated water source. The transpiration studies in trees are carried out by injecting tree trunks with tritiated water and sampling the foliage until all the tritium has passed through the tree. In the lab studies, algae are being grown in tritiated water to determine rates and amounts of incorporation of tritium into organic molecules.

Results: Onset of transpiration in the spring in pine trees was correlated with soil temperatures. Transpiration did not begin until the soil was completely thawed even though free water was available both above and below the final lens of frozen soil which occurred at 10 centimeters depth. No evidence of winter transpiration was found in trees which had received winter injections of tritiated water. Algae grown in tritiate water show an apparent deficiency in tissue bound tritium. The tritium-hydrogen ratio of algae tissue has consistently been about 30% less than the ratio of aqueous growth medium.

SUPPORTED BY U.S. Atomic Energy Commission

2.1002, COOLING TOWER STUDY

E. AYNSLEY, IIT Research Institute, *Chicago, Illinois* 60616

A recently initiated study of water cooling towers is aimed at outlining and assessing related environmental effects, particularly with reference to natural draft units. Natural draft cooling towers are becoming increasingly popular throughout the United States in attempts to alleviate problems associated with limited availability of cooling water supplies, thermal pollution problems and legislation limiting disposal of thermal wastes.

Inadvertent weather modifications such as fogging, cloud initiation and formation which result from tower emissions of water vapor and heat will be considered. Already there have been reported fogs of increased frequency and density which are attributed to cooling tower operations. Interaction of cooling tower plumes with other nearby stack plumes will be investigated particularly in the context of SO2 oxidation. Other aspects include a theoretical description of heat and water vapor diffusion in the plume and droplet carryover of recirculating water.

A survey of all natural draft towers currently operating and planned in the United States will be included.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1003, A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE

H.N. GUTTMAN, Univ. of Illinois, School of Liberal Arts, *Chicago, Illinois* 60680

First tests by others have revealed the presence of a very few types of algae viruses which are now being tested as potential controllers of nuisance algae. The methods for virus selection selects against isolation of the rarer viruses which may be more valuable because of different host specificity, etc.

We are therefore critically evaluating two methods for isolation and purification of algal viruses to determine whether the commonly used method inadvertently selected out for the few most abundant viruses and against the rarer viruses which may have more eventual value as algal controllers.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1004, DISPERSION OF CONTAMINANTS IN JOINTED ROCK

R.J. KRIZEK, Northwestern University, School of Technology, *Evanston, Illinois* 60201

Deep injection wells into jointed rock strata provide one of the promising methods for the disposal of certain liquid wastes. However, relatively little is known about the characteristics of flow behavior in jointed rock. From a water resources point of view, such knowledge is very valuable when appraising the long-term quality of water from a jointed rock aquifer. Accordingly, the objectives of this research are (1) to formulate a basic seepage law for the flow of a homogeneous fluid through jointed rock, and (2) to develop a theoretical model for the dispersion of a miscible contaminant into a homogeneous parent fluid which saturates a jointed rock stratum.

The investigation will be both theoretical and experimental in nature, and emphasis will be placed on plane and axi-symmetric artesian flow under steady conditions. The entire practical range of Reynolds numbers will be investigated both for uniform seepage flow and for dispersion. The experimental model will consist of an orderly array of impermeable prismatic blocks separated by relatively narrow flow channels which will intersect at various angles. Concurrent with the development of an experimental flow law for this system, a theoretical analysis, based on a finite difference solution of the Navier- Stokes equations, will be performed. Hopefully, the synthesis of the experimental and theoretical results will lead to the development of a model which will have broader application to more complex systems.

2. WATER QUALITY

SUPPORTED BY University of Illinois

2.1005, ECOLOGY OF SPHAEROTILUS IN ACTIVATED SLUDGE
W.O. PIPES, Northwestern University, School of Technology, *Evanston, Illinois* 60201

This project is a survey of activated sludge plants to determine 1) what types of filamentous organisms are present when the sludge has poor compaction characteristics, 2) the extent to which the compaction characteristics of the sludge depends upon the presence of filamentous organisms, and 3) environmental factors which encourage the growth of filamentous organisms in activated sludge. The research plan consists of collecting samples of sludge from a number of activated sludge plants; physical, chemical, and biological analyses of the sludge samples; and statistical analysis of the data to find correlations between the various parameters. Loss of sludge in the effluent due to poor compaction in the secondary settling tank or for other reasons is the most common operating problem with the activated sludge process and delineation of the factors which contribute to this condition should result in significant improvements in process operation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1006, INVESTIGATION OF PERMEABILITY OF FINE GRAINED GLACIAL SEDIMENTS IN RELATION TO WASTE DISPOSAL IN ILLINOIS
R.E. BERGSTROM, State Geol. Survey, *Urbana, Illinois* 61801

The objective of the research is to evalute current methods and to develop practical procedures for determining the field permeability of fine grained glacial sediments. These sediments -- mainly tills -- are too tight to be analyzed for permeability on the basis of conventional pumping tests. Field measurements will be made using several methods of injection -- and possibly pumping -- in shallow bore holes. Laboratory tests will be made on cores by standard permeameter methods.

The permeability data will be obtained from representative glacial deposits of known character and extent, so that results may be extrapolated, and will be evaluated for such practical applications as selecting sites for surface waste disposal, protecting shallow aquifers from pollution, and appraising drainage and ground-water recharge conditions.

Illinois State Geological Survey review, June 1970: Project continuing in FY 1971.

SUPPORTED BY Illinois State Government - Springfield

2.1007, HYDROGEOLOGY OF SOLID WASTE DISPOSAL SITES
G.M. HUGHES, State Geol. Survey, *Urbana, Illinois* 61801

The objectives of this project are to investigate, in northeastern Illinois, hydrogeologic environments which are currently being used for shallow solid waste disposal, and to evaluate the factors which control ground-water movement of refuse leachate in these environments. Criteria are sought to judge the suitability of proposed disposal sites not only in glaciated areas, such as northeastern Illinois, but in many other areas as well.

Existing landfills are being studied, and the investigation is proceeding by: (a) drilling by wash boring or with hollow stem augers to determine the character and sequence of deposits, (b) installation of piezometers to define fluid potential distribution and the ground-water flow system, (c) sampling of the ground water for chemical analysis, (d) a monitoring program of the piezometers to determine seasonal variations of the flow system.

Illinois State Geological Survey review, June 1970: Project completed - final report on project to be published in FY 1971.

SUPPORTED BY Illinois State Government - Springfield

2.1008, ASSIMILATION OF A WASTE TREATMENT PLANT EFFLUENT BY A CREEK-RIVER-MAINSTREAM IMPOUNDMENT SYSTEM
R.W. LARIMORE, State Natural History Survey, *Urbana, Illinois* 61801

The purpose of this study is to investigate the assimilation of a waste treatment plant effluent by a creek-river-mainstream impoundment system. Various physical, chemical, and biological measurements will be used in this investigation. Areas of intensive study include (1) tracer studies to determine the transport and dispersal of pollute within the system, (2) measurements of the biota within the area affected by pollutant material, (3) measurements of the assimilation of the pollutes by the system, (4) measurements of primary productivity and fish production, and (5) the effects of the treatment plant effluent upon this production. Information obtained here may be useful in indicating a means of managing reservoir productivity through controlled introductions of nutrient material from the waste treatment plant.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1009, EFFECTS OF CONTAMINANTS ON REAERATION
Y. KOTHANDARAMAN, State Water Survey, *Urbana, Illinois* 61801

The water quality aspects of a well-conceived water resources management plan require an accurate knowledge of the rates of atmospheric reaeration. Insight into the interrelationships of stream impurities, DO saturation values, and rates of reaeration will greatly aid in assessing more precisely a stream's capacity to assimilate waste.

An investigation is in progress on Illinois River water to: 1) investigate the extent of variation in DO saturation values at 20C due to changes in the concentration of contaminants in the water and 2) delineate the effects of the constituent contaminants in natural water on the reaeration rate constant, K2. Each river sample is analyzed for suspended solids, dissolved solids, chemical oxygen demand (as a measure of organic impurities), and surface active agents. These are the classes of impurities found to have a significant effect upon atmospheric reaeration rates.

SUPPORTED BY Illinois State Government - Springfield

2.1010, BOUNDARY EFFECTS ON JET FLOW PATTERNS RELATED TO WATER QUALITY AND POLLUTION PROBLEMS
W.H. MAXWELL, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

This experimental program will be divided into two phases: (1) Collection and analysis of further experimental data on velocity distributions downstream from a water jet introduced horizontally beneath the free surface of a deep reservoir. (See Project A-010-111). The diameter of the jet, submergence of the jet and velocity of efflux from the jet will be varied systematically to determine their influence on the flow pattern. (2) Velocity traverses will be taken of the flow field downstream from a water jet introduced horizontally beneath the free surface of a shallow reservoir. The diameter and submergence of the jet, velocity of efflux and the vertical location and slope of the lower fixed boundary will be varied systematically.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1011, METHODOLOGY FOR SYNTHESIS AND OPTIMIZATION OF DIFFUSION PATTERNS IN FLOW SYSTEMS
W.H. MAXWELL, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

The influence of non-uniformity of velocity distributions in natural flow systems on the diffusion of tracers, pollutants, etc., requires clarification.

The objectives are to synthesize non-uniform flows using distributions of infinitestimal point source jets of different strengths to represent the momentum, heat or mass flux. Sources of pollution or tracer may then be readily combined with the ambient distribution to predict the diffusion pattern. Orientation and location of injection sources will be varied to determine the most practically desirable diffusion pattern for different objectives. If the technique proves successful it will provide a single solution for a given flow without the necessity of matching two approximate solutions downstream from the point of injection.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1012, HYDRAULIC GEOMETRY AND LOW STREAM-FLOW REGIMEN
J.B. STALL, Univ. of Illinois, State Water Survey Division, *Urbana, Illinois* 61802

A completed project shows there to be, for the 18 river basins in Illinois, a consistent pattern in which the width, depth, and velocity of flow in a stream change along the course of the stream, with a constant frequency of discharge. These channel characteristics are termed Hydraulic Geometry and constitute an interdependent system which can be described by a series of graphs having simple form, or by equations. Relations are strongest at high and medium flows.

These results have been used to compute provisional time-of-travel for 46 major stream reaches in Illinois. The results seem adequate at high and medium flows, but only fair at low flows. The proposed research would characterize and evaluate the complex flow regimen at low stream- flows in selected stream reaches, and check computed times-of- travel by using dye tracer measurements. Dispersion in the stream will be evaluated also. The results can potentially be generalized throughout the stream system to allow prediction of the assimilative capacity of the stream and dispersion of a contaminant.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1013, MINIMIZING NITRATE POLLUTION OF GROUNDWATER AND STREAMS
S.A. BARBER, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907

The aim of this project is to characterize the reason for the inability of the plant root to remove a higher proportion of the nitrates from the soil water. Nitrates move to the root primarily by mass-flow since they are transported to the root in the water used in transpiration. Because of this it should be possible for the crop to absorb a large proportion of the nitrate from the soil water. The ability of various types of roots to absorb nitrates from water will be examined. The results of these investigations will be used to formulate procedures that can be used to reduce the nitrate level of soil water.

The specific objectives of this research are: 1. To determine the principles involved in the absorption by plant roots of nitrate from water in the soil profile. 2. To develop water, soil, crop, and fertilizer management procedures that will minimize the movement of nitrate down the soil profile in percolating water.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1014, DISPERSION DURING FLOW IN HETEROGENEOUS POROUS MEDIA
R.A. GREENKORN, Purdue University, School of Chemical Engineering, *Lafayette, Indiana* 47907

The immediate objective of this project is to study the theory and measurement of dispersion in heterogeneous anisotropic porous media. A better understanding of dispersion phenomena is necessary to obtain useful flow models of real porous media. Initially, we will study the differential equations associated with dispersion. Present statistical models will be extended to include heterogeneity and anisotropy. Dispersion coefficients will be measured in linear and radial flow in heterogeneous anisotropic media using tracer techniques and these data will be used to determine the statistical range of the dispersion coefficient in view of microscopic and macroscopic heterogeneity, fluid properties, and anisotropy. A better understanding of the fundamental nature and description of disperson will allow better calculation of miscible flow in porous media. This study of effects of heterogeneity and anisotropy on disperson has immediate practical application: in tracing seepage of contaminates into underground fresh water; in reclamation of waste water; in underground disposal of chemical, bacterial, and radioactive wastes; in ion exchange; in filtration theory; in the movement of fluids in the human body; and in the flooding of oil reservoirs.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1015, IMPROVING THE QUALITY OF OUR WATER RESOURCES
E.J. MONKE, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01460)

OBJECTIVE: Study the dynamics of water and pollutant movement in unsaturated soil. Study the role of plants in water quality management. Evaluate treatment of polluted water by filtration through the soil mantle.

APPROACH: The basic approach is to simulate the dynamics of pollutant-laden moisture through the natural filter composed of soil, plants, and many forms of bacteriological life for use in the design of engineering systems for water quality control. Research will be done mainly under controlled environmental conditions in the laboratory with occasional pilot studies being performed at the Southern Indiana Forage Farm.

PROGRESS: An analysis of infiltration equations was made on the basis of experimental data obtained in erosion studies with a plot-sized rain-fall simulator. An overland flow analysis was used to determine infiltration-time relationships from runoff hydrographs. Regression fits of the 4 equations to experimental data for 52 tests on 13 soils showed that all of the equations adequately described infiltration phenomenon. Difficulty of applying any of these equations is in evaluating equation parameters. An approximate method for defining conductivity function of unsaturated soils was developed. Method utilizes the water retention curve and the influx-time relationship for infiltration into an initially dry soil column to determine the effective conductivity function. Tests have shown the procedure gives results which closely approximate the original conductivity data. Measurements required in the proposed method can be made in a relatively short time. It can be adapted also for in-place, field determinations of unsaturated conductivities. This procedure along with further refinements in numerical techniques and computing hardware which are bound to come about can make the solution of the 'exact' governing equation a practical means for quantifying infiltration on a field scale.

SUPPORTED BY U.S. Dept. of Agriculture

2.1016, DENITRIFICATION AS A PATHWAY FOR NITRATE REMOVAL IN RIVERS AND PONDS
D.W. NELSON, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907

Denitrification has been shown to occur in soils and solution cultures, and there is recent evidence to indicate that denitrification will occur in surface waters and may be an important natural pathway for the removal of nitrate from rivers and ponds. The following objectives have been established for this study: 1. To determine the rate of denitrification occurring in river and pond waters which have widely different nitrate loading rates, dissolved oxygen concentrations, soluble organic carbon contents, and microbial populations. 2. To determine the potential denitrifying capacities of river and pond waters which vary widely in dissolved oxygen content, microbial population, and other factors which influence microbial activity. 3. To determine the effect of environmental factors such as temperature, pH, soluble organic carbon content, and dissolved oxygen concentration on the rate of denitrification in river and pond waters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1017, USING SOIL FILTRATION TO REDUCE POLLUTION POTENTIAL OF LAGOON EFFLUENT ENTERING GROUND WATER SYSTEM
C.E. BEER, Iowa State University, School of Agriculture, *Ames, Iowa* 50010

The practice of disposal of animal manure and collection of feedlot runoff in lagoons is being widely used. In most cases Pollution Control Commissions will not permit the direct release of lagoon effluent into surface water streams.

The objectives of this research are to develop land application criteria for the lagoon effluent whereby the quality will be such that pollution potential will be minimal, and the effluent may

enter the ground water system. The change in the soil structure, soil chemistry and biological environment will be also studied.

The experimental procedure will involve the sprinkling of lagoon effluent (swine wastes) at controlled rates and frequencies on the experimental area. A tile network will intercept the effluent after infiltration and filtering through the soil and permit the change in quality of the effluent to be evaluated. The soil samples to be studied will be taken directly from the experimental areas.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1018, EFFECTS OF LIMNOLOGICAL FACTORS ON WATER TREATMENT

D.B. MCDONALD, Univ. of Iowa, School of Engineering, *Iowa City, Iowa* 52240

Limnological studies of the Coralville Reservoir, Johnson County, Iowa, and the Iowa River above and below the impoundment are currently being conducted. Additional studies of the reservoir and river will be conducted under the proposed project to determine the effects of various chemical and biological conditions within the reservoir and the river on the quality of water utilized by the University of Iowa Water Treatment plant, located on the Iowa River about five miles below the Coralville Dam. In-plant studies, involving modification of treatment methods, chemicals used, points of application of chemicals and rates of treatment, will be conducted to determine the best treatment methods under varying conditions of water quality.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1019, RESEARCH INITIATION - MIXING AND TRANSFER PROCESSES FOR HEATED EFFLUENTS IN OPEN CHANNEL FLOW

W.W. SAYRE, Univ. of Iowa, School of Engineering, *Iowa City, Iowa* 52240

The discharge of large quantities of waste heat into streams and rivers has become a subject of increasing concern in recent years. To assess beforehand what the probable effects will be, environmental engineers should be able to predict the downstream temperature changes resulting from a given combination of effluent temperature and discharge, source configuration, and streamflow conditions.

The principal aim of the research proposed herein is to obtain a better understanding of the processes by which the effluent heated water mixes with the flowing streamwater and the excess heat is transferred to the surrounding phases of the environment, and furthermore, how these processes combine to produce the resulting temperature distribution pattern in the stream. These phenomena would be investigated in a controlled temperature system, consisting of a recirculating flume housed in a controlled environment chamber, wherein the temperatures of the flume water, the flume boundary and the air can be controlled independently.

The experimental data would be analyzed with a view toward obtaining longitudinal, transverse and vertical mixing coefficients as well as heat transfer coefficients for the water surface and channel perimeter. Functions which relate these coefficients to known streamflow, effluent and channel properties, and other pertinent environmental conditions, would be sought.

SUPPORTED BY U.S. National Science Foundation

2.1020, NATURAL MIXING AND TRANSFER PROCESSES FOR THERMAL LOADS IN STREAMS

W.W SAYRE, Univ. of Iowa, School of Engineering, *Iowa City, Iowa* 52240

The principal aim of the proposed research is to obtain a better understanding of the natural processes in streams and rivers by which effluent heated water mixes with the flowing streamwater and the excess heat is transferred to the surrounding phases of the environment, and furthermore, how these processes combine to produce the resulting temperature distribution pattern in the stream. These phenomena would be investigated in a controlled temperature system, consisting of a recirculating flume housed in a controlled environment chamber, wherein the temperatures of the flume water, the flume boundary and the air can be controlled independently.

The experimental data would be analyzed with a view toward obtaining longitudinal, transverse and vertical mixing coefficients as well as heat transfer coefficients for the water surface and channel perimeter. Functions which relate these coefficients to known streamflow, effluent and channel properties, and other pertinent environmental conditions, would be sought.

Finally, the investigation would be directed toward the development of mathematical predictors for temperature distribution patterns resulting from various combinations of effluent temperature and discharge, source configuration, streamflow and other environmental conditions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1021, DISPERSION OF WATER POLLUTANTS IN CURVILINEAR FLOWS

W.W. SAYRE, Univ. of Iowa, School of Engineering, *Iowa City, Iowa* 52240

In a sinuous channel with successive bends representing river meanders, which was specially built for this project, the dispersion of simulated pollutants is studied experimentally. Velocity and conductivity probes developed for this project are used to determine the flow characteristics and the concentration of the pollutant simulator. Experiments in a smaller channel are performed to gain knowledge about dispersion when there is a density bias. In addition to the experimental study, analyses are being developed with the purpose of interpreting the experimental results and of achieving methods of predicting dispersion of pollutants in water streams. A Ph.D. dissertation has been completed recently by Mr. Fukuoka, and is now available on loan from the Institute of Hydraulic Research.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1022, REMOVAL OF SUSPENDED MATTER AND TURBIDITY FROM WATER BY FLOCCULATION

V.L. HAUSER, Technion, *Haifa, Israel* (A10-SWC-25)

OBJECTIVE: Determine electrokinetic properties of suspended particles, the reactions occurring when suspended in saline waters and flocculation effects of additive coagulant materials.

APPROACH: Preliminary tests will determine settling characteristics of suspended matter in natural flood water and changes brought about by additions of commercially available polyelectrolytes and other flocculant aids. Electrochemical and other properties of the suspended material will be determined as flocculants are added. Reaction of the suspended materials in waters of various salt concentrations will be studied. Field application studies will also be developed.

PROGRESS: The study showed that water-soluble polymers can be used as primary flocculants for clarification of dilute clay suspensions typical of surface runoff water. Required doses are much lower than those of conventional flocculants, such as alum. Large, fast settling and shear-resistant flocs are obtained by the use of polymeric flocculants, as contrasted to small, slow-settling flocs that result from the use of alum. Organic matter in the water increases the colloidal stability of the dispersed clay. The required doses of flocculating agents are considerably higher as a result of chemical reactions taking place between the organic substances and the flocculant. The organic substances compete with the clay minerals in their interaction with the cationic polymer and, therefore, the removal of mineral turbidity is delayed until the organics have reacted with the flocculant.

SUPPORTED BY U.S. Dept. of Agriculture

2.1023, WATER CLARIFICATION FOR GROUND WATER RECHARGE

V.L. HAUSER, Technion Res. & Develop. Fdn., *Haifa, Israel* (A10-SWC-80)

OBJECTIVE: Remove suspended solids and turbidity from muddy runoff water with polyelectrolytes and/or other chemicals.

Study basic chemistry of solids removal, chemical and organic interference, and biological processes.

APPROACH: Basic physics and chemistry of flocculation of suspensions with polyelectrolytes and hydrolysing flocculant combinations will be studied including the effect of organic matter. Effect on bacterial quality will be investigated with the coliform group of bacteria. An experimental pilot plant will be used to study real systems.

PROGRESS: Methods for flocculating suspended materials in the presence of organic matter have been investigated. Colloidal dispersions of clay turbidity and organic matter with varying degrees of clay-organic interactions were treated with alum and polymeric flocculants. Treatment effectiveness was correlated to organic matter content and clay-organic interaction. A continuous flow pilot water treatment plant was designed and is being installed. It consists of flocculation and sedimentation units. Effects of polymeric flocculants on flocculation kinetics in continuous flow will be studied. Transport of particulates through porous media in relation to filtration is being investigated. From experiments on laboratory sand filters, preliminary data have been obtained on contract coagulation-filtration on sand using hydrolytic and polymeric flocculants. Larger filtration units were designed, and a program was developed to study clogging and particulate transport at filtration rates representing recharge and sand filters. Treatment effects on filtration will be studied and attempts made to relate findings to field conditions in Bushland, Texas.

SUPPORTED BY U.S. Dept. of Agriculture

2.1024, OXYGEN CONSUMPTION IN CONTINUOUS BIOLOGICAL CULTURE

W.J. OBRIEN, Univ. of Kansas, School of Engineering, *Lawrence, Kansas* 66044

The objectives of this research are to measure the rate of oxygen consumption of nutrient limited, completely mixed, activated sludge systems and to utilize these measurements to develop a theoretical basis for the response of these systems to abrupt changes in the influent nutrient concentration.

Hydraulic means residence times in the aeration basin of from three to twenty-four hours are being investigated. Both aeration only and aeration with sludge return systems will be considered.

Preliminary results indicate the existence of a peak rate of oxygen consumption during transition growth periods following an increase in the influent nutrient concentration in aeration only systems. This peak will be of critical importance in establishing aeration design criteria for the recently proposed plants using biological compartmentalization of the influent nutrient followed by chemical flocculation to remove the micro-organisms from solution.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1025, DISPOSAL OF HEATED WATER THROUGH GROUND WATER SYSTEMS

G.P. WILLHITE, Univ. of Kansas, School of Engineering, *Lawrence, Kansas* 66044

This proposal seeks to evaluate the technical and economic feasibility of using a ground water system, hydraulically connected to a larger body of water, as a means of introducing waste heat into the larger body. In the proposed process hot water would be injected into the ground water system through wells, entering the larger body at numerous points along the sides and bottom. Some of the heat would be dissipated by conduction to the underlying and overlying strata. The remainder would be dispersed in the large body of water as the heated water rises due to density differences.

The proposed project has two phases. Stage I will determine the conditions under which the process can be used to introduce heated water into the larger body of water when the temperature of the larger body remains within thermal pollution limits. Scaled laboratory and mathematical models of the process will be developed for a river system. Process parameters obtained in Stage I will be used to develop the economics of disposing of heat in the Kansas or Missouri Rivers in Stage II.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1026, GROUND WATER RECHARGE THROUGH PITS AND WELLS

H.L. MANGES, Kansas State University, School of Engineering, *Manhattan, Kansas* 66502

Irrigation development increases the drainage problem in areas with poor natural surface drainage. An alternative to an organized Drainage District is to dispose of excess water by recharge into the underground aquifer. This can be accomplished by pits or wells if suspended material is removed from the surface water.

A series of recharge pits will be dug to the top of the underground aquifer. The pits will be backfilled with a filter material. Various materials, including fiberglass, sands and gravels, will be evaluated in the laboratory before selecting a filter design for field trials.

Underground draintile will be installed to determine if the natural soil profile can be used as an effective filter for removing suspended particles from surface runoff water. Runoff from rainfall and irrigation will be diverted onto the area and the flow rate and amount of suspended sediment determined.

The potential recharge rate of a selected aquifer will be determined. Water will be pumped from an existing irrigation well into a recharge well.

The work will be accomplished at Kansas State University, Manhattan, and the Sandyland Irrigation Field at St. John, Kansas.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1027, PRE AND POST-IMPROVEMENT LIMNOLOGICAL ANALYSES AND FISH POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SE KANSAS

C. BASS, State Forest. Fish & Game Com., *Pratt, Kansas* 67124

Objective: To conduct pre- and post-improvement analyses of the limnological conditions of strip-mine lakes in Cherokee and Crawford Countries, Kansas. To establish and monitor fish populations and neutralized and previously acid strip mine lakes in Cherokee and Crawford Counties, Kansas. be made with eckman Zeromatic II glass electrode pH meter. b. Turbidity to be determined by the use of standard 20 cm diameter Secchi plate. c. Dissolved oxygen is to be determined by one of two techniques; (1) the sample- blank modification of the basic Winkler method, or (2) Beckman Model 707 Dissolved Oxygen Analyzer. d. Ortho- and meta-phosphates to be determined by methods outlined by Hach. e. Nitrate concentrations to be determined by a modification of the brucine-sulfate sulfinilic acid test outlined by the APHA (1965). f. Carbon dioxide determinations to be obtained mathematically from procedures outlined by Moore (1939). g. Boiling-point acidity determined according to procedures outlined by the APHA (1965). h. Total alkalinity test procedures are those outlined by the APHA Standard Methods (1965). i. Temperatures (air and water) to be determined by direct reading from a Yellow Springs Instrument Co. tele- thermometer. j. Soil-analyses to be made according to techniques proposed by Jackson (1958). k. Determinations of numbers of benthic organisms per square meter of bottom material to be in accordance with procedures outlined by Welch (1948). l. The number of planktonic organisms per liter of original water sample will be determined according to the total-count method outlined by Welch (1948). 2. a. Growth rate and condition will be determined for fish populations established in certain strip-mine lakes, which have previously undergone rehabilitation. b. New populations of fish will be established in certain strip-mine lakes following the neutralization of acid waters by agricultural lime (non- project activities). These populations will be monitored over a period of time, rates of growth checked, and the dynamics of the population- balance investigated ultimately, as a means of determining the feasibility of sustaining such fish populations in previously acid strip-mine lakes.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1028, THE DIFFUSION COEFFICIENT IN OPEN CHANNEL FLOW
B.J. BARFIELD, Univ. of Kentucky, Graduate School, *Lexington, Kentucky* 40506

The turbulent diffusivity in open channel flow will be investigated as a function of channel roughness, shear velocity, and cross-sectional area. Investigations will be conducted in a research flume using a hot- film anemometer as the basic instrument. Prediction equations will be developed for the turbulent diffusivity as a function of flow parameters and channel parameters. The resulting diffusivity profiles, in conjunction with existing models, will be applicable for predicting the effects of proposed stream modifications on sediment load, predicting the pollution of streams from proposed sewage disposal systems, and for modeling other systems in which diffusion and dispersion are important.

SUPPORTED BY U.S. National Science Foundation

2.1029, THE DISPERSION OF CONTINUOUSLY INJECTED EFFLUENTS IN OPEN CHANNELS
D.P. HARRISON, Louisiana State University, School of Engineering, *Baton Rouge, Louisiana* 70803

The hydrodynamic factors controlling lateral and vertical dispersion of effluents injected continuously into open channels will be studied. Specifically, background information on the dispersion process will be studied, the mathematical description of dispersion will be investigated, and the feasibility of using hydraulic models to develop necessary experimental data will be examined. Further, assuming the feasibility of model studies, experimental plans using hydraulic models at the U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi are to be developed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1030, RESTORATION DYNAMICS FOR ESTUARIES
K.I. MUMME, Univ. of Maine, School of Technology, *Orono, Maine* 04473

Chemical reactor theory has been applied to the problem of maintaining water quality control of the Penobscot Estuary in Maine. This research will investigate the possibility of operating the 'reactor' (the river) such that the reaction becomes 'runaway' (dissolved oxygen content of the water increases in a runaway manner). It is intended to develop a means of assisting restoration of the river rather than simply controllinng or stopping deterioration of the river.

If the research is successful the river can be considered in either of two ways: active restoration would allow the river to handle even more waste without violating the stream classification; or, the same amount of waste could be discharged into the river but the water could maintain a higher classification than is now possible. This new study will be extended to the entire tidal estuary and the dynamic interaction between the ocean and the river.

SUPPORTED BY U.S. National Science Foundation

2.1031, INDUCED AIR MIXING OF LARGE BODIES OF POLLUTED WATER
S.A. ZIEMINSKI, Univ. of Maine, School of Technology, *Orono, Maine* 04473

The Problem: Organic matter of industrial and natural origins tends to settle on the bottom of lakes and other large water reservoirs where it decays depleting the water of dissolved oxygen necessary to ensure normal aquatic life. Although the upper surface of water which is in direct contact with atmosphere may be saturated with oxygen, the mixing resulting from density differences is too small to replenish the oxygen deficiency in the lower layer. The resulting anaerobic conditions lower the water quality. Formation of hydrogen sulfide as well as sulfides of iron and manganese takes place. The carbon dioxide concentration increases and the pH decreases. This anaerobic decomposition can produce undesirable organics, imparting bad taste, odor and occasionally toxicity to the water. The unoxidized organic matter piles up on the bottom and gradually the body of water becomes smaller and shallower.

Plan of attack: Introduce compressed air in appropriate places of the body of water. The resulting mixing oxygen supply and improved surface aeration will provide the whole body of water the oxygen necessary for bio-oxidation of the waste organic matter. In addition to substantital increase in dissolved oxygen the application of this method results in precipitation of iron, reduction in carbon dioxide content, improvement of color, etc. Although this method has a tremendous potential in decreasing pollution of large bodies of water, very little is known about the various factors affecting the efficiency of the system and therefore its optimum design.

The objective: A mathematical analysis has been conducted in our laboratory which resulted in selection of a mathematical model which correlates the rate of mixing, density differences produced by the induced air, depth of immersion of the aerator, etc. A complete experimental procedure has been worked out to check or modify the model. It is expected that this work will allow a successful and efficient design of induced air systems for different shapes, sizes and depths of large bodies of water.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1032, TEST AND EVALUATE EQUIPMENT FOR CONTAINING AND REMOVING OIL SPILLS IN HARBORS AND ADJACENT WATERS
A.E. LANGLOIS, State Port Authority, *Portland, Maine* 04111

Conduct a series of practical tests to evaluate the performance of various equipments for containing and removing spilled oil.

Design and construct a skimming device for removing oil-water mixtures from oil spills. Conduct a desk top study of a complete system for oil skimming, separation and reclamation of spilled oil under varying conditions.

Commercial oil skimmers and/or separators may be tested if available.

Tests will be conducted at various locations in or near the harbor of Portland, Maine. Some tests will be performed at an outdoor laboratory area in South Portland, Maine.

Results of the tests should be valuable to harbormasters and other marine personnel who must contend with oil spills. Results should also indicate specific requirements for improved equipment and optimum methods of using equipment under various conditions.

Field testing is performed by Altenburg, Kirk and Company, an Industrial Research firm in Portland, subcontractors to Maine Port Authority. Close cooperation maintained with civic, marine and Coast Guard organizations in the area. Project was started in August of FY 1968-69 and is scheduled for completion in February of FY 1969-70.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1033, DETERGENT DISPERSANT CHARACTERISTICS OF PETROLEUM FUELS
M.E. LEPERA, U.S. Army, Coating & Chemical Lab., *Aberdeen Proving Ground, Maryland*

Technical Objective: Investigate the detergent/dispersant properties of petroleum fuels that affect its performance in the field.

SUPPORTED BY U.S. Dept. of Defense - Army

2.1034, NAVY ENVIRONMENT--TURBULENT DIFFUSION AND EXCHANGE PROCESSES IN ESTUARINE, COASTAL AND OCEAN WATERS
A. OKUBO, Johns Hopkins University, Chesapeake Bay Institute, *Annapolis, Maryland* (N00014-67-A-0163-0006)

Technical Objective: The Navy requires a knowledge of diffusion processes in the ocean and the flushing characteristics of

estuarine and coastal areas that may be contaminated by radioactive or dissolved chemical materials emanating from its own or enemy forces. This research is intended to supply basic information for prediction of the dispersion of contaminants through an examination of the theoretical and empirical laws governing the turbulent diffusion of estuarine, coastal and oceanic waters.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.1035, DIFFUSION AND TRANSPORT OF CONTAMINANTS IN TURBULENT SHEAR FLOW
S. CORRSIN, Johns Hopkins University, School of Engineering, *Baltimore, Maryland* 21218 (AT(30-1))

The objective is to try to understand the transport of momentum and the transport of a passive scalar contaminant (such as heat) in a turbulent shear flow. We hope that this will help to establish bases for the estimation of transport rates. We have succeeded in generating a nearly homogeneous turbulent shear flow, and are measuring the statistical properties of the turbulence field, including diffusion of heat from a local source. During the coming year we expect to extend the diffusion experiments to the case of a turbulent boundary layer.

SUPPORTED BY U.S. Atomic Energy Commission

2.1036, PHYSIOLOGY OF ACIDOPHILIC BACTERIA OF ACID MINE WATERS
T.M. COOK, Univ. of Maryland, Graduate School, *College Park, Maryland* 20740

This project consists of a fundamental physiological study of the nature of the acid-resistance and acid-requirement of bacteria associated with acid mine waters. A precise definition of each of these phenomena will be obtained and then an attempt will be made to uncover the mechanisms responsible. The permissible limits of pH for various physiological activities will be determined for the autotrophic ferrobacilli and thiobacilli, as well as a new acidophilic heterotrophic bacterium isolated from acid mine water. A study will be made to determine the relevance of this heterotroph to the management of acid mine water pollution.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1037, DISPOSAL OF WASTES FROM SWINE FEEDING FLOORS TO MINIMIZE STREAM POLLUTION
W.F. SCHWIESOW, Univ. of Maryland, School of Agriculture, *College Park, Maryland* 20742

To investigate methods for disposing of waste from swine feeding facilities. To develop guide lines for design of systems to minimize water pollution by swine wastes.

The present research installation is to be modified and improved to provide data on quantity of waste, characteristic properties of the waste, and performance of the system. Analysis of data obtained from this project is expected to establish guidelines for design of commercially installed systems.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1038, SYSTEM STUDY, DESIGN, AND EVALUATION OF THE LOCAL STORAGE, TREATMENT, AND REUSE OF STORM WATER
C.W. MALLORY, Hittman Associates Inc., *Ellicott City, Maryland* 21043

A comprehensive study was made to determine the economic and technical feasibility of using system for the local storage, treatment, and reuse of storm water as a method of providing pollution control. With this concept, storm water runoff is collected in small reservoirs dispersed throughout urban communities, treated to remove pollutants and is either released to receiving bodies of water or further treated for reuse. The benefits derived from the reuse of storm water are used to offset the cost of pollution control.

As part of this study, a synthesized hydrograph using mathematical expressions derived by regression analysis techniques were used to predict the runoff from ungaged watersheds following urban development. A system analysis technique was used to evaluate the various combinations of system components, possible plant locations, and quality and quantity of reuse. The systems were optimized by computer techniques based on a net system cost given local site conditions as constraints. The cost of pollution control by conventional means and the value of the reused water were taken as benefits.

Four systems were considered for application to the Wilde Lake watershed in Columbia, Maryland. Three were based on the local storage concept with (1) potable reuse, (2) sub-potable reuse, and (3) pollution control only. The fourth system was a design for pollution control of the same area using conventional design approaches and methods. For the Wilde Lake watershed, the local storage and treatment system for potable reuse was found to be the most economical system. The local storage system for pollution control would have a slightly greater net cost than the potable reuse system. The sub-potable reuse system and conventional system were found to be considerably more expensive systems.

This program included the development of plans, schedules, and cost data for the demonstration of the local storage, treatment, and reuse of storm water and for the collection and analysis of data on urban hydrology.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1039, OPTIMIZING STRATEGY FOR STATE WATER POLLUTION CONTROL IN THE POST 'PLAN OF IMPLEMENTATION' PERIOD
B.B. BERGER, Univ. of Massachusetts, Water Resources Research Ctr., *Amherst, Massachusetts* 01002

A survey will be made of institutions that have evolved or have been designed to accomplish a regional objective in environmental quality control, natural resources allocation and conservation, and in related fields. Efforts at regionalization in Massachusetts will be reviewed. Based on these steps: (1) the essential features of effective institutions for regional or basin-wide water quality management will be detailed and (2) the special problems in evolving such institutions in Massachusetts will be described; a strategy will be proposed for official consideration of alternative institutions that provide the essential requirements for regionalization of water quality control and appear to be fitted to the needs of Massachusetts and New England.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1040, DETERMINATION OF THE FEASIBILITY OF REMOVAL OF ALGAL NUTRIENTS IN LAKE WATERS BY ION-EXCHANGE
O.T. ZAJICEK, Univ. of Massachusetts, Graduate School, *Amherst, Massachusetts* 01002

The objective of this project is to develop a simple and (relatively) inexpensive technique for the in situ removal of phosphate from natural waters by an ion exchange process. To this end, the behavior of various ion exchangers will be studied for exchange characteristics and selectivity for phosphate species as a function of pH, counter ions, temperature, and flow rate. In addition, attempts will be made to prepare phosphate specific ion exhangers. The information acquired will be used to develop a device and optimum conditions for the removal of phosphates from natural waters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1041, DEGRADATION OF SEWAGE AND SOIL MICROORGANISMS
R. MITCHELL, Harvard University, School of Engineering, *Cambridge, Massachusetts* 02138

It is proposed that a project entitled 'Enzymatic Degradation of Sewage and Soil Microorganisms by a Marine Microflora' be initiated. The research would entail a study of predation by the indigenous marine microflora on those microorganisms carried into the sea as sewage or in run-off water. An attempt will be made to evaluate the significance of enzymatic degradation in the eradication of sewage and soil microorganisms from the sea. Special emphasis will be placed on the decomposition of Escherichia coli.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1042, OIL DISPERSION COALESCENCE BY POROUS SOLID CONTACT
L.A. SPIELMAN, Harvard University, School of Arts, *Cambridge, Massachusetts* 02138

Aqueous wastes, such as those from industrial processing or shipboard balast and bilge discharges, often contain significant amounts of extremely small oil drops which cannot be separated effectively by gravity settling alone. Flow of such suspensions through porous granular materials results in the continuous and efficient coalescence of the unsettable droplets into larger readily settled globules. The proposed study will endeavor to clarify the fundamental mechanisms underlying bed coalescence and thereby formulate general design criteria through a mathematical description of pressure drop and coalescence performance. The formulation will be guided by the experimental determination of the extent of phase separation and pressure drop under controlled variation of inlet drop size, suspension chemistry, medium grain size, bed depth, flow rate and grain surface treatment. The results of this study should be of use in the design of separation processes for treating waste aqueous oil dispersions prior to their discharge. The results of this work should also make clear the relative advantages of granular versus fibrous media.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1043, ENRICHMENT OF METALS IN SEAWATER BY FOAM PRODUCTION
T.R. GIBB, Tufts University, School of Arts, *Medford, Massachusetts* 02155

The work to be done relates to the general problems of the food- chain in the sea, pollution and the nature of the air/sea interface. It is expected to provide an inexpensive and chemically mild method of concentrating certain trace metals which are associated with strong ligands such as humic acids and aminoacids, or which are present as macromolecular species in seawater. It is directed at an analytical level just above the present state of the art viz: in what forms do the trace metals exist in seawater? The availability of larger quantities of metal compounds, concentrated by this non-destructive method, is expected to permit identification of coordination compounds, complex oxides, etc. The series of bubble generators will be used to produce a stable foam which will be separated from sea water. The composition of the foam will be evaluated by emission spectroscopy. Development of trace-analytical methods is proposed in those cases where more precise determinations are necessary. Approaches will include optical and X-ray emission spectroscopy.

SUPPORTED BY U.S. National Science Foundation

2.1044, TURBULENCE IN A STRATIFIED FLOW
W.R. DEBLER, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

This research will experimentally investigate the generation, decay and structure of turbulence in a stratified flow. Transport phenomena will also be examined. The study will be carried out in an existing wind tunnel in which the flowing air can be stratified in the vertical direction by selective heating, meanwhile maintaining a low ambient turbulence level. The data that will be gathered, and the subsequent comparisons with homogeneous flows which will be made, should be of interest and value to researchers in meteorology and oceanography and in civil and sanitary engineering as related to water resources and pollution problems.

SUPPORTED BY U.S. National Science Foundation

2.1045, REVERSAL OF EUTROPHICATION THROUGH ARTIFICIAL AERATION OF LAKES
R.C. BALL, Michigan State University, Institute of Water Research, *East Lansing, Michigan* 48823

Lake stratification results in uneven ionic distributions, biotic spatial restrictions, and certain other undesirable conditions. Artificial aeration may reduce or eliminate these conditions. Artificial aeration with compressed air may be accomplished either by thermal destratification, or by hypolimnion aeration. In the latter case, oxygen is added directly to the bottom waters without complete mixing of the water mass. We will study the effects of both systems on two northern Michigan lakes located in the Pigeon River State Forest. Field studies will be conducted during the summers of 1969 (control) and 1970 (test). The lakes will be aerated during the latter period. We will determine the effects of artificial aeration on: (A) physical- chemical properties, such as temperature, oxygen and phosphorus, (B) phytoplankton and periphyton, (C) primary production, (D) benthic fauna, (E) insect emergence rates, and fish depth distribution.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1046, THE INFLUENCE OF SOILS ON POLLUTION
A.E. ERICKSON, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL03030)

OBJECTIVE: Study pollutant fixation, movement and decomposition in soils, and the influence of the soil environment on the fixation and/or decomposition of pollutants. Modify soils to improve their efficiency in depolluting various wastes.

APPROACH: The equilibrium between various soils and various pollutants will be studied to determine the levels of the pollutants that are mobile in the soils. The movement of pollutants will be studied in the laboratory and the field by measuring effluent from percolation tubes as well as drainage water from drain tile, ditches or streams. Laboratory and field studies will be undertaken to determine the best environment for depolluting the percolating water. Soils will be modified so that conditions can be produced for depolluting the water passing through these soils.

PROGRESS: The water from three agricultural drainage tile lines, one drainage ditch and three streams from agricultural watersheds have been sampled throughout the year and analyzed for nitrogen, phosphorous, calcium, magnesium, and potassium. This work has been financed by the Michigan Water Resources Commission. A study of the nitrogen and phosphate counts of the soil and in the water at the shallow water table below lawns on various soil types surrounding a well-developed recreational lake was made to determine the influence of lawn fertilization and soil type on the nutrients entering the lake. This study was financed by a group of interested lake property owners. Another study considered the phosphate adsorbing capacity of soil horizon samples taken from a range of soil types. These data were interpreted on the basis of the capacity of the soil to remove phosphate from a percolating effluent, the phosphate content of the equilibrium leachate and the ability of these soils to recover their adsorption capacity with time. Financed by the Michigan Water Resources Commission.

SUPPORTED BY Michigan State Government

2.1047, NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA
W.C. LARSON, Detroit Lakes Engin. Dept., *Detroit Lakes, Minnesota*

Disposal of nutrients from municipal, private, domestic, and agricultural wastes in the Detroit Lakes, Minnesota area poses a serious problem owing to the high groundwater table, very permeable gravel aquifer, and wide interception routes of groundwater underflow. Several lakes in the chain of lakes in this area very important to the recreational needs of the community and valuable to the tourist industry have experienced catastrophic aquatic weed and algal growths in recent years as a result of nutrient enrichment. These lakes are interconnected by the Pelican River or its tributaries and are situated down gradient (to the southwest of Detroit Lakes, Minnesota). Since sources of nutrients are widely scattered it would not be economically feasible to intercept all waste outfalls with a central distribution system and provide subsequent treatment. It is proposed that nutrients in this sewage disposal system be intercepted or diminished in two different ways. 1) by dispersing the effluent from secondary treatment facilities on peat land and 2) by harvesting aquatic vegetation which contains nutrients. It is intended that by manipulation of natural

$ environmental processes the rate of eutrophication will be arrested at minimal expense.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1048, MATHEMATICAL MODEL OF STORM AND SANITARY INTERCEPTOR SYSTEM
C.E. BOWERS, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414

The objective of this study is the development of a mathematical model of the interceptor system of the sanitary district, to assist in the operation of diversion structures in the trunk sewer system. A model has been developed to take precipitation data at several locations around the area as input and compute runoff in the trunk system, inflow to the interceptors and route the flow through the interceptors. It computes information on peak flows to assist in operation of diversion structures in the system, to assist in reduction of pollutants discharged into the Mississippi River. The final report is in preparation.

SUPPORTED BY Saint Paul City Government - Minnesota

2.1049, ECOLOGICAL STUDIES ON THE DYNAMICS OF PLANKTONIC BLUE GREEN ALGAE, WITH SPECIAL REFERENCE TO THEIR MICROSTRATIFICATION
A.J. BROOK, Univ. of Minnesota, School of Biological Sciences, *Minneapolis, Minnesota* 55455 (AT(11-1)-1820)

Although the collection of field data will be continued during the current year, the emphasis of the research plannedfor 1970-71 will be directed towards an experimental approach involving the manipulation of the artificial environments of columns established in the laboratory and in lakes. In the laboratory columns an attempt will be made to assess the influence of temperature, light and nutrients in the formation of algal strata. Observations on the occurrence of such strata of different lakes indicates that factor interaction must be involved and the proposed experiments will be designed to investigate certain of these interactions. In the plastic columns introduced into the study lakes, the primary focus will be in enrichments, the progress of which will be followed primarily by enzymatic assay monitoring. Enrichment will be induced on the one hand by over-turning artificially and so mixing the nutrient rich metalimnetic waters with its other poorer epilimnion, on the other by the addition of nitrogen and phosphorus.

Results: It has been established that not only 'Oscillatoria agardhii' but all major components of the phytoplankton tend to stratify in an orderly sequence in the lakes studied. Experiments with laboratory columns have demonstrated some of the effects of light on the formation of strata of 'Oscillatoria agardhii'. The columns established in lakes have indicated that enrichment stimulates the proliferation of 'Oscillatoria agardhii'. These column studies have also shown phosphatase activity in the epilimnion and thus some phosphorus deficiency in the algae. No severe phosphorus limitation has, however, been demonstrated, a sign which agrees with results obtained for other non-nitrogen fixing blue greens.

SUPPORTED BY U.S. Atomic Energy Commission

2.1050, PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES
R.O. MEGARD, Univ. of Minnesota, School of Biological Sciences, *Minneapolis, Minnesota* 55455

The objective of this project is to analyse the nutritional requirements and the photosynthetic system of the phytoplankton in four Minnesota Lakes that receive nutrients from different sources and produce dense populations of nuisance algae. Algal nutrition, photosynthesis, and population densities will be studied before and after the nutrient influx to one lake is reduced, whereas nutrient- abatement programs for the others are either being discussed or they are in various stages of implementation. Analyses of algal nutrition, photosynthesis, and population densities that were begun during a retional limnological survey will be continued, but the emphasis will be somewhat different at each lake.

The research will monitor the effects of stopping the flow of sewage in the productivity of Lake Minnetonka. Advanced sewage treatment as a lake-management procedure and its effectiveness compared to sewage diversion will be evaluated in Shagawa Lake studies. The effectiveness of diverting sewage effluent from Sallie Lake and using the effluent for spray irrigation will be appraised. The results of the research project should assist the State in solving its lake pollution problems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1051, LAKE ERIE DIKE
E. SILBERMAN, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414

The Bethlehem Steel Corporation at its Lackawanna, New York plant proposes to contain the slag and other waste products previously dumped freely into Lake Erie by enclosing the waste area within a dike. It was the first purpose of the investigation to determine the optimum outline and structure of the dike to (1) limit interference with navigation into Buffalo Harbor by wave reflection and refraction and (2) prevent contamination or silting of the several adjacent water intakes, especially the Erie County Water Authority and the City of Buffalo intakes. This phase of the study was made by means of a physical model of the east end of Lake Erie at a distorted scale of 1:600 horizontal and 1:60 vertical and has been completed. A second phase of the study involves model tests in a wave tank of the dike cross section to design its reflection characteristics. One to 50 and one to 34 scales are being used.

SUPPORTED BY Bethlehem Steel Corporation

2.1052, NUTRIENT ASSIMILATION RATES - FIELD STUDIES
W. ABBOTT, Gulf Coast Research Laboratory, *Ocean Springs, Mississippi* 39564

A series of estuarine ponds have been formed by capturing a bayou channel between levees. The ponds are utilized for factorial experimentation on effects of various nutrients in multiple dose combinations.

Phosphorus studies have shown that the ultimate fate of an added tracer spike is conditioned by the recent fertilization history of the pond. Ability of the whole pond ecosystem to function as a sort of 'phosphorus buffer' is indicated by the results.

Repetition of phosphorus studies and studies on the nitrogen cycle are planned for the near future.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1053, ANIMAL WASTE UTILIZATION FOR POLLUTION ABATEMENT
O.E. CROSS, Univ. of Nebraska, School of Agriculture, *Lincoln, Nebraska* 68503

The proposed research plan involves laboratory and field investigations aimed at determining the maximum allowable rate of applying livestock manure to cultivated soil without causing pollution of surface runoff or underground water.

Field investigations would include surface runoff water and underground water analysis as influenced by: 1. Low, medium and high application rates of beef feedlot manure. 2. Plowing the manure under to depths of 24", 12", and 8". 3. Test plots set-up on fine textured soil and coarse textured soil. 4. Two plant population densities. 5. Manure to be applied in the fall in accordance with normal feedlot management practices. 6. Irrigation of test plots to follow recommended practices.

Laboratory investigations would involve: 1. Analyses of surface runoff and underground waters. 2. Analyses of change of physical, chemical, and microbiological changes of the soil. 3. Analyses of plant response and plant root growth.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1054, WATER-QUALITY REGIMEN OF TAHOE-TRUCKEE SYSTEM
J.V. SHARP, Univ. of Nevada, Desert Research Institute, *Reno, Nevada* 89507

2. WATER QUALITY

The principal objective is development of a digital simulation model which will simulate inorganic water-quality records under various regimes of flow and waste disposal in complex hydrologic systems which include ground-water and dispersed components. A second objective is to develop methodology for building a water-quality model from intensive, short-term water-quality records. Although the model is being developed on the Tahoe-Truckee system, basic concepts used in its formulation are independent of the system, permitting transfer of the conceptual model to similar hydrologic systems.

A preliminary model has been developed for the upper part of Tahoe- Truckee system. This model, based on eighteen months of data, simulates total dissolved solids. Research pertaining to 1) modeling, 2) investigation of environmental/human factors, and 3) data collection will be continued during FY 1971. The model will be extended to the remainder of the system, refined, and expanded to simulate individual constituents. Investigation of environmental/human factors and their relation to inorganic water quality will continue and results will continue to be used for refinement and testing of the model. The model will be tested on the Tahoe-Truckee system by comparing simulated data with 1) limited historic data available at Farad-Floriston, and 2) data collected as a part of the research. A comprehensive report on development and operation of the Tahoe-Truckee model will be submitted at the end of FY 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1055, ANALYSIS OF THERMAL POLLUTION DISPERSION
R.C. AHLERT, Rutgers the State University, School of Engineering, *New Brunswick, New Jersey* 08903

The purpose of this research is to describe the dispersion of thermal effluents. Molecular and turbulent diffusional coefficients will be used to generate temperature gradients in both longitudinal and normal directions. Models which characterize these temperature gradients in terms of outfall temperature, relative effluent flow rate, and outfall location will be developed. Because of the contributions of natural convection in some outfall configurations, laboratory experiments will be used to clarify the contribution of stratification or natural convective effects in the development of cross-sectional profiles.

Reaeration processes including pollution demands, interfacial transport and photosynthesis are nonlinear in temperature. Therefore, the model of stream behavior that assumes the stream to be a continuous reactor with both longitudinal and normal temperature gradients will be more precise than earlier models involving cross-sectional uniformity. Once appropriate temperature profiles have been developed for typical thermal effluent situations, these relations will be coupled with mass and energy balances. The ultimate result will be a clearer picture of the effect of thermal pollution on total stream properties.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1056, PHOTOSYNTHETIC REAERATION IN THE UPPER PASSAIC RIVER
J.V. HUNTER, Rutgers the State University, School of Agriculture, *New Brunswick, New Jersey* 08903

The purpose of this research is to determine the contribution of photosynthesis to the reaction of the upper Passaic River, and to determine the effect of this photosynthesis on the dissolved oxygen level - specifically, the diurnal fluctuations, in both a natural state and under conditions of artificial aeration.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1057, INSTREAM AERATION AND PARAMETERS OF NITROGENOUS BIOCHEMICAL OXYGEN DEMAND
W. WHIPPLE, Rutgers the State University, Water Resources Research Inst., *New Brunswick, New Jersey* 08903

The proposed investigation involves laboratory and field investigations to determine the explanation for the very high deoxygenation parameter observed downstream of artificial aerators installed in polluted rivers. This effect has been noted in a previous research and demonstration program involving the same principal investigators and others at the N.J. Water Resources Research Institute. Field tests will be made with mechanical aerator and oxygen diffuser equipment in the Passaic River, New Jersey, and samples and data will be obtained from other sites. Laboratory tests will be made, with and without nitrifying inhibitors, to determine the part played by dissolved oxygen level and turbulence in the reaction. Observations of nitrifying populations will be made by a microbiologist. The objective is to determine appropriate parameters for systems analysis for location of instream aeration stations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1058, OXYGEN REGENERATION OF POLLUTED RIVERS
W. WHIPPLE, Rutgers the State University, Water Resources Research Inst., *New Brunswick, New Jersey* 08903

The purpose of this project is to demonstrate the effectiveness and economy of commercially available equipment in restoring to satisfactory dissolved oxygen levels the polluted waters of one small river, the Upper Passaic, and one large navigable river, the Delaware. After detailed analysis and preparation, aeration units of several types, of a size sufficient to materially change the oxygen level, will be installed on the Passaic River. Utilizing information gained from this portion of the study, aeration equipment will be installed on the banks of the Delaware. By field tests and dispersion analyses, the optimum configuration and type of stations, adapted to affect entire cross sections without interfering with the navigation, will be obtained.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.1059, ACID WATER TROUT STUDIES
R.H. SOLDWEDEL, State Div. of Fish & Game, *Trenton, New Jersey* 08625

Objective: To determine the means necessary to render acid water (pH 4.3 - 5.5) streams and lakes throughout the state capable of supporting brook trout populations for the purpose of angling.

Procedure: The monitoring of daily stream flow and pH data will be continued in Oyster Creek in conjunction with the U.S. Geological Survey Water Resources Division. Efforts will be continued to press for the development and activation of a pH recorder suitable for this purpose.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1060, NEUTRALIZATION EXPERIMENTS
R.W. STEWART, State Div. of Fish & Game, *Trenton, New Jersey* 08625

Objective: To evaluate the use of lime as a means of improving the habitat and fish population potential in Lakes No. 1 & 2, Winslow Tract.

Procedure: Neutralization experiments previously conducted at Lakes No. 1 & 2, Winslow Tract, as part of Jobs I-3 and I-4, are being combined herein.

The purpose of this segment is to prepare for publication a formal report on the results of this work.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1061, REACTION CAPACITY OF STREAMS IN NEW JERSEY
O.O. WILLIAMS, U.S. Dept. of the Interior, Geological Survey, *Trenton, New Jersey* 08607

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of New Jersey.

Purpose: To determine the ability of the state's streams to assimilate pollution loading.

Methods: Empirical relations developed by Langbein and Durum will be used to compute the reoxygenation coefficient (k2) of the Streeter- Phelps equation for a selected stream reach. Observed D.O. and B.O.D. values will be used to compute first (k1) and second (k2) coefficients for comparison with the coeffi-

cients derived using the empirical relations. Computer programs will be developed for computation of reaeration capacity of streams in New Jersey.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1062, CHANNELIZATION STUDIES
R. FIFE, U.S. Dept. of the Interior, Bureau of Reclamation, *Albuquerque, New Mexico* 87103

Work is being done on the Middle Rio Grande Project, New Mexico, from Cochiti Diversion Dam to Elephant Butte Reservoir. The three original features of the program are: (1) the evaluation of river channel improvement by jacks (structural shape); (2) the evaluation of channeling water through low-flow conveyance channels; and (3) the determination of the efficiency of settling basins for sediment control.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.1063, RESEARCH ON PHYSICAL ASPECTS OF THERMAL POLLUTION
T.R. SUNDARAM, Cornell Aeronautical Lab. Inc., *Buffalo, New York* 14221

The program is concerned with three problems on the physical aspects of thermal pollution. The first problem is concerned with the study of the mechanisms responsible for the formation and maintenance of the basic thermal structure of stratified lakes. The second problem is concerned with the effects on this basic thermal structure of thermal discharges at or below the level of the thermocline. The third problem area is concerned with the study of the nature of the mixing processes at the interface between a warm layer of water and underlying cooler water. Significant new results have been obtained in all three problem areas. A mathematical model has been constructed for the stratification cycle of temperate lakes and the results of this model give very good agreement with actually observed thermal structures. It has been shown that thermal discharges at or below the level of the thermocline may lead to increases in the length of the stratification period as well as the volume of the epilimnion. It has also been demonstrated that while the transfer of heat across the interface between the warm layer and underlying cooler layer is severely inhibited by the stable buoyancy gradients, the transfer of momentum is influenced to a lesser degree.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1064, EVALUATION OF LOW-FLOW AUGMENTATION ON THE CHEMISTRY AND BIOLOGY OF THE BUFFALO RIVER, BUFFALO, NEW YORK
R.A. SWEENEY, State University of New York, Graduate School, *Buffalo, New York* 14222

The purpose of this three (3) year study, which was initiated in 1967, is to ascertain the effects of the Buffalo River Improvement Project on the chemistry and biology of the Buffalo River. (Through the Buffalo River Improvement Project, 100 mgd is added to the river to augment the flow of this normally sluggish stream which receives both industrial and domestic sewage.) Sediment and water samples were gathered from four (4) stations during early June, late July and early September. Waters were gathered from four (4) stations during early June, late July and early September. Waters were quantitatively analysed for alkalinity, conductivity, pH, dissolved oxygen, solids, phosphates and nitrogen; sediment for solids, iron, oils, COD, BOD, chlorine demand, phosphates and nitrogen. The variety and number of macroinvertebrates were ascertained.

The latter indicates that there has been an improvement in the river down-stream of augmentation out-falls. However, the upper reaches are deteriorating in quality primarily due to domestic wastes.

SUPPORTED BY Allied Chemical Corporation

2.1065, EFFECT OF CHEMICAL STRUCTURE ON BIODEGRADABILITY OF ORGANIC MOLECULES
M. ALEXANDER, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00081)

OBJECTIVE: Determine the effect of structure of organic compounds on their biodegradability by natural communities of aquatic microorganisms. Establish biochemical principles governing the inability of natural aquatic microfloras to degrade synthetic organic compounds.

APPROACH: Appropriate classes of compounds which represent actual or potential water pollutants will be selected. The choice will also be conditioned by the availability of a reasonable number of model compounds, their stability and solubility and the potential for establishing principles relating structure to biodegradability. On the basis of prior investigations using soil or sewage organisms, our own or studies of others, if is expected that the investigations will include the effect of type, number and position of substituents, branching, N- alkylation, unsaturation and ether and thioether linkages on the ability of natural populations of aquatic microorganisms to degrade pollutants and model compounds representing potential pollutants.

PROGRESS: Tests based upon O(2) consumption demonstrated that microorganisms of soil are less able to degrade monomethyl-substituted than unsubstituted organic acids, while dimethylsubstituted compounds are strikingly resistant to biodegradation. Compounds containing a quaternary-carbon---like dimethyl-substituted malonic, succinic, valeric, glutaric, octanoic and undecanoic acids---are decomposed very slowly by heterogeneous communities; nevertheless, individual bacterial populations seem able to metabolize certain of these refractory molecules. Studies of cometabolism as a basis for the incomplete transformation of classes of non- or poorly biodegradable chemicals were continued. An Achromobacter cometabolizing 3-methyl- and 4- chlorocatechols produced from them the corresponding 2-hydroxymuconic semialdehydes. These products, which were not further degraded, were identified by UV and IR spectrometry and mass spectroscopy. These reactions appear to be catalyzed by an enzyme not previously described.

SUPPORTED BY U.S. Dept. of Agriculture

2.1066, COMPUTE SIMULATION OF DIFFUSION STUDIES
E. MEHR, New York University, Geophysical Sciences Lab., *New York, New York* 10003

The objective of this grant is the study of Monte Carlo simulation models for both diffusive and turbulent phenomena, and their application to water pollution problems.

The Diffusion Simulation Model will simulate streams and estuaries in both one and two dimensions. Further the third dimension will be simulated by means of two or three depth layers. Results will be checked by means of available data.

The Turbulent Simulation Model, the classical approach to estuarian diffusion problems, essentially involves specifying initial and boundary conditions, assuming or calculating values for mixing coefficients and solving the resulting differential equations. In applications the problem is frequently solved for a wide range of conditions and values for mixing coefficients since these quantities may not be known to a high degree of accuracy. A detailed discussion of the advantages and disadvantages of this approach is not the purpose of this report. Suffice to say that alternate approaches to the problem are of interest.

The purpose of this phase of the research is to investigate an alternate approach. The approach is to develop a model for small scale velocity disturbances that can simulate the role of turbulence in estuarian diffusion problems. The details on the structure of this velocity field is given in the next section; here a brief outline of the procedure is presented. The turbulent velocity field is simulated in the computer by specifying the flow characteristics in a combination analytic-random fashion. In principle the adequacy of the simulated turbulence can be checked by comparing the simulated Reynolds stress functions, velocity correlation functions and power and cross power spectral functions with observations from laboratory and field measurements. Once the simulation model has been judged successful then it can be applied to estuarian diffusion problems.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1067, MIXING, DIFFUSION AND CIRCULATION RATES IN OCEAN WATERS
W.S. BROECKER, Columbia University, Lamont Doherty Geolog. Observ., *Palisades, New York* 10964 (AT(30-1)2663)

Studies of the circulation and diffusive mixing in the deep and bottom waters will be carried out at several points in the ocean using the STD and radon techniques. Dye tracer experiments will be undertaken in near surface waters. Preparations for the GEOSECS program will continue. Our group will also participate in the JOIDES pore water program. Studies of gas exchange rates of CO2, O2 and radon in the laboratory and at sea will proceed as will investigations of the oceanic chemistry of Ba, Ra, and Pb.

Results: Measurement of exchange rates and residence time of the major water masses of the world through radioisotope techniques.

SUPPORTED BY U.S. Atomic Energy Commission

2.1068, INORGANIC SULFUR OXIDATION BY IRON-OXIDIZING BACTERIA
D.G. LUNDGREN, Syracuse University, Biological Research Labs., *Syracuse, New York* 13210

The objective of the research is to determine the role of biological sulfur oxidation by iron-oxidizing bacteria in mine water wastes. Reduced sulfur compounds are associated with iron containing materials (pyrites) present in coal which can serve as potential energy sources for these bacteria. Their oxidation can contribute to water pollution associated with both acid and alkaline mine discharges. Specifically, the enzymes (and the reactions catalyzed) involved in the oxidation of reduced sulfur compounds are being identified and characterized. The sulfur oxidizing enzyme, thiosulfate oxidizing enzyme, and the thiousulfate splitting enzyme have been isolated from Ferrobacillus ferroxidans. The important enzymes APS reductase and sulfite cytochrome c reductase have yet to be demonstrated in iron-grown bacteria. The effect of the presence of organic materials upon the aforementioned enzymes is also to be investigated. F ferroxidans is capable of growth on certain organic substrates which alters its autotrophic mode of life.

Sulfur and thiosulfate oxidizing bacteria have been isolated from alkaline mine drainage and their role in certain alkaline wastes is being assessed. Two organisms have been isolated: one produces some acid from thiosulfite oxidation, whereas the other produces alkaline products. How these organisms are related to those found in acid wastes and their contribution to pollution is being determined.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1069, OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA
H.T. ODUM, Univ. of North Carolina, Inst. of Marine Science, *Chapel Hill, North Carolina* 27514

This project will provide information on the feasibility of establishing associations of organisms in estuaries which can process man's wastes, metabolize inflow, develop the missing loops of the mineral cycles, and channel the fertility into one or more populations with food potential. Nine marine ponds will be constructed in a high marsh area along the coast of North Carolina. Three of the ponds will be continually seeded with mixtures of marine organisms (larvae, adults, plankton, micro-organisms, etc.) and will receive a steady flow of urban waste mixed with sea water. Three ponds will be seeded, but will be supplied only with sea water, i.e., no wastes. The remaining three ponds will receive the wastes mixed with sea water, but will not be seeded artificially.

Principal populations, some principal nutrient cycles and the total photosynthetic production and system respiration will be measured. Those populations of larger organisms which develop in large mass will be studied for growth rate and not production per area of meat potential.

SUPPORTED BY U.S. National Science Foundation

2.1070, MICROBIAL DEGRADATION OF HYDROCARBONS
J.J. PERRY, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

This project will investigate the possible use of certain types of bacteria for breaking down oil pollutants in water.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1071, DEGRADATION OF PETROLEUM AND RELATED COMPOUNDS IN THE BIOSPHERE
J.J. PERRY, Univ. of North Carolina, Graduate School, *Raleigh North Carolina* 27607

The research supported by this grant concerns the microbial degradation of hydrocarbon substrates in marine environments. The investigations consist of (1) a survey of the number and distribution of hydrocarbon utilizers in sea water, salt marshes and soil in the coastal regions by means of laboratory cultures of material from these areas, by counts of bacterial colonies that develop on hydro-carbon-coated glass slides after they have been buried for periods of time in selected environments and by determinations of the relative uptake of hydrocarbon by microoganisms in marine soil and water; (2) determinations of substrate specificity of organisms isolated on a single hydrocarbon or a single fraction of petroleum; (3) examination of the ability of organisms isolated in step 2 to grow on that substrate in the presence of crude petroleum or other fractions thereof; (4) studies of the degradation of complex petroleum by a mixed population of microbes that can degrade all the fractions of the complex petroleum; (5) determinations of the other requirements (mineral, vitamin, salinity, etc.) of marine hydrocarbon utilizers; and (6) the rate of turnover for hydrocarbons in marine environments. Data from these investigations will provide a basis for determining the effect of petroleum pollutants on the microbial population of the marine biosphere and the feasibility of cleaning up areas polluted with hydrocarbons by adding microbes which utilize hydrocarbons or by encouraging their growth.

SUPPORTED BY U.S. National Science Foundation

2.1072, THE MICROBIAL DEGRADATION OF HYDROCARBONS IN MARINE ENVIRONMENTS
J.J. PERRY, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

Studies will be conducted on the degradation of hydrocarbon substrates in marine environments. The total number and distribution of hydrocarbon utilizers in sea water, salt marshes, and soil in the coastal region of North Carolina will be investigated. This can be accomplished by plate counts, by counting the number of colonies that develop on hydrocarbon-coated glass slides after they have been buried for periods of time in selected enivronments, and by a determination of the relative uptake of hydrocarbon by the organisms in marine soil or water. The substrate specificity of organisms isolated on a single hydrocarbon or fraction of pertroleum will be determined. The ability of organisms isolated on one hydrocarbon or on a fraction of petroleum to grow on that substrate in the presence of crude petroleum or other fractions thereof will be examined. Studies will be conducted on the degradation of complex petroleum by a combined population of microbes that can degrade all fractions of the complex. The nutritional requirements (mineral, vitamin, etc.) of marine hydrocarbon utilizers will be determined along with the requirement for high salinity.

SUPPORTED BY North Carolina State Government - Raleigh

2.1073, CONCENTRATION OF PHOSPHATES FROM INDUSTRIAL WASTES BY BLUE-GREEN ALGAE
H.E. SCHLICHTING, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

This project proposes to study the abundance and species of blue- green algae in the estuaries and sounds and to determine whether practical use can be made of the ability of the blue-green algae to remove phosphate pollutants from water.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1074, FILTRATION OF KRAFT PULP LIQUOR THROUGH CHIPS
A.J. STAMM, Univ. of North Carolina, School of Forestry, *Raleigh, North Carolina* 27607

The purpose of the project is to investigate the purification of Kraft wash water by utilizing wood chips as a filtering medium. The wash water, containing insufficient pulping chemicals for profitable recovery, will be contacted with wood chips normally kept as inventory stock. In addition to reducing the alkaline pH of the Kraft wash water and adsorbing water soluble chemicals, the wood chips will undergo a mild prepulping action as a result of the contact with the wash water.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1075, EPIDEMIOLOGICAL STUDY OF CORRELATION OF WATER QUALITY AND DISEASE
L.J. MCCABE, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Cincinnati, Ohio*

Objective of the project is to provide a health effects base for water quality standards and water supply practices. There are two aspects of the investigation: one concerns the occurrence of disease that is known to be waterborne -- such as infectious disease outbreaks that are found to be transmitted by water; and the second is the investigation of the occurrence of chronic and metabolic diseases that may be caused or aggravated by organic and inorganic contaminants in drinking water.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1076, STUDY OF WATER CURRENTS AND MOVEMENTS IN LAKE ERIE
W.J. LICK, Case Western Reserve Univ., School of Engineering, *Cleveland, Ohio* 44106

This research will be an extensive study of the circulation and water motions in Lake Erie. The analyses and results will be immediately applicable to, and useful in, pollution control programs.

The general program areas to be investigated are (1) the steady currents, (2) the time-dependent currents, and (3) thermal discharges in Lake Erie. A major emphasis of the program will be an investigation of water movements in a stratified shallow lake. The work will be theoretical and experimental in nature. The analyses will suggest further field observations and it is expected that field work will suggest additional theoretical and experimental work. It is believed that the investigation and solution of these problems will lead to a thorough understanding of the fluid dynamics of Lake Erie and will give a valid basis for pollution control programs.

SUPPORTED BY U.S. National Science Foundation

2.1077, RESEARCH INITIATION - THERMAL DISCHARGES
J.M. PRAHL, Case Western Reserve Univ., School of Engineering, *Cleveland, Ohio* 44106

This research will investigate experimetally the interaction of a warm, turbulent jet of water with a relatively cooler, quiescent basin of water over a range of Froude numbers, density difference ratios, and geometries that is relevant to actual river entrance flows and cooling water return flows to large lakes and oceans. The experiments will be performed on a laboratory sized model of the appropriate scaling. Coriolis effect will be neglected and the receiving basin will be a fluid of uniform density. A water table, 20ft. x 6ft. will be constructed to accommodate the experiments. The incoming jet velocity and temperature will be controlled and measurements of velocity and temperature profiles will be taken by scanning the jet at various locations with hot film anemometer probes and thermo-couples. The results will be recorded on a multichannel recorder. Variations in bottom slope can be accomplished by tilting the table, and end and side effects will be minimized by the judious adjustment of false, porous sides with controlled head behind them to match up with inflow at the sides and outflow at the end.

SUPPORTED BY U.S. National Science Foundation

2.1078, OIL SPILLAGE CONTROL
E.J. MARTIN, Cleveland Dept. of Pub. Util., *Cleveland, Ohio*

The work on this project is intended to solve the problem of removing oil that has been spilled on the surface of a river or lake. The approach will be to foam the oil, remove the foam by vacuum to an area where it is reconverted to a liquid and then to collect the liquid. The investigation will examine surfactant, air dispersing methods, vacuum recovery and foam breaking. These aspects will first be investigated in the laboratory where a choice of materials and techniques will be made. A prototype model for use on large tanks of material will be built and tested. A design for an operating model will be produced.

The work will be done at Horizon's Inc. at 2905 E. 79th Street, Cleveland, Ohio and the Bureau of Industrial Waste on Broadway in Cleveland, Ohio. The project will be started in FY 1970 and be completed in FY 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1079, COMPARATIVE STUDY OF PHYTOPLANKTON IN NEW AND RECLAIMED ACID MINE DRAINAGE PONDS
C.V. RILEY, Kent State University, Graduate School, *Kent, Ohio* 44240

The purpose of the project is threefold: to compare the algal flora of new (very acid) and reclaimed (near neutral) strip mine ponds, to evaluate the role of algae in the reclamation process, and to study the nutrition of algae in an extremely acid ecosystem.

Water samples are taken weekly in both pond types and phytoplankton species identified and enumerated. Routine limnological measurements of pH, dissolved oxygen, hardness, alkalinity, and plant nutrients are also made.

Control and experimental columns of water are isolated in transparent polyethylene bags and resuspended in the ponds. Plant nutrients are added to the experimental bags to determine those ions which may be in limiting concentration in the ponds. The importance of chelators is to be carefully evaluated.

In an effort to estimate the importance of algae in the reclamation process, laboratory algal populations are cultured under semi-natural conditions and changes in water quality with time are studied.

SUPPORTED BY Kent State University

2.1080, STREAM REAERATION
W.R. DUFFER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

The purpose of this investigation is to correlate stream reaeration rates with parameters expressing stream geometry and flow. This work will essentially extend the work of other investigators from tidal estuaries and streams having large flows to low-flow streams which are more representative of the southwestern United States.

In addition, the study will lead to an evaluation of the actual oxygen balance of the system with reference to photosynthesis, respiration, and diffusion. Further, the study will differentiate between these oxygen parameters in both the free-flowing stream and the benthos.

Present investigations are under way at the two test sites in Rock Creek, a stream of the Arbuckle impoundment system. One site is located upstream from a municipal sewage disposal plant, while the other is located downstream from the plant. Both sections of Rock Creek are characterized by limestone substrate. Plastic chambers will be used to separate the effects of photosynthesis, diffusion, and respiration under conditions of very little organic enrichment (upstream) and heavy organic enrichment (downstream).

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1081, REMOVAL OF NUTRIENTS FROM ENRICHED FLOWS & WASTE EFFLUENTS BY THE HYDROPONIC CULTURE OF SUITABLE FORAGE PLANTS & GRASSES
J.P. LAW, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

Hydroponic culture is a well-established method for growing many different types of plants. Normally, solutions are prepared with proper proportions of all required nutrients and are fed to the root systems of the growing plants. Algae have been grown for the removal of nutrients from lagoons receiving sewage effluents, but the difficulty of harvesting the growth makes this an undesirable approach.

It is proposed that higher plants can be successfully grown using a gravel-bed support in specially designed structures for the removal of nutrient materials remaining in waste effluents. Some of the principal objectives of this research are: 1. To improve the quality of surface streams receiving wastes and effluents by the removal of nutrients. 2. Finding the most suitable plants to be grown by this method. 3. Determine economic feasibility of the method, based on expected yield, cost of installation, operation, harvesting methods, etc. 4. Determine quantities of nutrients removed by the process. 5. Propose design criteria for application of the method to waste treatment installations.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1082, MINING-POLLUTION CONTROL TECHNOLOGY - OIL PRODUCTION GROUND-WATER RECLAMATION BY SELECTIVE PUMPING
L.G. MCMILLION, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

This is a field research project designed to develop and demonstrate a method for alleviating brine contamination in ground water reservoirs by selective development and pumping of the contaminated water. The contaminated area to be investigated is similar to many hundreds of other contaminated areas in the southwest, especially in West Texas and New Mexico where localized contamination has resulted from land disposal of oil filed brines. The project will develop guidelines for use by industry and governmental agencies in the correction of groundwater contamination and will report on the practicability of use of poor quality water for secondary oil recovery. Field site for the project is near Hobbs, New Mexico.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1083, RECLAMATION OF POLLUTED FRESHWATER AQUIFERS BY PURGING
P.A. DICKEY, Univ. of Tulsa, Graduate School, *Tulsa, Oklahoma* 74104

The proposed research plan is to investigate the feasibility of using fresh water to purge contaminants from polluted fresh water aquifers.

Records of governmental agencies would be studied, and residents living in areas of pollution would be interviewed. Standard mapping techniques would be employed to locate areas of contamination and to identify sources of contamination. Water testing of samples obtained from polluted wells will be employed.

Laboratory models would be constructed to simulate the performance of the aquifer and results would be scaled upward by simulation on an electronic computer.

A pilot project will be designed with complete cost estimates for the installation and operation of the pilot.

A cost estimate would be made of total aquifer reclamation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1084, COASTAL DIFFUSION OF POLLUTANTS
D.J. BAUMGARTNER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

The Georgia-Pacific Corporation, Toledo, Oregon currently discharges its kraft process pulp mill wastes to an ocean outfall which discharges approximately 6 million gallons per day through a diffuser section at a depth of 40 feet at a distance of 3000 feet off the Oregon Coast at Newport. The dilution achieved by the diffuser process and by the horizontally flowing field under the influence of natural forces will be investigated by frequent sampling of the near coastal waters, plus continuous monitoring of wind direction and speed. Current meters will be installed at various depths and at three locations in the near shore area to determine the relationship between the dilution of the field and the current structure. Additional surface current measurements may have to be made on the basis of drift cards or dye fields. Model tests will be performed in an 8-foot diameter, 3-foot deep tank to reproduce the hydrodynamic characteristics of the diffuser port and the density structure or the wind stress. This should, in addition to improving the methodology for describing jet diffusion, provide a method for estimating the influence of the non-steady current structure in the receiving fluid by comparing the observed performance in the prototype with the observed performance in the controlled model.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1085, ESTUARINE DIFFUSION OF POLLUTANTS
D.J. BAUMGARTNER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

The most general characteristic of pollutants which plays a part in the assessment of their fate is concentration. Since the concentration is a function of its dilution in the environment as a result of mixing and diffusion, as well as decay of the component, it is of considerable importance to be able to determine how the concentration of a pollutant will vary in the receiving water at various locations and perhaps at various times if the pollutant or the environment is not in steady state.

Uncertainty exists with regard to the value of the turbulent diffusion coefficient to be used in problem analysis. To provide a means of determining this value at points in time and space, as well as providing additional understanding of the forces which influence estuarine diffusion, a predictive model of salinity will be constructed on the basis of time series analysis of observations in Yaquina Bay, Oregon.

Continuous recording salinometers will be installed approximately every five miles along Yaquina Bay to obtain the record of the time variation of salinity at the surface. Once a week, vertical traverses of salinity will be obtained to provide information on the vertical stratification in the estuary. If necessary, additional salinometers will be placed near the bottom to obtain information on the vertical distribution. Fresh water inflow will be estimated by stream gauging of the three principal surface streams in the area. Direct runoff and direct rainfall can be estimated. Information on tide height and frequency will be obtained from three tide gauges, while continuous information on wind speed and direction will be obtained at the entrance to the bay and other locations if necessary.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1086, MOVEMENT OF RADIONUCLIDES IN THE LOWER COLUMBIA RIVER
W.L. HAUSHILD, U.S. Dept. of the Interior, Geological Survey, *Portland, Oregon* 97208

The objective of this project is to quantitatively determine the concentrations and loads of specific radionuclides that are solutes and sorbed on sediments in the Columbia River from Hanford, Washington to the estuary. The spatial and temporal variation and distribution of the radionuclide concentration and loads are to be studied, and an approximate budget of the radionuclides is to be determined.

The physical, chemical and mineral properties of the suspended and streambed sediments are being studied; and these properties, insofar as is possible, will be related to sediment transport, sorbed radionuclides, and the equilibrium balance between the solute and sorbed radionuclide phases.

The extent and characteristics of sediments deposited on the streambed and sorption of radionuclides by these sediments in the

natural channel, reservoir, and tidal-affected reaches are being surveyed.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1087, TRANSPORT OF SOLID SUSPENSION IN CONDUITS

W.H. GRAF, Lehigh University, School of Engineering, *Bethlehem, Pennsylvania* 18015

This proposal results from ideas formulated by the principal investigator during work on the project, 'The Transport of Solid Suspension in Conduits,' sponsored by the Federal Water Pollution Control Administration of the U. S. Department of Interior (research grant - WP-00838). Essentially, this proposal outlines further research to be done as a continuation of the present project. The research will be divided into two parts: (1) Design criteria for minimum transport velocities of non-depositing solid - liquid mixtures in pipe lines will be investigated. Only recently, the progress report of ASCE's Combined Sewer Separation Project points out a complete lack of data in this area. The proposed research will try to provide a modest contribution to adequate combined-sewer design, focusing primarily on suspended pressure conduit. (2) Further development of the modified Venturi meter to measure mixture flow rate and concentration simultaneously is suggested.

It is believed that the proposed research will provide further knowledge about the design of conduits transporting solid - liquid mixtures.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1088, RESPIRATION OF AQUATIC MACROPHYTES IN EUTROPHIC SYSTEMS

A.J. MCDONNELL, Penn. State University, Inst. for Res. on Land & Water, *University Park, Pennsylvania* 16802

The investigation is intended to incorporate results of prior laboratory studies on aquatic plant respiration into a model for stream analyses. Three basic models defining the control of oxygen uptake by (a) simple diffusion, (b) diffusion with reaction and (c) diffusion with reaction and internal storage will be structured. Simulation of the proposed models on an analog computer and subsequent comparison of computer output with observed data will follow.

The resulting mechanism will be incorporated into a stream oxygen model to demonstrate its applicability to calculation of the waste assimilation capacity of receiving streams and the evaluation of primary productivity in eutrophic streams.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1089, MUNICIPAL WATERSHEDS, URBAN-SUBURBAN TREES AND ENVIRONMENT, AND CORRELATING WATERSHED RESEARCH RESULTS

H.W. LULL, U.S. Dept. of Agriculture, N.E. Forest & Range Expt. Sta., *Upper Darby, Pennsylvania* 19082 (NE1603)

OBJECTIVE: Determination of sound management practices for municipal water yield and quality in the Northeast; determining how much the human environment is affected by urban and suburban trees and forest; and prediction of effects of forest watershed management practices in eastern U.S. from evaluation of all knowledge available.

APPROACH: Conduct cooperative studies on municipal watersheds on the effect of forest treatment on water-yield increases. Determine by field measurement the influence of species, age and spacing of street trees, residential-lot plantings, forested parks, and greenbelts on local climate, comfort indices, house-heating and -cooling, and disposition of storm runoff. Observe and evaluate projects of waste- water disposal on wooded lands. Analyze long-term streamflow records, available research results, and historical land use with respect to hydrologic condition of forest land and streamflow yield and distribution.

PROGRESS: A survey of municipal watersheds in the Northeast has found over 750 municipalities that derive water supplies or water-supply protection from city, state, or federal forested lands. Their total area is over 2 million acres. Forty-one percent is municipally-owned, 13 percent in private ownership, 36 percent in state lands, and 10 percent in federal. Timber harvesting is allowed by 54 percent of the municipalities and recreation-use by 59 percent. Watershed managers are principally concerned about water quality control, water yield management, and recreation. Sources of contamination: urban areas 38 percent of the 750 properties, recreation 36, industry 13, and logging 9 percent. Research has shown, country-wide, that substantial increases in annual water yield may be obtained by clearcutting, and substituting a protective ground cover, at levels of from 3 to 10 inches in the East and 2 to 18 inches in the West, varying with forest type and climate. Smaller increases can be derived from even-aged management under sustained yield programs. Costs of obtaining increased water yields are well below costs of distilling sea water, transmitting water from surplus to water-short regions, or water harvesting. Forecasts suggest that increased water yield from forest management, conservatively, could supply 50 percent of increased consumptive use expected by year 2020.

SUPPORTED BY U.S. Dept. of Agriculture

2.1090, DISPOSAL OF SLUDGE FROM ACID MINE DRAINAGE TREATMENT PLANTS

F.W. NIGGEMYER, Hi Hillsranch Incorporated, *Waynesburg, Pennsylvania* 15370

The objectives of this research and demonstration are to show that the sludge from the acid mine neutralization plants can be dispersed on the soil without pollution to the streams or ground water and also provide filteration of the solids without harm to the soil or vegetation. Unsettled lime neutralized mine drainings will be sprayed to demonstrate that sprinkler irrigation can be used to aerate the waste to remove the iron and the soil used to filter the solids. Controlled runoff will be maintained at the site. Various sprinkler types and vegetative cover will be used to optimize this operation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1091, PHARMACOLOGY

J. DEFEO, Univ. of Rhode Island, School of Pharmacy, *Kingston, Rhode Island* 02881

One of our projects involves the subjection of a large number of extracts of marine plants and animals prepared by the pharmacognosy department of our college to a variety of in vivo and in vitro testing procedures to determine any pharmacological activity which might eventually lead to the isolation of a compound that would have importance medically or as an aid in experimentation on biological systems. The significance, therefore, lies in the possibility of finding either a new drug or a new source of an old drug.

Studies are also being conducted to determine what reactions marine organisms are capable of carrying out in metabolizing foreign organic compounds with which they may come into contact. These reactions are important in the handling of pollutants and their subsequent toxicity to the marine organisms themselves and other members of the food chain. In addition the experiments are designed to give information on the phylogenetic development of these metabolizing systems.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1092, BIOCHEMICAL OXIDATION OF HYDROCARBONS IN NATURAL WATERS

C.W. HOUSTON, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

The proposed study involves the investigation of microbial degradation of hydrocarbons in natural waters. Although a great deal is known about the bacteria affecting health, relatively little is known about bacteria and biochemical processes that are fundamental to the assimilation of waste products that get into natural waters.

It is intended to evaluate factors which influence the clearance of hydrocarbons for natural waters by - 1. determining cultural conditions and composition in a natural water source and studying the dynamics of the system by a continuous culture study in a simulated environment; 2. investigating the role of co-oxida-

tion phenomenon in the accumulation of toxic hydrocarbon intermediates; 3. correlating the amount, type and the degradation rate of hydrocarbons to seasonal and cultural parameters for the purpose of recommending a suitable decontamination policy.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1093, DIFFUSION OF THERMALLY BUOYANT WATER JETS INTO A MOVING WATER STREAM
F.L. TEST, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

This project is concerned with the behavior of a two-dimensional plane jet of high temperature water diffusing into a moving water stream. The objective will be to determine by analytical and experimental means the velocity components and temperatures in the region of the diffusing jet as a function of turbulence level, stream velocity, jet velocity, jet angle, density difference, and relative geometry of stream and jet.

The experimental portion of the project will consist of studies of velocity and temperature perturbations resulting from warm water injected by a plane jet into open channel flow. Velocities and temperatures will be measured by hot film probes and thermistors, respectively. The analytical procedure will attempt to determine the solution to the diffusion problem from the basis of a theoretical model.

The results of this project can be used to improve the design of outlets for the discharge of high temperature water into moving streams.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1094, DEVELOPMENT OF A PROTOTYPE FOR REMOVAL OF ORGANICS FROM WATER
B.H. PRINGLE, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

For some time, use has been made of a carbon filter system for removal of organics from water supplies and extracted by chloroform and/or alcohol. The weight of these evaporated extracts has been used as a measure of the organics present in such supplies. This collection system itself is fraught with disadvantages, such as: (1) all organics are not removed in the collection process; (2) some organics are either not removed or only partially so; (3) there is interaction between organic molecules on the filter due to time; temperature, oxygen, and bacteria, results in compounds being formed which are not originally found in the water itself; (4) the weighed extracts are numbers representing no direct relation to public health. It is planned, therefore, to attempt to remove the first three disadvantages of the carbon filter system through the development of a closed extraction system. The fourth disadvantage, that of health implication of those organics found in water, will be reviewed. It is proposed, through the Sub-Committee on Organics other than Pesticides of the Public Health Drinking Water Standard Revision Committee, to attempt to derive a system for grouping organics such that a quantitation of the health implication of these materials might be obtained. This is also now under study.

Objectives: To develop a prototype system for the complete removal of organics from water such as to maintain the original identity of each particular compound contained in the water sample.

Accomplishments through FY-1970: Library research on procedures for removal of organics from water were continued.

Plans for FY-1971: Library research will be completed following which one or two procedures will be studied in the laboratory for their effectiveness in removal of various groups of organics which might be found in drinking water supplies. It is then planned, on the basis of this particular study to select the system found to be most effective for organic removal.

A pilot model prototype will be designed around the system selected. The prototype will then undergo study using various organic group systems as models. It will finally be tested with selected water systems for operational effectiveness. Finally, it will be field tested from which results, a field model will be derived. It is hoped that a laboratory prototype may be developed by the end of FY-71.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1095, COLD WATER STUDIES - WALLUM LAKE
J.A. STOLGITIS, State Div. of Conservation, *Providence, Rhode Island* 02903

Objectives: To correct an acid condition in Wallum Lake through the application of ground limestone.

Procedures: This project will be a joint venture between the Massachusetts Division of Fish and Game and the Rhode Island Division of Conservation. Massachusetts will contribute one-half of the materials and labor involved in application. Rhode Island will, in addition, research the project and monitor the effects of liming. A summary of water quality data will be assembled. Also, the monitoring of water quality will continue at least quarterly throughout the duration of the project and annually therafter under Pond Surveys, Job I,I. Collections of bottom sediments will be analyzed to delimit exchange capacities prior to and following application of lime. Results will be published in a suitable journal.

Crushed limestone will be spread on the ice during February using farm tractors and fertilizer spreaders. A total of 350 tons of lime will be applied, which is approximately equal to 75 pounds per acre foot. It is anticipated that, at this rate of application, the pH can be raised at least 1.0 unit. It is also anticipated that a replicate application will be necessary during 1972. Evaluation during the summer of 1972 will dictate degree of success and direction of pursuit in the management of Wallum Lake.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1096, TEMPERATURE DISTRIBUTION IN THE VICINITY OF WASTE HEAT DISCHARGES
M.A. CHURCHILL, U.S. Tennessee Valley Auth., Div. of Environ. Res. & Dev., *Chattanooga, Tennessee* 37401

Research will provide means for predicting temporal and spatial distribution of excess heat in streams receiving condenser cooling water from steam-electric generating plants. This involves development of correlations for describing and predicting cooling rates based on meteorological data. The study also includes the development of mathematical models which account for the combined effects of cooling and mixing in rivers and reservoirs. There is particular interest in situations where the warm water, due to its lower density, stratifies in the surface layers of the receiving stream or reservoir and there loses much of its excess heat to the atmosphere before mixing takes place. Extensive data have been collected for such a thermally stratified river. Heat is distributed across the river immediately below the discharge allowing the situation to be analyzed as two dimensional.

Several more complex situations will provide data for the evaluation of temperature distribution in three dimensions. This situation occurs when discharge is into a reservoir or larger river. Data obtained below existing power plants will be used in developing and verifying the prediction methods.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1097, TRANSIENT FLOW MODEL FOR BETTER WATER QUALITY CONTROL, KENTUCKY RESERVOIR
B.J BUEHLER, U.S. Tennessee Valley Auth., *Knoxville, Tennessee* 37902

A mathematical model of Kentucky Reservoir is now under development to permit accurate determination of the transient flow at any point along the 184-mile-long reservoir. The transient flow is created by independent hydroplant operations at each end of the reservoir and by an uncontrolled canal connecting Kentucky Reservoir to Barkley Reservoir. Continuous knowledge of transient reservoir conditions are desirable to permit the controlled release of waste discharges to the reservoir in order to maintain high dilution and good water quality. As now envisioned, the model will be used to make 24-hour forecasts of the transient flows based on planned operations of the upstream and downstream hydroplants and the canal.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1098, TURBULENT MIXING IN SUBMERGED TWO-DIMENSIONAL WALL JETS

C.J. REMENYIK, Univ. of Tennessee, School of Engineering, *Knoxville, Tennessee* 37916

This project is concerned with turbulent mixing mechanisms which result as a stream of water bearing soluble or thermal pollutants is discharged into a second stream. The research objective is to provide fundamental information useful for engineering predictions of the pollutant concentration in the vicinity of the stream junction.

Applicability of the concept of eddy diffusivity to mixing flows will be investigated. The experiments will involve the measurement of Reynolds stress distributions in a two-dimensional wall jet of air.

Need for such an investigation is indicated by previous research which produced evidence that the application of the concept of eddy diffusivity to mixing streams may not be valid.

Goals: 1. Verify findings of last paragraph with (1a) A higher degree of accuracy than was possible previously and (1b) to do that by an independent method. 1a. Will be achieved with a hot wire anemometer equipped with a new linearizer circuit. 1b. Will be achieved by a single rotated hot wire method. 2. Gather experimental information to establish quantitatively details of the relationship between the turbulent shear stress and velocity distributions. The results will be used to construct a model modifying or replacing the concept of eddy diffusivity.

The results of this study will be applicable through scaling to the solution of problems existing today in the Southeastern United States due to thermal and chemical pollution of streams and lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1099, CENTER FOR RESEARCH AND TRAINING IN HYDRAULIC AND HYDROLOGIC ASPECTS OF WATER POLLUTION CONTROL

P.A. KRENKEL, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

To formally establish a training and research center for the study of the hydraulic and hydrologic factors affecting water pollution control; to continue existing research endeavors in this area of study, and to instigate new investigations utilizing the Tennessee Valley Authority and the Corps of Engineers reservoirs as 'laboratories;' to establish an information retrieval center for the subject area that would be of world-wide value; to eventually construct a building solely for the purposes described herein; and to continue and expand the existing training program designed to produce engineers knowledgeable in hydraulics, hydrology, and wate pollution control. The project will be coordinated by a joint committee, comprised of members of the Federal Water Pollution Control Administration and Vanderbilt University.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1100, NATIONAL SYMPOSIUM ON THERMAL POLLUTION

P.A. KRENKEL, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

Project Objectives: To illustrate the need for research in thermal pollution, to elucidate the problems involved and their magnitude, to satisfy the need for exchange and dissemination of information concerning the thermal pollution problems confronting industry, municipalities and regulatory agencies involved in water pollution control work and to present the present state of knowledge in this rapidly growing field.

Plan of Operation: Two symposia will be held; one in Portland, Oregon, concerned with the biological and chemical aspects of thermal pollution; and the other at Vanderbilt University involving the engineering and economic aspects of thermal pollution. The meeting will be co-sponsored by Vanderbilt University and the Federal Water Pollution Control Administration and will utilize the most competent people available.

Need for Project: The United States has more than doubled its electrical power production every ten years since 1935 and the corresponding increasing quantity of heated water discharged to our receiving waters is expected to continue to more than proportionately increase. A definite need exists to increase public and technical awareness of the problems caused by thermal pollution and to stimulate research and adequate water quality management of water temperature.

D. Facilities Available: The staff and faculty of Vanderbilt University and the Federal Water Pollution Control Administration will cooperate in planning the conferences and making the necessary arrangements. In Portland, the Bonneville Power Administration Auditorium will be used for the meetings and the Sheraton Motor Inn for accomodations. The Nashville Meeting will utilize the facilities of Vanderbilt University.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1101, DISCHARGE OF NEGATIVELY BUOYANT FLUIDS

F.L. PARKER, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

Discharges from industrial plants containing higher concentrations of impurities than in the ambient fluid will act as negatively buoyant jets. It is possible for heated discharges, if the water was originally taken from cold hypolimnetic waters and discharged to warm epilimnetic waters to act also as negatively buoyant jets. The means of achieving uniform mixtures of the jets and the ambient fluids will be sought. The problem of discharge of a salt solution heavier than the ambient receiving fluid has already been studied. Parameters to be more comprehensively treated include the river densimetric Froude number; the jet densimetric Froude number; the jet angle with the vertical; the number, size and spacing of the jet ports, Those parameters can be varied by changing jet velocities, jet densities, and flume flow. The study of density stratification in the receiving fluid would also be studied. The items of ultimate interest are the definition of the distance required for attainment of a uniformly mixed profile. Those conditions most conducive to such mixing will be sought, as well as defining situations wherein complete mixing does not occur, for example, in a layer along the bottom. Preliminary data indicates that the data net may have to be increased near the jets and near the bottom to adequately define the movement of the jet material. If the initial jet momentum is insufficient to provide uniform mixing, downstream sections will be observed to detect further mixing due to dispersion and turbulent diffusion. Little work has been done in defining diffusion parameters in those cases where density differences exist; this shortcoming also exists for treatment of heated discharges. Concurrent with data collection and analysis, efforts will be made to use principles of fluid mechanics and mixing processes for establishing mathematical models. This project was begun in July 1969 and is scheduled for completion in September 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1102, TURBULENT DIFFUSION AND REAERATION IN NATURAL RIVERS

E.L. THACKSTON, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

Project Objective - To demonstrate the utility of refined tracer techniques in measuring flow times and dispersion in stratified reservoirs, with analysis of tracer to be made by activation analysis techniques; and to analyze newly available data on reaeration rates in natural rivers to test and demonstrate the applicability of theoretical mathematical models recently developed at Vanderbilt describing reaeration in natural rivers.

Plan of Operation -Tracer tests in a reservoir have already been performed and samples taken. They will be analyzed by activation analysis to produce time-concentration curves. New reaeration data will be obtained from Professor Ernest Tsivoglou at Georgia Tech. Some old data will be made useful by gathering hydraulic data not presently available on the streams used. All data will be processed and analyzed using a digital computer.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1103, EFFECT OF GEOGRAPHICAL LOCATION ON COOLING POND REQUIREMENTS AND PERFORMANCE
E.L. THACKSTON, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

The completion end result of this project will be the publication of a handbook on cooling pond sizes for various geographical locations in the United States. Such a publication will be of great value to Federal and State personnel responsible for the prevention of thermal pollution. It will be possible to determine reasonable sizes of cooling ponds for various sizes of power plants in different parts of the country. If the proposed plans do not conform to these average values, then more detailed scientific justification of the pond size chosen would have to be provided. The equilibrium temperatures have been calculated, the heat exchange coefficients have been determined and the net plant temperature rise for 1500-acre ponds for locations throughout the country have also been determined for 1000 megawatt plants. This project was begun in May 1969 and is scheduled for completion in August 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1104, WATER QUALITY CONTROL
R.A. ELDER, U.S. Tennessee Valley Auth., Engineering Laboratory, *Norris, Tennessee* 37828

TVA is conducting research to develop engineering methods which can be used in the planning, design, and operation of river and reservoir water control structures associated with multipurpose water resource projects for management of water quality as well as water quantity. Specifically, the water quality management problem consists of developing methods of predicting water temperatures, dissolved oxygen concentrations, and flow patterns upstream from, within, and downstream from existing and proposed reservoirs for a given reservoir inflow- outflow program, including the effects of locating thermal or other industrial plants upstream from, on, or downstream from the reservoir. The ultimate goal of this research is to provide information needed to operate river and reservoir systems so as to make the best possible use of the water from the standpoints of quality and quantity.

The Engineering Laboratory is engaged in a continuing program of studies aimed at solving some related specific problems. Since 1965, studies have been conducted of the thermohydrodynamics of flows through several of TVA's existing reservoirs. A procedure was developed for predicting withdrawal layer thicknesses and internal flow distribution. Also a method was developed to predict the approximate discharge temperatures and dissolved oxygen concentrations from reservoirs. An effort was made to combine the laboratory's heat transfer studies with a mathematical model of reservoir stratification which was developed independently by one of the laboratory's consultants.

Important adjuncts to these basic studies are comprehensive field studies which are undertaken to verify the developed methods. To obtain simultaneous data on the many important factors which influence the temperature and certain other water quality characteristics of the outflow from a stratified reservoir, an intensive one-year study was made at TVA's 29-mile-long, 450-foot deep Fontana Reservoir in 1966. The analyses of these data is in progress.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1105, WASTE DISPOSAL BY HYDRAULIC FRACTURING
K.E. COWSER, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831

The hydraulic fracturing project is directed toward the ultimate disposal of intermediate-level liquid waste into deep, subsurface geologic formations, and the development of techniques to evaluate the suitability of a site for disposal by hydraulic fracturing. The specific objectives of the project are - (1) to improve the technique of hydraulic fracturing for ultimate disposal of radioactive wastes to the point of unqualified endorsement, (2) to validate new methods of presite testing, such as seismic techniques to locate the position and determine the orientation of induced fractures, (3) to demonstrate the applicability of the hydraulic fracturing method in a different geologic setting (western New York), and (4) to investigate hydraulic fracturing as a tool to measure the state of stress in the earth's crust, thus furnishing needed information to evaluate the site potential for waste disposal by hydraulic fracturing.

A 1500-foot-deep core hole was drilled in western New York State to explore the geology. This hole was then cased to convert it into an observation well. Three more observation wells were drilled at the corners of a square, and an injection well, also 1500 feet deep, was drilled at the center. A preliminary test injection of some 114,000 gallons of water was made at 1450 feet. It would appear that this injection resulted in a complex fracture pattern. The evaluation will not be complete until results of a radioactive tracer injection are available.

SUPPORTED BY U.S. Atomic Energy Commission

2.1106, RELATION OF PASS OPENINGS ON PHYSICAL EXCHANGE AND SALINITY IN ESTUARIES
F.D. MASCH, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

It is generally accepted that there is not enough fresh water to meet the State of Texas' inland water requirements, and at the same time provide the fresh water necessary to maintain fisheries, pollution control, and recreation in the coastal bays and estuaries. Consequently, alternatives for meeting the desired salinity distribution and pollution control requirements in estuarine waters must be considered.

Most of the estuaries along the Texas Gulf Coast are separated from the Gulf of Mexico by a long thin chain of offshore or barrier islands. The exchange between gulf and bay waters takes place through a few natural and artificial passes through the barrier islands. It is the principle objective of this proposed project to determine whether the physical exchange of waters between the bays and gulf can be increased by either dredging new passes, or by enlarging existing passes through the barrier islands. In particular, the effects of modifications or additions of passes on the volume of physical exchange, the degree of mixing, and on salinity gradients is to be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1107, HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE
F.D. MASCH, Univ. of Texas, School of Engineering, *Austin, Texas* 78712 (C-1158)

This proposed research involves the development and verification of a numerical model to evaluate transport characteristics in shallow vertically-mixed estuaries of irregular shape. The model is designed to assist in developing water quality requirements and evaluating the assimilative capabilities of the shallow irregular estuaries found along the Gulf Coast of the United States.

The study includes the following three phases: 1. Adaptation of an explicit numerical model of the two-dimensional convective dispersion equation to the irregularly-shaped estuary. 2. Evaluation of the dispersion coefficients from graphical and analytical considerations of the circulation and scale of turbulence in the estuary. 3. Verification of Phases 1 and 2 in a hydraulic model and then in the field.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1108, MIXING AND DISPERSION OF CONTAMINANTS IN RESERVOIRS
F.D. MASCH, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

Field studies on the dispersion of a conservative tracer have been made in Lake Travis, Texas, a deep fresh water reservoir in which the predominant currents are generated by the wind. The purpose of the study was to examine the current velocity distribu-

tion with depth, the rate of dilution, and the dispersion coefficients for correlation with such parameters as the surface velocity and wave conditions. In all cases, time scales were limited to six hours and all tracer releases were made at the surface.

Results show that vertical and lateral diffusivities increase with the energy in the wave spectrum, but longitudinal diffusivity decreases. The dominant mechanisms for dispersion appears to be the shear flow mixing resulting from the vertical distribution of velocity.

The peak concentration in a dispersing cloud was found to decrease with the -2.5 power of time. This rate appears to be independent of the ambient conditions and the geometric characteristics of the site.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1109, METAL ION-CATALYZED OXIDATION OF PHENOLS AND AROMATIC AMINES

A.E. MARTELL, Texas A & M University System, Graduate School, *College Station, Texas* 77843

The purpose of this investigation is to study the kinetics and mechanisms of the oxidation of phenols and aromatic amines by molecular oxygen in the presence of manganese salts, and of other metal salts, as catalysts. Such reactions are of interest because of the use of permanganate, and because of the presence of compounds of other metals, in the purification of water containing phenols and aromatic amines derived from industrial contamination. Understanding of the reactions by which these substances are oxidized to innocuous compounds is expected to lead to improvements in methods of water purification.

The oxidation of phenols and aromatic amines will be studied with various oxidation states of manganese, and with the higher oxidation states of other metal ions such as iron, cobalt, and vanadium, as oxidizing agents. Similar reactions with molecular oxygen, in which the metal compounds have catalytic functions, will also be studied. Oxygen insertion reactions of the oxyanions of the metals will be investigated with isotopic 0-18 tracers. Special attention will be paid to oxygen- carrier systems in which the metal ions form complexes with molecular oxygen that are useful in the oxidation of organic compounds.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1110, FEASIBILITY OF THE USE OF LOCAL SOILS AS ION EXCHANGE MATERIALS FOR DISPOSAL OF LIQUID RADIOACTIVE WASTE INTO THE GROUND

K. MAHMOUD, Atomic Energy Establishment, *Cairo, United Arab Republic*

A study of the feasibility of the use of local soils as ion exchange materials for disposal of liquid radioactive waste into the ground.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

2.1111, MULTILAYER FILTRATION

K.J. IVES, Univ. Coll., *London, England, United Kingdom*

The theory of the filtration of water or wastewater through deep granular beds indicates that an improvement in design can be obtained if the size of the granular media decreases in the direction of flow. This has been demonstrated experimentally for particulate suspension in water by filtering in an upflow direction through size-graded sand, or by downflow through three layers of coarse anthracite, medium size sand and fine garnet. The three-layer design is to be tested for the filtration of flocculent metal hydroxide suspensions, and compared with normal sand filtration. Various arrangements of grain sizes and layer thickness will be tried to determine an optimum design. This aspect will also be explored theoretically. Other media (e.g., magnetite, glass beads, crushed flint, plastics) will be examined to see if they are of any practical use, and to see if the three-layer concept can be extended to several layers.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1112, EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE

W.T. HELM, Utah State University, School of Natural Resources, *Logan, Utah* 84321

Bear Lake at the present time is a clear oligotrophic lake. With the recent increase in recreational use of the area, however, a number of boat harbors and breakwaters have been constructed. These structures have interrupted the normal shoreline currents. Along unprotected shores, the currents scour the bottom, limiting the amount and diversity of rooted vegetation and bottom organisms. Modification of this habitat by creating relatively quiet pockets protected from the wind driven water currents has encouraged the growth of a wide variety of organisms. The non-turbulent circulation pattern in these areas insures the retention of at least part of any intruding nutrient-rich water. The reactions of the rooted vegetation and benthic invertebrates to this altered environment will provide an assessment of the advisability of permitting such manipulations of the environment.

Measurements of selected physical and chemical parameters will be made at distances of a few millimeters to a meter or more from the bottom. Samples of plants and animals living on and in the bottom sediments will be collected in the same areas to determine how the differences in environment are expressed in the biota. Samples will be obtained from regions sheltered by breakwaters and harbors as well as from open, exposed littoral regions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1113, WATER MEASUREMENT AND APPLICATION DEVICES

C.W. LAURITZEN, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00496)

OBJECTIVE: Develop methods of measuring and diverting water; methods of removing trash and sediment from irrigation water, and methods of handling and transporting movable irrigation and water application systems.

APPROACH: Devices for measuring and diverting water and handling and moving tubing will be designed, constructed and tested. Models will be built and tested under controlled conditions; and later, full-scale structures will be built and tested under operating conditions.

PROGRESS: It was demonstrated that lay-flat tubing could be installed as an underground conveyance structure. Still to be determined, however, are material requirements for the tubing and the conditions and operational techniques that will govern the probability of this approach as a method for conveying and distributing irrigation water.

SUPPORTED BY Utah State Government

2.1114, OPTIMUM DESIGN OF WASTE STABILIZATION PONDS

G.Z. WATTERS, Utah State University, School of Engineering, *Logan, Utah* 84321

This project will involve the measurement of flow circulation patterns and temperature distributions in the existing waste stabilization ponds operated by the city of Logan. The degree of density stratification will be observed and its effect on circulation patterns will be sought. The effect of wind on mixing will be measured.

With this information, a hydraulic model will be built and used to determine an optimum shape and hydraulic operation to best achieve optimum sewage treatment. Consideration will be given to location and types of inlets and outlets and placement of baffle systems, which will insure that the largest percentage of water will remain in the ponds the required treatment period.

The dispersion characteristics and general circulation patterns in the ponds will be evaluated by introducing fluorescent dye at the entrance to the pond and sampling periodically at predetermined grid points. The temperature of the samples will be measured and the samples will be sent to other researchers for bacterial and biological evaluations.

2. WATER QUALITY

The hydraulic model will be constructed in the Utah Water Research Laboratory. The model will have adjustable walls which can be formed into a large variety of shapes. By using different temperature waters it is hoped to model the effects of density currents.

The data from the field and model investigations will be used to formulate design recommendations and procedures for more efficient operation of waste stabilization ponds.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1115, LAKE DIKING AS A WATER POLLUTION MANAGEMENT TOOL
D.K. FUHRIMAN, Brigham Young University, School of Engineering, *Provo, Utah* 84601

This research will include the investigation of various alternative schemes for the location and operation of dike systems for Utah Lake as related to the water quality of the lake and the effect of the quality differences on the projected uses of the lake waters. It is expected that these studies will provide recommendations regarding location and management of the dikes which are planned for construction as part of the Central Utah Project, USBR. This project will provide planning and management details to enable better control of water quality as the future development of the lake goes forward. Project started June 1, 1970 and will be completed May 31, 1973.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1116, UNSTEADY FLOW AND SALINE INTRUSION IN ESTUARIES
R.A. BALTZER, U.S. Dept. of the Interior, Geological Survey, *Arlington, Virginia* 22209

It is of fundamental importance to recognize that flow in natural channels is basically unsteady flow. To be sure, the degree of its unsteadiness is often of such minor significance that, with sound reason, such flow can be assumed to be steady flow, thereby taking advantage of greatly simplified analytic representation. Nevertheless, proper and thorough understanding of the mechanics of unsteady flow is important per se in determining the discharge of regulated streams, in flood routing, in determining flows in tidal reaches of homogeneous density, and, in fact, in any situation where open-channel flow cannot be assumed to be steady flow. Moreover, an understanding of the mechanics of unsteady flow is fundamental to improving the understanding of saline intrusion and diffusion in estuaries.

The ultimate objective of this investigation is the development of mathematical models representing unsteady open-channel flow, particularly as associated with estuarine channels. These models, hopefully, could then be used to predict-- or using certain field obtained parameters -- to determine such quantities as outflow, saline intrusion, and effects of channel changes upon flow.

A thorough appraisal of present knowledge of unsteady, open-channel flow is being conducted, including categorization of flow types and their required mathematical representation. Mathematical models will be derived and evaluated utilizing various solution techniques employing both analog and high-speed digital computers. Selected field data will be employed in the evaluation process.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1117, POTOMAC RIVER BASIN PROJECT
F.W. TRAINER, U.S. Dept. of the Interior, Geological Survey, *Arlington, Virginia* 22209

Streamflow augmentation through ground-water manipulation may offer a significant opportunity for increasing the flow of the Potomac River during late summer and early fall, when river flow is critically low for water-supply and waste-flushing needs in the Washington area. Ground water provides the low-flow discharge of the surface streams. The ground-water flow system is poorly understood, however, and additional studies are needed to determine the nature of ground-water discharge to the streams, in area and in time.

The study consists of two parts: (1) investigation of alluvial deposits, principally floodplain deposits along the Potomac River and its major tributaries; and (2) study of the consolidated rocks of the basin, with principal emphasis on limestones of the Applachian Valley. The following principal activities are planned: (a) Preparation of a geohydrologic map and supporting maps (e.g. water-table maps) and of an analog-study model. Both map and model are to be revised as necessary. They will provide the basis for planning the other studies below. (b) Reconnaissance of alluvial deposits (mapping, test-augering, geophysical work). (c) Limestone hydrology. (d) Supporting studies (stream- discharge studies, well inventory, observation-well program, quality-of-water studies of stream and ground waters). (e) Basic hydrology (several small studies of such topics as geochemistry of stream water, land-use problems, small-basin hydrology, and quantitative geomorphology).

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1118, IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS
S.W. BINGHAM, Virginia Polytechnic Institute, School of Agriculture, *Blacksburg, Virginia* 24061

The proposed research involves investigations directed at the determination of the fate of pesticides in water and aquatic environment. The main approach is to determine the effectiveness of various aquatic plants for removal of pesticide residues from water.

In the growth chamber and greenhouse, radioisotopic methods will be used to evaluate the effectiveness of selected aquatic plants for degradation of residual pesticides. The plant tissues and water in the cultures will be sampled and radioassayed at intervals after exposure to radioisotopically labeled pesticides. Quantitative changes of the pesticide levels in the water and tissues will be determined by low background gas flow counting and/or liquid scintillation spectrometry of ground plant material, fractional extraction, or nutrient media. Degradation of labeled pesticides in aquatic plants will be evaluated by the collection of carbon dioxide. For partial degradation of the pesticide molecule, chemical extraction, fractionation, and chromatography of authentic compounds and unknowns will be involved.

For these studies, a few relatively new but already economically important pesticides will be selected. In a similar manner, specific aquatic plants that are important weed species will be evaluated for channels of pesticide degradation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1119, THE RECOVERY RATE OF AQUATIC COMMUNITIES OF STREAMS RECEIVING ACID MINE DRAINAGE
J. CAIRNS, Virginia Polytechnic Institute, School of Arts, *Blacksburg, Virginia* 24061

The purpose of this project is to study the biological recovery from acid mine drainage into streams. Several control areas above the entrance of acid mine water will be compared with a substantial number of downstream areas to determine (1) the extent of biological damage, (2) the distance required for recovery, and (3) the influence of sewage, industrial wastes, and tributary streams upon the recovery process. With increased pressure on limited water resources it is essential that stream damaged by acid mine drainage be restored to a condition in which they can serve society in a variety of beneficial ways. In order to determine how these streams might best be restored, a good starting point is the restoration process in a natural situation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1120, REMOVAL OF TRACE ORGANICS FROM WATER BY ADSORPTION ON COAL
P.H. KING, Virginia Polytechnic Institute, School of Engineering, *Blacksburg, Virginia* 24061

The proposed research involves laboratory investigations to determine the extent of adsorption of trace quantities of biochemically resistant organic materials on coal. Specific methods to be employed include both batch and fluidized column

studies utilizing a variety of selected solutes with a wide range of physical and chemical properties. Data obtained will be analyzed to show the kinetics of the adsorption process. The distribution of organic material between the aqueous phase and the adsorbed portion will be described if possible by an appropriate adsorption isotherm. The extent of adsorption on coal will be compared with similar data for activated carbon.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1121, ECONOMIC DISPOSAL OF WASTE SLUDGES FROM WATER TREATMENT PLANTS
P.H. KING, Virginia Polytechnic Institute, School of Engineering, *Blacksburg, Virginia* 24061

The disposal of sludges resulting from conventional water treatment processes such as coagulation, softening and filtration will be examined with a view of developing alternatives to disposal by dilution in cases where water quality stream standards would be violated or in situations where disposal to lagoons would not be feasible due to land costs.

Particular attention will be given to the parameters of treatment plant operation and to sludge conditioning techniques which result in rapid and thorough sludge dewatering on either open sand drying beds or through use of vacuum filters. The use of newly developed synthetic organic polyelectrolytes as a conditioning aid will be investigated. The economics of alternative methods of water treatment plant sludge disposal under varying conditions will be evaluated

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1122, UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELS IN ESTUARINE WATER RESOURCES RESEARCH AND MANAGEMENT
W.J. HARGIS, Virginia Inst. of Marine Sci., *Gloucester Point, Virginia* 23062 (C-1428)

Increased use of hydraulic and mathematical models in research, planning engineering and conserving estuarine and coastal environments is important. The proposed project will utilize VIMS hydraulic model of the tidal James system and analogue, digital and hybrid mathematical modeling capabilities in a program of research designed to evaluate and improve the capabilities of each technique. Thus, the accuracy, precision and capabilities of all likely will be improved, or at least clarified.

It is expected that improved ability to predict the changes which will result in such biologically, economically, socially and politically important environmental factors as salinity distribution, currents sedimentation, bottom scour and shore erosion will result.

This program is relevant to the projected Chesapeake Bay Hydraulic Model.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1123, FRESH-SALT WATER IN ESTUARIES SEDIMENTATION PROCESSES
M.M. NICHOLS, Virginia Inst. of Marine Sci., *Gloucester Point, Virginia* 23062 (DA)

Technical Objective: To determine how suspended sediment accumulates in the fresh-salt water transitions of estuaries to cause turbidity maxima. Information developed should be of great value in terms of improving capability for analytical studies and in defining pertinent phenomena to be considered carefully in connection with hydraulic model studies. The phenomena proposed for investigation are extremely important to a better understanding of the shoaling characteristics and rates of shoaling in estuaries.

SUPPORTED BY U.S. Dept. of Defense - Army

2.1124, FUNCTION OF THE MARSHES IN REDUCING EUTROPHICATION OF ESTUARIES OF THE MIDDLE ATLANTIC REGION
R.A. WADE, Virginia Inst. of Marine Sci., *Gloucester Point, Virginia* 23062

Completed and current estuarine studies indicate that the nutrient budget of a highly enriched tidal system cannot presently be followed from the source of enrichment to the mouth. Analytical and physical data indicate that nitrogen and phosphorus compounds are 'lost' within the system and cannot be accounted for in soluble, suspended or deposited forms. The data indicate that adjacent marsh lands may be serving as nutrient storage areas, thus reducing environmental degradation and aquatic nuisance conditions in estuaries.

This study is designed to investigate the biology, chemistry, geology, and hydrography of a marsh adjacent to a highly enriched estuary and a marsh off a relatively unmodified system. Emphasis will be placed on water and soil chemistry with the necessary associated effort on classification, productivity, and hydrography.

Water samples will be collected at 2-hour intervals during spring and neap and dry weather and freshet periods. Complete chemical analyses of the samples will determine if the marshes serve as Purdy described the Washington, D.C., tidal pools, like lungs which purify on each tidal cycle.

The data will be analyzed in view of estuarine systems with and without associated marsh systems. The results should aid those agencies charged with decisions regarding the expendability of salt marshes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1125, CONTROLLING THE LOCATION AND DISPERSION OF A THERMAL POLLUTING EFFLUENT
C.C. LOMAX, Washington State University, School of Engineering, *Pullman, Washington* 99163

The proposed research is to study the significance of controlling the location and the dispersion of a heated effluent discharged into a natural stream.

In the laboratory a dyed effluent will be injected into an open channel stream and the dispersion and location of the pollutant traced using photographic and fluorometric techniques. A fluorescein dye will be used as the pollutant. The following parameters will be investigated: 1. velocity and direction of the effluent stream at entry, 2. controls on the effluent at its point of entry to restrict turbulence and mixing with the main stream.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1126, FLUSHING OF SMALL SHALLOW LAKES
E.R. TINNEY, Washington State University, School of Engineering, *Pullman, Washington* 99163

In recent years the quality of lake waters has become increasingly important, first because of the growing demand for recreational uses and, second because the use of lakes and adjacent lands has accelerated their deterioration. Research studies too numerous to mention have dealt with the quality of lake waters but most of the previous work is related to eutrophication and the biological processes involved. In recent years some studies have been made on the currents in a lake which markedly affect the limnological behavior but these studies have, for the most part, dealt with mixing phenomena associated with wind and the density currents associated with solar heating and relatively cold inflows.

The question of how best to improve a small lake by enhancing natural flushing has received little attention. This proposal treats this particular problem with specific attention to the flushing of a small shallow lake. The primary objective of this study will be to clarify the flushing phenomena in small lakes, recognizing that mixing is also enhanced in natural water bodies by wind and solar heating. Hopefully the end result of this would be an explanation of flushing that would indicate how much and in what manner water should be introduced into a class of small lakes to achieve a prescribed flushing action.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1127, VERIFICATION OF MODELS USED IN THE MANAGEMENT AND CONTROL OF WATER QUALITY
B.W. MAR, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

2. WATER QUALITY

The proposed research involves the utilization of data and models resulting from the State of Washington Water Quality studies to develop a generalized model for intra-industry waste discharge, to verify existing water quality models, and to formulate and evaluate a water management policy based on discharge rights.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1128, SYSTEM ANALYSIS OF EUTROPHICATION CONTROL BY FLUSHING

R.T. OGLESBY, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

This research project is designed as an intensive study of a highly eutrophic lake before and after additions of nutrient poor flushing water. System analysis techniques will be applied to this information, together with data obtained through laboratory and field experiments, to meet the following objectives: (1) establish knowledge and information concerning the functional performance and effectiveness of flushing as a means of eutrophication control; (2) define the engineering concepts, design procedures, and design criteria necessary for the general application of this method; and (3) further understanding of the relationship of primary production to the environment in which it occurs. A further objective is to promote significant improvements in the water quality of that portion of the lake under study most densely inhabited and most intensively used for recreation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1129, ESTUARINE ECOLOGY RESEARCH

E.O. SALO, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105

Objectives of the estuarine ecology project include: 1) To develop a mathematical model of important physical and chemical processes of the Duwamish Estuary, including rates of dilution of pollutants. 2) To investigate the ecology of pelagic and demersal fishes in the estuary and nearshore marine environment affected by industrial and domestic waste discharges. This investigation includes primarily studies of the estuarine and early marine life of immature chinook salmon (Oncorhynchus tshawtscha), including mortality, distribution and growth. 3) To determine factors that affect distribution, period of estuarine residence, timing of migration and behavior of adult chinook salmon before, during and after pollution abatement. 4) To develop an in situ bioassay technique for use with resident demersal fishes to procure essential biological input for the water quality simulation model. Observations will include the formation of abnormalities, mortality, growth, behavior, condition and resistance to disease. Water quality will be automatically monitored. 5) To determine the relationship between the quality and abundance of zooplankton and the horizontal and vertical stratification of water quality before and after pollution abatement in estuary.

Emphasis is being devoted to the Duwamish Estuary because a wealth of physical and chemical data exist there. The Municipality of Metropolitan Seattle and the U.S. Geological Survey maintain four telemetry stations in the estuary which record pH, dissolved oxygen, water temperature, conductivity and turbidity.

It is apparent that the effects of chronic pollution are subtle. Only through intensive sampling and sophisticated treatment of the data can they be measured.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1130, ESTABLISHING GUIDES FOR COORDINATING URBAN PLANNING AND THE DESIGN, ENGINEERING, AND CONSTRUCTION OF URBAN STORM RUN-OFF SYSTEMS

D.D. WOOLDRIDGE, Univ. of Washington, School of Forestry, *Seattle, Washington* 98105

Our current research 'Objectives and Comprehensive Planning for Urban Storm Water Removal' has developed several apparent factors: 1) There is increasing emphasis and desire to maintain natural environments particularly near water. 2) There is a very marked desire to eliminate pollution and restore a near natural ecological balance to lakes and river systems. 3) Compatible with these two objectives it is necessary to deliver storm water to each successively larger receiving water body at natural flow rates. Many have stated long-term goals of completely natural stream and river systems protecting stream vegetation, flood plains and natural hydrologic balance. Protected areas would be incorporated in a parks, walkways or a greenbelt system. We will continue to examine alternatives as our current study progresses.

This new proposal has a major objective of establishing step by step guides for accomplishing desired long term goals of urban storm water systems. It combines efforts of the University of Washington, King County, the Storm Water Control Subcommittee of the Forward Thrust Committee, Cities of Redmond, Bellevue and interested citizens and groups. It will detail major considerations of altered physical hydrology and soil erosion due to urbanization providing sources of technical information, local governmental regulations and related actual construction problems during urban development. In logical order, major phases from urban planning to complete development are: 1) planning, 2) design and engineering, 3) construction, and 4) financing (as incorporated in all phases).

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1131, LIMESTONE DRUM PRODUCTIVITY STUDY -- POPULATION STUDY

R. MENENDEZ, State Div. of Wildlife Resour., *Charleston, West Virginia* 25305

Objectives: To determine the effects of limestone drum installation on an existing fish population and to establish trout in formerly acid waters.

Procedures: Much of the allocated time will be devoted to preparation of the final report for both the Otter Creek (Work Plan 1) and Sherwood study (Work Plan 2). Population samples will be collected at designated stations in June and September. Fish collections will be made using electro-fishing gear and the mark and recapture method will be used to make population estimates. Data collected will be used to determine standing crop, growth rates, condition and mortality. Comparisons of population density, growth, condition and mortality with past years will be used to determine the carrying capacity.

Modified wolf-type traps will be installed in the stream at strategic locations to monitor fish movement both up and down stream. All trout collected will be marked for future reference and released.

A reconnaissance of the entire stream below the treatment station will be made to determine the location of suitable spawning areas and the use of the areas will be determined by observation. Several trout nests in both areas greatly affected by treatment and areas affected to a lesser extent will be excavated and egg or fry survival will be determined. Since the effects of treatment gradually diminishes downstream, knowledge of spawning and reproductive success may help establish the degree of acid neutralization necessary for successful reproduction. Data collected will also aid in determining if poor reproduction in the lower section is due to inadequate spawning areas or inadequate treatment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1132, LIMESTONE DRUM PRODUCTIVITY STUDY-LIMNOLOGICAL STUDY

R. MENENDEZ, State Div. of Wildlife Resour., *Charleston, West Virginia* 25305

Objectives: To determine the limnological effect of limestone drum installation on selected streams and lake with special emphasis this segment on determining factors which limit bottom fauna production in the treated stream sections and the effects of trout predation on bottom fauna. Much of the allotted time will be devoted to preparation of the final report for both the Otter Creek study (Work Plan 1) and the Sherwood study (Work Plan 1).

Procedures: Artificial type substrates consisting of rock filled wire baskets and multiplate samplers will be placed throughout the stream in both treated and untreated sections. They will be serviced at six-week intervals and all organisms on the devices will be collected. Comparisons on abundance of organisms between treated and untreated sections can then be made.

Several sections of the stream below treatment will be blocked off for use as experimental units. These units will be located immediately below the treatment station where acid neutralization is greatest and at points downstream where neutralization is not as great. A known number and weight of trout will be placed in one unit at each location and one will remain free of trout. Bottom fauna numbers within each unit will be sampled monthly. Estimates of trout production in each unit will be based upon the changes in weight during one-month sampling intervals. The mean weight gain per recovered fish will be used in computing production whenever fish were lost from a unit during sampling. In the stream immediately below treatment, duplicate units will be set up; two containing a poor substrate and two containing an artificially prepared substrate. Known numbers and weights of trout will be placed in one each of the units. Differences in bottom fauna numbers in all units and in trout production in the two units will be measured. This additional field work will complement the overall study and tie together previous study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1133, MANIPULATION OF RESERVOIR WATER FOR IMPROVED QUALITY AND FISH POPULATION RESPONSE
T.L. WIRTH, State Dept. of Nat. Resources, *Madison, Wisconsin* 53701

The number of small recreation reservoirs (50-200 acres) in Wisconsin's lakeless region is rapidly increasing. The formation of these impoundments alters the downstream channel while the fertility of the region causes the reservoirs to become highly eutrophic with limited aesthetic value due to aquatic nuisances. Recreational angling in the reservoirs appears to be depressed due mainly to intense algal growths and adverse aquatic environments (anerobic hypolimnion) which limit fish production in the steep-sided basins. Different management techniques are being applied to two in-line reservoirs. The downstream impoundment, which first filled in May 1967, is equipped with an outlet structure which continuously discharges hypolimnion water.

The upstream impoundment discharges epilimnion water and is being continually mixed to prevent thermal stratification. Quantity and quality (temperature, pH, D. O., transparency, major nutrients, and elements) of the inflow, and impounded waters are being measured throughout the year. Fish production and harvest are measured through techniques of population estimates, growth rates, age distribution, and angler's catch for comparison to previously measured levels. Invertebrate species composition and relative abundance are being measured in both of the impoundments and in the stream below the lower reservoir to ascertain changes brought about by manipulation. Aquatic vegetation changes are also being noted in the stream below.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1134, MODELING OF VENTED HYDROTURBINE REAERATION
W.C. BOYLE, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

The objective of this project is to obtain a generalized mathematical model for vented hydroturbine reaeration.

The experimental objective is to modify and to operate a small Francis turbine in a closed cycle, reservoir-pump-turbine system and to measure its performance as an aerator. The contribution of the vented draft tube to mass transfer will then be assessed separately from the gross systems transfer by means of a factorial test design. The interfacial surface area generated within the tube will be independently estimated by calculation and by photographic technique. With these estimates of surface area, the parameters customarily used to describe the performance of mixers and gas transfer equipment would be used to fit and to develop a correlation for all of these data.

The theoretical objective is to determine whether the draft tube functions in a manner analogous to that of a turbulent flow device such as a mixing orifice or to that of an impeller in a vessel.

The final objective would be to test the correlation against published field test data to determine its value for generalized prediction or modeling.

SUPPORTED BY Wisconsin State Government - Madison

2.1135, IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION
H.D. BRUHN, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

This research proposes to investigate methods for the more efficient handling of cut aquatic vegetation. Feasible alternatives are sought for present slow and costly methods, which are at the same time compatible with over-all water management programs. Knowledge concerning the physical processing properties of aquatic plants is quite limited. Initially research would be conducted to determine how plants are affected by such standard operations as dewatering by crushing, homogenizing, maceration, etc., the objective being to identify potentially effective procedures.

Following acquisition of certain fundamental handling and processing data, the research can proceed on an applied basis. This second, pilot scale phase will attempt to determine the most practical combinations of methods for transportation and disposal of the entire, unprocessed plant, the entire plant after processing in some manner, complete disposal at the source, or other combinations.

The objective is to alleviate some of the bottlenecks which limit the capabilities of today's aquatic vegetation harvesting machinery to small fractions of rates achieved with agricultural machinery. The high cost of systems and procedures for mechanical control of aquatic vegetation have prevented realistic evaluations of its effectiveness as a management measure in eutrophic waters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1136, SIGNIFICANCE OF ARTHROBACTER IN ECOLOGY OF WATER AND SOIL
J.C. ENSIGN, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

Bacteria belonging to the genus Arthrobacter are found in large numbers in soil and water. In some environs they are the predominating single group of bacteria. They comprise an important part of the stable autochthonous microflora. The purpose of this investigation is to explore the role of Arthrobacter in soil and water ecosystems. The mechanisms whereby these bacteria are able to maintain fairly constant and large populations, regardless of variations in environmental conditions, will be studied. Resistance to starvation, desiccation, adverse temperatures and other environmental conditions will be compared in both rod and sphere stage cells of the organism. The degradation of cellular macromolecules, reserve materials and intracellular pools will be followed during starvation. The results are to be compared to those obtained with Pseudomonas, which are part of the fluctuating, or zymogenous, microflora.

Members of the genus Arthrobacter have been found to actively degrade pyridine-ring compounds. A second aspect of this investigation involves studying the pathways and enzymes involved in catabolism of pyridine, nicotinic acid and several herbicide and insecticide derivatives of the pyridine ring.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1137, DISPERSION AND SALT WATER INTRUSION IN NON-HOMOGENEOUS POROUS MEDIA
J.A. HOOPES, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

In the study of dispersion in non-homogeneous porous media, a general solution for the distribution of a contaminant in flow through a layered porous media has been obtained. The resulting expression is simple and easily adapted to any arbitrary non-homogeneity. The basic feature of the analysis is that it treats the media as a continuum with a spatially varying dispersion coefficient. In this way the boundary conditions at the interface between successive layers are automatically satisfied.

For flow through two-layered media, arranged parallel to the flow direction, the analytical solution including the lateral dispersion has been obtained. In addition, a numerical solution for dispersion through a two-layered media, with its boundary at an arbitrary angle to the flow direction has been obtained.

Experiments have been carried out for layered systems, with layers oriented parallel, perpendicular, and at 45 degrees to the flow direction, over the Reynolds number range of 0.1 to 10. The results are in good agreement with the theoretical prediction.

Sea water intrusion into non-homogeneous, coastal aquifers, including the effects of dispersion and density difference, is currently being studied. Numerical solutions for the time average salinity and stream-function distributions for homogeneous and non-homogeneous aquifers have been obtained. An attempt is also being made to solve this problem analytically using a perturbation method. In addition, an experimental model is being constructed in order to test the theory.

SUPPORTED BY University of Wisconsin

2.1138, SHALLOW GROUND-WATER FLOW SYSTEMS IN RELATION TO INDUSTRIAL AND MUNICIPAL WATER SUPPLY AND WASTE DISPOSAL REQUIREMENTS
D.A. STEPHENSON, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The occurrence and seasonal fluctuations of shallow groundwater flow systems in various geologic environments of Wisconsin will be investigated within the framework of their relation to waste disposal practices of selected industries and municipalities. Solid and liquid waste disposal sites of the canning, dairy, and paper-pulp mill industries, plus municipal sanitary land fill sites will be areas wherein shallow flow systems are to be investigated.

It is anticipated that limited site selection criteria for the specified disposal practices can be developed based on the hydrogeologic framework. Where liquid wastes are being disposed of through spray irrigation or ponding, formulas will be developed to control rotation of equipment used for the waste effluents. It is further anticipated that more extensive investigations can be initiated following this preliminary study.

Surface and subsurface geologic, hydrologic, and geophysical data are to be collected, compiled, and interpreted. Laboratory and field studies will be interpreted to provide a basis for practical application of results.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1139, MICROFUNGI IN THE WATER, LITTER AND MUD OF A CATTAIL MARSH BORDERING LAKE BUTTE DES MORTS
L.L. TEWS, Univ. of Wisconsin, Graduate School, *Oshkosh, Wisconsin* 54902

The intent of the project is the determination of the number and types of microfungi in the water, mud and litter of a cattail marsh bordering the northeastern shore of Lake Butte Des Morts, a lake in the extensive Fox River-Wolf River System of central Wisconsin. Water, mud and litter samples will be collected aseptically monthly from June through July along a transect running perpendicular to the shoreline from open water to a zone where cattails no longer predominate. The samples will then be processed by filtration, culturing and dilution. After pure cultures have been obtained, the fungi will be identified and data will be recorded as 1) the frequency of isolation and 2) as either the number of fungi per 100 ml of water or the number of fungi per g of dry weight of mud or litter. The project is envisioned as the first step in determining the role microfungi play in the degradation of litter and pollutants passing through the marsh to the open water of Lake Butte Des Morts and the River System.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1140, WATERSHED RANGE CONDITIONS AND THEIR EFFECTS ON WATER QUALITY
A.A. BEETLE, Univ. of Wyoming, School of Agriculture, *Laramie, Wyoming* 82070

The major objective of this study is to relate variations in bacteria count and water chemistry with range conditions and use, therefore offering management personnel guidelines for multi-use management of watersheds. The objective will be accomplished by: (a) relating range conditions with type and amount of use, and (b) relating fluctuations of bacteria count and water chemistry with range use and conditions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

E. WASTE TREATMENT

Includes Sewage, Sludge, Or Wastewater Treatment Techniques Or Processes, Waste Reuse, Recycling, Or Related Commodity Development.

2.1141, GAMMA RADIATION OF TEXTILE WASTE WATER TO REDUCE POLLUTION
J.F. JUDKINS, Auburn University, School of Engineering, *Auburn, Alabama* 36830

The object of this proposal is to study gamma irradiation as a means of treating textile waste. The gamma irradiation will be supplied by a Cobalt-60 source with a variable geometry and a maximum disintegration rate of 12,000 curies.

Polluting agents common to textile waste are starch, basic hypochlorite bleach, dye compounds, sulfides, sulfites, and various detergents. The research will be broken down into three phases. These will be the study of the effect of gamma irradiation upon (1) aqueous solutions of individual polluting agents, (2) mixtures of the polluting agents, and (3) industrial samples of textile wastes. Experimental parameters, such as pH, dissolved oxygen concentration, temperature and radiation dosage will be varied.

The effect of the total irradiation dose and dosage rate on the starch samples will be evaluated by viscosity change, starch-iodine spectra and reducing sugars formed.

Standard chemical analysis will be used to determine the radiolysis products of the sulfides and detergents while radiolysis of the dyes will be evaluated spectrophotometrically. The chemical and biochemical oxygen demands of the radiolysis products and the original samples will also be measured.

Attempts will be made to predict optimum radiation dosage and dosage rate for degrading a particular waste to a satisfactory level. These predictions will then be tested by the radiolysis of actual textile industrial waste water samples.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1142, COLOR REMOVAL FROM TEXTILE DYE WASTES BY COAGULATION
J.M. JUDKINS, Auburn University, School of Engineering, *Auburn, Alabama* 36830

The treatment methods presently used for textile dye wastes have not been very successful in removing the color from these wastes. The discharge of highly colored wastes into streams is objectionable.

Laboratory studies using the standard jar test will be conducted to determine the extent of color removal from textile dye wastes by coagulation. Several coagulants, including alum and ferric sulfate, both with and without polymeric agents will be evaluated at different pH levels. Color removals will be measured with an electrophotometer. Initial and final BOD and sulfide concentrations will be determined on sulfur dye waste samples. The costs of the more promising treatment methods will be studied on a plant-scale basis.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1143, ELECTROMEMBRANE PROCESS FOR REGENERATING ACID FROM SPENT PICKLE LIQUOR
R.E. LACEY, Southern Research Institute, *Birmingham, Alabama* 35205

This project provides for the experimental investigation of an electro-membrane process for the recovery of sulfuric acid and iron or iron oxide from spent sulfuric acid pickling liquors. The investigation will determine the technical feasibility of the process in a bench scale operation, provide engineering data for the

design of larger recovery units, and develop engineering cost estimates to indicate the ecomomic feasiblity of the process. The bench scale studies will be directed at development of the configuration, mode, and conditions of operation required to minimize power requirements.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1144, DEMINERALIZATION OF WASTEWATER BY THE TRANSPORT-DEPLETION PROCESS
E.W. LANG, Southern Research Institute, *Birmingham, Alabama* 35205

The primary objectives are to determine the technical feasibility of the transport-depletion process for reducing the dissolved solids of secondary wastewater and to determine how well the transport depletion process can overcome the problems that have been encountered when conventional electrodialysis is used with wastewater. Other objectives include determining operating limits of the process, including types of feed pretreatment, when demineralizing secondary effluent, obtaining engineering design data and providing preliminary cost estimates to indicate the economic promise of this process for demineralizing wastewater.

To achieve these objectives, it is proposed to install and operate a transport-depletion stack and auxiliary equipment at a local sewage treatment plant. The treatment plant effluent, augmented with salts to bring the composition up to typical sewage effluent composition if necessary, will be demineralized over a wide range of operating conditions. The maximum demineralization capacity of the unit and the ability of the unit to operate without intolerable increases of electrical resistance with different types of water pretreatment, with a range of solution velocities within the stack compartments, and with high ratios of product-waste flows will be determined.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1145, ENTERIC VIRUS SURVIVAL IN AQUEOUS ENVIRONMENTS
E.W. AKIN, U.S. Environ. Protection Agcy., Gulf Coast Water Hygiene Lab., *Dauphin Island, Alabama* 36528

This project is concerned with determining the survival characteristics of human enteric viruses in the various aqueous environments used and consumed by man. This includes (1) estuarine water which may be utilized for recreation, and shellfish production and converting to community drinking water; and (2) freshwater, both natural and treated. Polluted surface water is increasingly becoming the initial source of our daily water intake. Sound judgments regarding the role of water in the transmission of disease by viruses are virtually impossible without critical knowledge of their survival pattern in the water environment. The intent of this project is to provide definitive information on virus survival so that a realistic indication of the health hazards of viruses in water may be intelligently assessed. Survival characteristics of poliovirus 1 in estuarine water will continue to be studied in the field with emphasis being placed on greater approximation of natural conditions. Laboratory studies will be designed to further identify the major factors contributing to the inactivation or protection of these viruses when they are suspended in various waters.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1146, TREATMENT AND DISPOSAL OF COMPLEX CHEMICAL WASTES
P.E. LAMOREAUX, State Geol. Survey, *University, Alabama* 35486

The proposed research will provide a means of treatment and disposal of complex chemical wastes consisting of five major efforts: (1) phase I - Drilling and testing of a deep well, (2) phase II - Completion of deep well for waste injection, (3) phase III - Surface installation for deep well system, (4) phase IV - Installation of surface plant for total treatment, and (5) phase V - Operation, maintenance and monitoring of total system.

All phases will be involved in standard procedures and concurrent research development of methodologies and/or testing techniques that will permit projections of the fate of the chemical wastes and assimilative capacity of underground formations for the waste to be studied. The deepwell phase will be carried to a point of decision and if the deep well does not prove feasible an alternative method of waste treatment and disposal will be initiated.

The work will be performed on the Reichhold Chemical property in Tuscaloosa.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1147, PRELIMINARY INVESTIGATION TO EVALUATE DEEP-WELL DISPOSAL POSSIBILITIES IN MOBILE, BALDWIN, AND ESCAMBIA COUNTIES, ALABAMA
W.E. TUCKER, State Geol. Survey, *University, Alabama* 35486

The high degree of industrialization and urbanization in southwestern Alabama makes it imperative that adequate methods of waste disposal be instigated if this area is to continue its growth and expansion. Surface disposal of wastes is in many ways unsatisfactory, and therefore detailed investigations of the possibilities of liquid- waste disposal in the subsurface are being conducted.

Electric logs are used to determine porosity and permeability of units which may be satisfactory for use in liquid-waste disposal. Rock cuttings from significant wells are described, analyzed, and tested in an effort to determine physical properties of significant units. Published literature and information from engineers in the field are used to obtain detailed knowledge on subsurface units in the area of study.

SUPPORTED BY Alabama State Government

2.1148, CONSERVATION OF FRESH-WATER RESOURCES BY DEEP-WELL DISPOSAL OF LIQUID WASTES
D.M. GRUBBS, Univ. of Alabama, Water Resources Program, *University, Alabama* 35486

This project will evaluate the geological and engineering parameters of subsurface rock formations which will permit disposal of liquid waste by deep-well injection procedures. Criteria and techniques will be sought which will have both quantitative and qualitative regional application in the development of underground disposal facilities. This will in turn alleviate the problem of usage of surface waters as carriers of waste effluent. Studies will be focused upon: 1. Derivation and analysis of information such as rock core and cuttings lithology, analysis of reservoir fluids, results of rock matrix and cementing material, electrical and other well-logging parameters, and petrophysical data such as porosity and permeability; 2. Laboratory analysis from simulated injection of liquid wastes into actual reservoir core samples to determine capacity, receptivity, continuity and compatibility, and pressure-time-distance response as a basis for prediction of systems behavior; 3. Development of mathematical models applicable to the identification and evaluation of potentially receptive disposal zones. Determination of restrictions to be placed upon types and volumes of liquid wastes which may be injected into specific deep-well reservoirs.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1149, COMPATIBILITY OF SUBSURFACE RESERVOIRS WITH INJECTED LIQUID WASTES
D.M. GRUBBS, Univ. of Alabama, Natural Resources Center, *University, Alabama* 35486

The proposed research plan involved laboratory determination of the long-term effects (compatibility) upon the physical parameters of subsurface rock formations resulting from the disposal of liquid wastes in deep-well injection practices. Purpose is to determine the extent of change in volumetrics and permeability of disposal reservoirs which may limit the economic practicability of this disposal method.

Laboratory methods will employ: 1. Chemical analysis of reservoir fluids, rock matrix, and cementing materials of selected subsurface reservoir rock samples. 2. Determination of potential receptive horizons. 3. Injection of typical industrial liquid wastes

into core samples under both surface conditions and elevated conditions of temperature and pressure over nominal to long periods of time to simulate actual reservoir conditions. 4. Re-examination of injected samples to determine changes in physical properties subsequent to long- term injection. 5. Chemical analysis of interstitial precipitates formed.

Data analysis will be directed toward prediction of effects of waste types on physical properties critical to receptivity and volumetrics of identified geologic horizons. Compatibility criteria will be formulated as a guide to the nature and volume of specific waste types which may be disposed of under limitations of local geologic conditions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1150, EVALUATION OF AN OXIDATION-DITCH WASTEWATER TREATMENT PLANT IN SUB-ARCTIC ALASKA

R.S. MURPHY, Univ. of Alaska, School of Engineering, *College, Alaska* 99735

The project plan is designed to evaluate an existing oxidation- ditch wastewater treatment facility located in the sub-Arctic near Fairbanks, Alaska. Operation procedures, problems and economics of the system will be studied. Sufficient data will be obtained such that a mathematical model describing the biokinetics and oxygen requirement of the system can be formulated. Investigations will cover both the warm and cold temperature regimes as well as the transitions between these extremes.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1151, SPREADING TREATED SEWAGE FOR GROUNDWATER RECHARGE

H. SHIPLEY, Phoenix City Government, *Phoenix, Arizona* 85003

This project is to determine the feasibility of groundwater recharge by spreading treated sewage as part of future programs for waste water utilization, and to collect information for optimum design, management, and operation of spreading basins. A pilot project will be installed in the Salt River bed West of Phoenix. Effluent from a new activated-sludge plant will be pumped to the site and inflow and outflow for each test area will be recorded and observation wells will be installed. Studies will include loading rates, quality aspects in the percolation zone, etc.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1152, METHODS FOR WATER QUALITY IMPROVEMENT AND ITS STORAGE UNDERGROUND

H. BOUWER, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Phoenix, Arizona* 85040 (SWC-012-GG-1)

OBJECTIVE: Investigate the effectiveness of vegetation filtration, soil percolation, and underground storage for renovating secondary sewage effluent.

APPROACH: Laboratory and field studies are conducted to study the flow process in a soil profile under intermittent inundation and to evaluate the quality improvement of the effluent and the optimum management of recharge basins. The possibilities for nitrate control in the final product by induced denitrification will be investigated. The laboratory studies involve soil columns with recording tensiometers, gamma ray densitometry, and computer applications. The field studies are carried out at a three-acre pilot recharge project now under construction west of Phoenix.

PROGRESS: Nitrogen removal rates of 80% continued to occur with 2- 3 week inundation periods at the Flushing Meadows Project where Phoenix sewage is reclaimed by ground-water recharge with infiltration basins. Grassed basins not only yielded higher infiltration rates than non- vegetated or gravel-covered basins - they also yielded higher nitrogen removal. The nitrogen removal patterns in the field could be duplicated in laboratory columns. Gas chromatography studies on the columns and analysis of the soil from the recharge basins indicated that a significant amount of the nitrogen removed was stored in the soil, probably due to a reaction of ammonia with organic matter under anaerobic conditions. Nitrogen removal in the columns became less effective with inundation longer than 1 month and ceased completely after 3 months' continuous inundation. Soil percolation at Flushing Meadows gave essentially complete removal of biochemical oxygen demand and fecal coliforms. Phosphates were reduced by 90% and fluorides by 60%. Cost of reclaiming water in a full-scale recharge system is estimated to be $5 per-acre-foot. An equation has been developed from basic flow theory that predicts experimentally observed drainage-time relationships better than previously published equations. Its upper limit is the familiar Young's equation, and its lower limit is a two-parameter equation. This latter equation was first found when statistically fitting drainage-time relationships. It is useful in predicting the hydraulic conductivity and total volume of drainage from soil columns.

SUPPORTED BY U.S. Dept. of Agriculture

2.1153, ADVANCED WASTEWATER TREATMENT USING POWDERED ACTIVATED CARBON IN RECIRCULATING SLURRY CONTACTOR-CLARIFIERS

C.F. GARLAND, Infilco Incorporated, *Tucson, Arizona* 85703

The objective of this project is to determine the process and operating parameters for adsorption of dissolved impurities from the secondary effluent of a municipal activated sludge plant by powdered activated carbon in two stages of continuously recirculating slurry contactor-clarifiers. The proposed work includes: 1. Preliminary laboratory investigations to evaluate three different commercial grades of powdered activated carbon will be performed during the procurement and construction periods (10 weeks). Carbon coagulation studies, adsorption isotherm studies, and adsorption rate studies will determine which activated carbon will be used in the subsequent field operations. 2. A 10-20,000 gal/day, two stage countercurrent, continuously recirculating contactor-clarifier will be constructed and evaluated during continuous operation for a twelve-week period. The independent process variables of flow rate, activated carbon feed rate, and slurry solids inventories will be investigated over ranges sufficient to determine the optimum combination for removal of adsorbable substances as determined by COD measurements. A brief study will be made of a single-stage contacting system.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.1154, TUCSON WASTEWATER RECLAMATION PROJECT

P. BEERMANN, Tucson City Government, *Tucson, Arizona* 85701

The project objectives are to demonstrate the chemical, biological, and virological safety, and the aesthetic acceptability of including renovated wastewater as a dependable and substantial portion of the future Tucson water supply and to determine what species of fish will live and provide the optimum production and growth rate in renovated wastewater. The renovated water will be supplied from a pilot scale spreading basin - horizontal flow filtration facility and experimental ponds.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1155, TECHNICAL, ECONOMIC & LEGAL ASPECTS IN THE EXCHANGE OF SEWAGE EFFLUENT FOR IRRIGATION WATER FOR MUNICIPAL USE (TUCSON)

C.B. CLUFF, Univ. of Arizona, Water Resources Research Ctr., *Tucson, Arizona* 85721

This proposed investigation is designed to study the concept of exchange of sewage effluent in the Tucson area for irrigation water, as a management tool. This proposed exchange should accomplish the following: 1. Increase available municipal supplies by transferring water from agricultural use to municipal use with a minimum economic loss to the agro-industrial complex. 2. Provide a method whereby high quality water now being used for irrigation can be used for municipal use, with sewage effluent characteristically high in plant nutrients being substituted for agricultural use. 3. Reduce the pollution potential of sewage effluent by using natural processes occurring in the soil profile during normal irrigation application.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1156, TURFGRASS MANAGEMENT-USE OF RECLAIMED WASTE WATER - USE OF TURF AND ORNAMENTALS
G.S. GREENE, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-0206-4164-107)

OBJECTIVE: Study use of reclaimed waste water, including excess surface run-off, industrial waste and sanitary sewage; study use of turf and ornamental plants in public parks and golf courses; test water irrigation techniques.

APPROACH: Not provided.

PROGRESS: This project is being conducted in connection with the Environmental Modification Facility under the general direction of Dr. Richard Dassander. It is located on an 84 acre site at the Tucson International Airport, and includes the development of an urban park and recreation area containing a 16 acre lake complex, a small golf course and other attendant features. Its primary purpose is to provide research and demonstration of such facilities in an arid region, using only industrial waste water and flood runoff without utilization of ground water resources. Preliminary design work has been completed. No new work has been done this year, since funds for construction and capital improvements have not been available. The work of construction will necessarily precede the start of research and demonstration.

SUPPORTED BY Arizona State Government

2.1157, A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY
C.N. HODGES, Univ. of Arizona, Inst. of Atmospheric Research, *Tucson, Arizona* 85721

The University of Arizona is developing a combination system for providing power, water and food. The system is designed for use, initially at least, in a coastal desert area.

Power is generated by a diesel-electric set. Waste energy from the diesel engine is utilized to heat seawater for a humidification desalination plant. The waste seawater from the desalination plant is used to provide the temperature and humidity control for a closed- environment greenhouse. Carbon dioxide from the diesel engine exhaust is used in the closed greenhouse to accelerate plant growth.

Various experimental components of the system have been constructed and tested at the Environmental Research Laboratory, Tucson, Arizona. A pilot facility has been developed at Puerto Penasco, Sonora, Mexico, in cooperation with the University of Sonora. A larger facility is under construction in Abu Dhabi, Arabian Gulf.

SUPPORTED BY Abu Dhabi Government

2.1158, GROUNDWATER RECHARGE AND QUALITY TRANSFORMATIONS DURING THE INITIATION AND MANAGEMENT OF A NEW STABILIZATION LAGOON
G.V. JOHNSON, Univ. of Arizona, Water Resources Research Ctr., *Tucson, Arizona* 85721

The overall objectives of the proposed study are, (1) to obtain field data on the interrelationships between seepage losses, groundwater recharge and associated water quality transformations, during the initiation of a new, raw sewage stabilization lagoon near Tucson, Arizona, and (2) to obtain information under controlled conditions on the effectiveness of turfgrasses to utilize N in stabilization lagoon effluent.

Existing research facilities located in or near the lagoon include PVC water sampling wells and access wells, used in conjunction with a recording neutron probe. Background information on water quality, water levels, etc. will be obtained prior to initiating the lagoon. During filling, seepage rates will be calculated and samples of effluent, pond water and ground water will be procured for chemical analysis. Water content profiles in access wells will characterize the growth and lateral spread of subsurface mounds in the stratified sediments underlying the lagoon. The natural sealing potential of benthic deposit will be studied, together with the effect of a benthic layer on quality transformations during seepage.

N-uptake by turfgrasses will be studied on 12 instrumented lysimeters. Three turfgrasses will be evaluated in four replications. Two of the replicates of each turf will be irrigated with effluent from the lagoon site and two will be irrigated with well water, supplemented with nitrogen equivalent to the concentration in effluent. Turf utilization of effluent N will be assessed by laboratory analysis of the clippings and soil solution samples from various depths in the lysimeter.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1159, REMOVAL OF PHOSPHATE AND SECONDARY B.O.D. FROM TERTIARY TREATED WASTEWATER BY AQUATIC ANIMALS
C.D. ZIEBELL, Univ. of Arizona, Water Resources Research Ctr., *Tucson, Arizona* 85721

The purpose of the proposed research is to test the practicability and methodology of phosphate removal from reclaimed wastewater by aquatic animals with subsequent harvest of these animals for a useful purpose.

Phosphate removal by present sewage treatment methods rarely is sufficient to prevent stimulation of undesirable algae growths. Rank algae growths are a secondary source for biochemical oxygen demand, they reduce the value of boating and fishing lakes and increase the difficulty of pumping reclaimed wastewater into permeable underground strata.

Project investigations will include: 1. Replicated experiments to measure rate of removal of algae and organic ooze (and incorporated phosphate) by selected fish and mollusks. 2. Experimental units at least 1000 gallons or larger depending on applicability. 3. Chemical analysis of water, bottom ooze and fish to evaluate degree of phosphate removal.

Data will be evaluated for practical application in sewage lagoons and reclaimed wastewater ponds with respect to recreation and domestic usage.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1160, HEAT AND MOISTURE CONDUCTION IN UNSATURATED SOILS
R.E. BABCOCK, Univ. of Arkansas, Water Resources Research Ctr., *Fayetteville, Arkansas* 72701

The object of this study is to solve the second-order, partial differential equations describing heat and moisture conduction in unsaturated soils. The set of initial and boundary conditions are those applicable to the process of simultaneously employing subsurface irrigation while disposing of nuclear reactor thermal waste water. The equations will be solved numerically in a piecewise manner using the 'leap frog' method. The analysis will be restricted to two dimensional conduction in a semi-infinite slab with a constant line source existing in the corner of the slab. Operations research methods will be applied to the model in order to schedule lateral spacing and irrigation flow rates for optimum plant growth.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1161, WATER AND WASTE WATER PURIFICATION
D.E. WEISS, Comm. Sci. & Indus. Res. Org., *Melbourne, Victoria, Australia*

The main effort has been the development of an ion exchange process of desalination ('Sirotherm') which uses hot water for generation of the resins. Now that resins with adequate physical properties have been devised, in association with local industry, work is proceeding on pilot-plant studies of the process.

In collaboration with the Australian Mineral Development Laboratory, an Asahi-type (Boby C1) continuous ion-exchange pilot plant has been successfully operated for partial demineralisation with almost theoretical consumption of acid and a lime slurry as chemical regenerants.

Work is proceeding on the use of finely divided, magnetic resins in other water treatment processes. Work has also begun on the removal of ammonia and nitrate from effluents.

SUPPORTED BY Australian Government

2.1162, REDUCING POLLUTION FROM POTATO AND ROOT VEGETABLE PEELING
A.H. BROWN, U.S. Dept. of Agriculture, Western Utilization Res. Div., *Albany, California* 94710 (W3-4-104)

OBJECTIVE: Devise peeling methods for potatoes and root vegetables which keep peeling residues separate from liquid effluent, to minimize pollution.

APPROACH: Modify present non-mechanical treatments such as lye or steam for softening or loosening the skin of tubers and root vegetables, leaving them as dry as possible. Devise new treatments as needed. Determine optimum concentrations, contact time, and temperatures. Develop mechanical methods for removal of softened tissue with a minimum of water. Evaluate solid peel residues for feed or other uses.

PROGRESS: Advice and guidance were provided for pilot and commercial scale extensions of our new dry caustic potato peeling method. A 5,000 lb. per hour dry caustic peeling system was installed in the Western Farmers Association plant, Aberdeen, Idaho, to test the commercial feasibility of the process. The pilot system was installed in parallel with a conventional lye peeler. The Potato Processors of Idaho Association cooperated in operation and evalution of the system. Results showed that the dry caustic peeling system not only eliminated the peel waste from the plant effluent, but it also resulted in lower lye consumption and lower peel losses. Lye consumption for the dry caustic peeling system was less than half of that used for the conventional peeler. Peel losses were reduced by about 30%. A 60,000 lb. per hour dry caustic peeling system has been placed in operation in Grand Forks, North Dakota. This plant is financed in part by the Federal Water Pollution Control Administration. Data collected from this installation will be made available to all potato processors. Field tests of the dry caustic peeling process were also made at two sweetpotato canneries. The process parameters must be slightly modified for sweetpotatoes, but the basic process developed for white potatoes can be applied to sweetpotatoes.

SUPPORTED BY U.S. Dept. of Agriculture

2.1163, EXPLORATORY STUDIES ON DISPOSING OF OR RECLAIMING FOOD PROCESSING WASTES
R.P. GRAHAM, U.S. Dept. of Agriculture, Western Utilization Res. Div., *Albany, California* 94710 (W3-1-150)

OBJECTIVE: Minimize pollution of land, waters and atmosphere from sources associated with food processing.

APPROACH: Study desalting of lye-peeling wash waters, including means for recovering salt or caustic. Reduce oxygen demand of liquid fruit-cannery wastes by enhanced oxidation of organic solutes. Reclaim water and brines by treatment of liquid effluents.

PROGRESS: Reclamation of olive storage brines is under study on a pilot scale in a project carried out by the National Canners Association and sponsored by the olive industry and the Federal Water Pollution Control Administration. Olives have been stored since harvest in salt brine reclaimed by passage through an activated carbon column. Although only half the normal storage period has passed, the olives are in satisfactory condition at present. Carbon treatment does not, however, remove a substantial amount of organic material from the brine. Further tests will be needed to determine how many times the brine can be reused. Meanwhile, dialysis and reverse osmosis are being investigated for removal of organics from the brine; present indications are that 75- 80% removal is feasible.

SUPPORTED BY U.S. Dept. of Agriculture

2.1164, A STUDY OF THE REMOVAL OF CARBONACEOUS, NITROGENOUS AND PHOSPHORUS MATERIALS FROM CONCENTRATED PROCESS WASTE STREAMS
H.F. LUDWIG, Engineering Science Inc., *Arcadia, California* 91006

This work is a laboratory evaluation of potential digester supernatant treatment processes. The study will include the characterization of process waste streams, the summarization and assessment of treatment technology and design and performance criteria for components of a treatment system.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1165, REDUCTION OF SALT CONTENT OF FOOD PROCESSING LIQUID WASTE EFFLUENT
J.W. RALLS, Natl. Canners Association, *Berkeley, California* 94710

1. Modification of an existing pilot ion-exchange unit from operation with brackish water to operation with olive processing waters. 2. Operation of the unit at a rate equivalent to 10,000 gallons of effluent per day while the effects in changes in influent composition on the unit performance are evaluated. 3. Investigation of the following variation in influent composition; salt content, pH, organic content, and suspended solids content. 4. Investigation of the effect of operation at different influent flow rates on the composition of purified column effluent and regeneration requirements. Investigate the highest sodium chloride concentration attainable in the regenerant effluent. 5. Operation for a sufficiently long period of continous use to develop cost factors for scale-up design. 6. Preparation of a comprehensive final report.

Project will initiate in fiscal 1970 and terminate in fiscal 1971. Current Project Period: January 1, 1970 to December 31, 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1166, DRY CAUSTIC PEELING OF TREE FRUIT TO REDUCE LIQUID WASTE VOLUME AND STRENGTH
J.W. RALLS, Natl. Canners Association, *Berkeley, California* 94710

1. To fabricate demonstration scale peel removing equipment for caustic treated apricots, peaches and pears. 2. To install the equipment in a commercial fruit cannery. 3. To make modifications to commercial scale equipment used to treat tree fruit with sodium hydroxide solutions which will provide material for testing and developing the peel removal equipment. 4. To determine the most useful operational conditions for peel removal from apricots, peaches and pears. 5. To evaluate the quality of dry-caustic peeled tree fruit in experimental packs of unfinished product. 6. To determine the changes in COD and suspended solids content of rinse waters and clean-up waters from dry-caustic peeling of tree fruit. 7. To determine the final product yield increase resulting from the use of dry-caustic peeling of tree fruit. 8. To develop sufficient operational experience with dry-caustic peeling of tree-fruit to design a full-scale commercial unit.

Project will initiate in fiscal 1970 and terminate in fiscal 1971: Current Project Period March 30, 1970 to December 31, 1970.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1167, ENTERIC VIRUS REMOVAL FROM SEWAGE STABILIZATION PONDS
R.C. COOPER, Univ. of California, School of Public Health, *Berkeley, California* 94720

In this study, it is proposed to investigate the ability of stabilization pond treatment systems to remove enteric viruses from sewage.

Studies will involve the determination of the mechanisms and the degree and rate of virus removal in laboratory model, pilot, and full- scale pond treatment systems. Virus removal efficiency will be related to the overall efficiency of the pond treatment systems as measured in terms of various treatment parameters.

It is believed that the determination of the mechanisms and the efficiency of enteric virus removal by sewage stabilization ponds will be a significant contribution to the evaluation of the potential hazard of virus transmission by water reclaimed from sewage.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1168, REMOVAL OF OIL FROM AQUEOUS WASTES BY FLOTATION

S.L. GOREN, Univ. of California, School of Chemistry, *Berkeley, California* 94720

A number of aqueous wastes carry micron and submicron droplets of emulsified oils which may affect the quality of the water into which these wastes are discharged. The proposed research is a theoretical and experimental study of air flotation applied to the removal of emulsified oils from aqueous waste. The objectives are to gain understanding of the mechanisms involved in flotation and to establish the degree and rate of clarification as functions of droplet size, bubble size, fluid and surface properties, chemical environment and other relevant parameters. Such information is necessary for the rational design and scale-up of air flotation devices for use in the treatment of aqueous wastes either alone or in combination with other treatment procedures.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1169, FILTRATION OF AQUEOUS EFFLUENTS CARRYING EMULSIFIED OILS

S.L. GOREN, Univ. of California, Graduate School, *Berkeley, California* 94720

A number of aqueous wastes carry micron and submicron droplets of emulsified oils which may affect the quality of the water into which these wastes are discharged. A promising method of separating such emulsions cheaply and throughly is to promote coalescence of the dispersed phase by passing the stream through a fibrous mat.

We are studying the coalescence of aqueous emulsions by fibrous media with the aim of elucidating the mechanisms involved and establishing the effectiveness of coalescence as a function of such variables as drop size, fiber size, mat geometry, fluid and surface properties, flow rate, etc. Our previous work has emphasized hydrodynamic factors. Current emphasis is on the role of the chemical composition of the stream, especially electrolyte type and concentration, which control double layer repulsive forces opposing coalescence. Emulsions well characterized as to drop size are passed through mats made from uniform diameter fibers, and the extent of coalescence is determined from measurements of turbidity and/or drop size distributions made with a Coulter counter before and after the mats. Pressure drop is also measured.

In addition to the purification of aqueous wastes containing emulsified oils, some of the results may be of importance in the filtration of solid wastes and in the improvement of water quality by percolation through soils.

SUPPORTED BY University of California - Berkeley, Cal.

2.1170, KINETICS OF ALGAL SYSTEMS IN WASTE TREATMENT

W.J. OSWALD, Univ. of California, School of Engineering, *Berkeley, California* 94720

The objectives of this research are: (1) To study the kinetics of algal and algal-bacterial symbiotics systems in biological waste treatment in relation to variables of substrate concentration (primarily, carbon nitrogen, and phosphorus sources), light exposure, cell concentrations, and applied turbulence on both a laboratory and on an outdoor pilot plant scale. (2) To develop a kinetic model that would incorporate the above variables, and make it possible to establish design parameters with which can be made the rational evaluation and prediction needed in utilizing algal and algal-bacterial systems in biological waste treatment, i.e., in primary, secondary, and tertiary (algae nutrient removal) waste water treatment. (3) Using the kinetic approach, to rationally develop criteria and parameters for use in the design of systems for accomplishing maximum removal of nutrients through assimilation by algae or algal-bacterial biomasses and bringing about maximum photosynthetic production of oxygen, thereby increasing the efficiency of the system, and hence reducing their areal and volumetric requiremets in practical applications. (4) Finally, through the development of a rational kinetic model for algal systems, (a) to provide a basis for a more adequate exchange and a clearer interpretation of data on waste treatment and field studies involving such systems than is presently possible, and (b) to arrive at a common denominator in the exchange of information with other scientific groups engaged in studies on systems involving algae.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1171, DRAIN DESIGN FOR NITRATE REDUCTION IN GROUND WATER

L.S. WILLARDSON, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Brawley, California* 92227

Research at the Southwestern Irrigation Field Station of the Agricultural Research Service in the Imperial Valley of California has shown that natural processes in the soil may be used to remove nitrates from ground water by reduction to nitrogen gas. More research information is needed on the degree and process of removal of nitrates from ground water moving into subsurface drainage systems. Research has also shown that soil conditions related to the reduction of nitrates are also related to iron and manganese clogging of tile drains. This study is undertaken with the following objectives: (1) to determine the effect of tile line submergence on the reduction of nitrate-nitrogen in ground water; (2) to determine the effect of surface application of organic matter on nitrate in ground water; (3) to determine the effect of tile drain submergence and surface application of organic matter on the movement of soluble iron and manganese in the soil.

On a full scale drainage system located in the San Joaquin Valley near Firebaugh, California, sampling equipment will be installed which will take moisture samples from the soil above and below the water table and in the vicinity of the drains. Platinum electrodes will be installed to measure redox potential throughout the soil. Soil samples will be obtained at various times to determine changes due to treatments. Tile lines for draining the field will be installed at various depths so that they can be submerged.

From water samples obtained from the tile lines and the soil, destruction of nitrates by natural conditions in the soil will be determined. The movement of iron and manganese in the soil toward the tile lines will be determined from the samples.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.1172, A STUDY OF A PROCESS FOR PHOSPHATE REMOVAL FROM WATER SUPPLIES USING LANTHANUM PRECIPITATION

H.L. RECHT, North Amer. Rockwell Corp., *Canoga Park, California* 91304

A laboratory investigation of the steps of a new process for phosphate removal from waste water will be performed. This process involves lanthanum precipitation of the phosphate followed by an alkali lanthanum recovery cycle. The purpose of the proposed program is to assess the technical feasibility of the process.

The speed and completeness of phosphate removal, and of each of the other process steps, as well as the extent of lanthanum and other reagent losses, will be determined parametrically in batch laboratory test using both pure solutions and sample water obtained from local treatment plants. From the results of the laboratory investigation, the technical feasibility of the process and an initial estimate of possible process economics may be determined. The results will also serve as a basis for design of an integrated laboratory process demonstration unit, which in turn would provide design data for an actual process demonstration pilot plant.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1173, PARAMETRIC STUDY OF THE KINETICS OF PRECIPITATION AND NATURE OF THE PRECIPITATE OBTAINED IN PHOSPHATE REMOVAL USING IRON AND ALUMINUM SALT

H.L. RECHT, North Amer. Rockwell Corp., *Canoga Park, California* 91304

2. WATER QUALITY

The rate of precipitate formation and the physical nature, chemical composition, and solubility of precipitates of phosphate with iron and aluminum under various conditions encountered in wastewater treatment will be investigated. Parameters to be studied include phosphate composition and concentration; pH; T.D.S.; precipitate formation; and stand time, temperature, and degree of agitation of solution during precipitate formation. Tests will be performed on pure solutions, synthetic wastewater effluents, and with secondary effluent. Results of experimental work will be used to explain the difference between predicted theoretical phosphate removals and actual removals, to identify and explain the mode of action of wastewater components contributing to the difference, and to suggest improved techniques for obtaining more complete phosphate removal by these chemical precipitation methods.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1174, ROLE OF SOLIDS IN COMBINED SEWAGE POLLUTION

D.L. FEUERSTEIN, Aerojet General Corporation, *El Monte, California* 91734

The program will establish the characteristics of combined sewage that are of significance with respect to solids separation operations and will investigate the feasibility of applying these operations for reduction of pollution from combined sewage overflows. The program consists of the collection and analysis of representative samples from the heterogeneous combined sewage and the conduct of laboratory studies to assess the impact of solids on disinfection practices. Sampling methods provide for determination of gross particle size distribution by screens in situ; thus actual effects of screening on particle coalescence and disintegration, solids separation and retention, and flow disturbance will be integrated into the results.

The sampling program will be performed in San Francisco, Calif.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1175, RENOVATION OF MUNICIPAL WASTEWATER BY REVERSE OSMOSIS SYSTEMS

D.L. FEUERSTEIN, Aerojet General Corporation, *El Monte, California* 91734

To perform laboratory-scale investigations to enhance and extend existing knowledge of the reverse osmosis process to waste water renovation applications and to determine operating parameters and relations required for system evaluation and optimization, as set out herein.

Laboratory-scale studies shall be performed using several grades of municipal waste water representing a broad spectrum of effluent qualities.

Except where noted and where necessary to the conduct of this program, flat membrane tests cells shall be utilized.

The laboratory-scale studies shall consist of three separate series of tests designed to elucidate and quantify for the reverse osmosis process the general performance, the effect of suspended solids on performance, and the membrane degradation by suspect compounds.

A mathematical model will also be developed to express the effect of above variables on process performance.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1176, NUTRIENT REMOVAL FROM AGRICULTURAL WASTE WATER

L.A. BECK, State Dept. of Water Resources, *Fresno, California* 93723

The project objective is to develop a practical biological treatment method for the removal of nutrients, essentially nitrate nitrogen, from agricultural subsurface drainage waters. The method of treatment that is being investigated is algal biomass production and harvesting. The nutrients are converted into algal cell material and removed with the cells.

Pilot scale growth units are being operated to optimize the parameters that affect algal growth. The parameters under investigation are nutrient addition, depth, detention time, mixing and climatic conditions.

Pilot scale separation units are being operated to determine the efficiency and economy of various harvesting techniques.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1177, EFFECT OF PHOSPHORUS REMOVAL PROCESSES ON ALGAL GROWTH

J.W. SCHERFIG, Univ. of California, School of Engineering, *Irvine, California* 92664

Increasing eutrophication of surface waters combined with a growing need for recreational water areas necessitate greater concern for removal of biostimulants including the classic nutrients from treated waste water. Major emphasis has been on methods for reducing the phosphorus and nitrogen content in effluents by combinations of chemical and biological processes.

There is however, little scientific evidence indicating that the efficiency of a treatment process in terms of the removal of biostimulants, can be measured only by the degree of phosphorus or nitrogen removal. Organic compounds acting as growth stimulants (such as vitamins) may be produced in significant quantities in traditional biological waste treatment processes.

Because of the complex and little understood phenomena related to algae blooms, the efficiency of current and proposed phosphate removal processes must be evaluated with respect to the removal of all biostimulants. The research proposed will seek to evaluate the individual steps in a sequence of treatment processes on the direct basis of algal growth in their effluents. It is believed that such information will provide a more rational basis for design of waste water treatment plants.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1178, A STUDY OF THE EFFECT OF ULTRASONIC ENERGY ON WASTE WATER

R. ROD, Amer. Process Equipment Corp., *Los Angeles, California* 90045

To prepare a report covering a study of the effect of ultrasonic energy on three characteristics of waste water, namely; disinfection, ammonia nitrogen content and refractory organic content. In each of the three areas of interest, the feed water shall be processed through two different air-operated ultrasonic atomizers, one operating at 50 KHz and the other at 100 KHz. In addition, an ultrasonic atomizing nozzle energized by an electro-restrictive transdoer-horn assembly operating at a frequency of 20 KHz shall be evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1179, ANTELOPE VALLEY WASTE WATER RECLAMATION FACILITY

J.A. LAMBIE, Los Angeles Co. Government, *Los Angeles, California*

The objective of this project is to demonstrate how waste waters can be reclaimed and utilized for agricultural, industrial, and aquatic recreational purposes. Tertiary treatment facilities will be used to produce the desired quality of effluent. These facilities will include oxidation ponds, chemical treatment, flocculation, clarification and filtration.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1180, TERTIARY TREATMENT IN THE PURIFICATION OF WASTE WATER

A.F. BUSH, Univ. of California, School of Engineering, *Los Angeles, California* 90024

Tertiary treatment process using trickling filter and clay coagulation to remove nitrates, phosphates, and biological contaminants from waste water is recommended in order to improve the prospects for wide use of reclaimed supplies.

As population density increases waste disposal must be oriented toward cleaner water with eventual use of reclaimed water rather than disposal.

Modern sewage treatment, like the septic tank, has duplicated many of the natural processes of waste stabilization. The aerobic conditions in the trickling filter and activated sludge systems have improved the process of biodegradation and effec-

tively destroyed the proteins, carbohydrates and fats. The water is then disposed of on spreading grounds, or into stream or oceans.

One of the advantages of soil percolation is that the water is purified by passing through it. The question arises whether a system can be developed which will produce all the results of the natural soil in a water purification process. It is a well established fact that clay in the soil profile removes phosphate and detergent.

It is now proposed that such results might be produced or closely approximated by a sequence of steps in which the trickling filter, followed by clay and alum flocculation unit and sand filter becomes the tertiary step following the algae pond (which in turn follows the activated sludge treatment).

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1181, EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS

J.E. FOXWORTHY, Univ. of Southern California, Allan Hancock Foundation, *Los Angeles, California* 90007

The principal objectives of the proposed work are: 1. To further demonstrate the applicability of previously proposed continuous volume source diffusion models to the dispersion of conservation tracer dye and bacteria within surface waste fields in the sea. 2. To ascertain the effect of the type of submarine outfall on the rate of dispersion of tracer dye and bacteria. 3. To determine, under field conditions, the rates of disappearance of coliform and Fecal Streptococcal Group bacteria. 4. To investigate the effect of vertical mixing combined with radiant energy (sunlight) on bacterial disappearance in surface waste fields.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1182, COMPARATIVE ANALYSIS OF ADVANCED WATEWATER TREATMENT PROCESSES

R.E. DELARUE, Stanford Research Institute, *Menlo Park, California* 94025

The objectives of the research are to (1) determine the costs of treating wastewater by several advanced wastewater treatment processes, (2) identify the important variables in each process and project the effects of future changes in the key process parameters on the costs of treatment, and (3) select the most promising processes for particular applications.

SUPPORTED BY No Formal Support Reported

2.1183, FURTHER STUDIES OF INFILTRATION

J.B. FRANZINI, Stanford University, School of Engineering, *Palo Alto, California* 94305

Several aspects of unsteady and unsaturated flow in soils are under analytic and experimental investigation. Numerical procedures for analyzing moisture movement in soils have been developed for both one- dimensional and two-dimensional flow. The impedance of infiltration by pressure build-up of trapped air has been investigated. The effect of an applied pressure on horizontal flow in soils has been examined.

Future work will include an investigation of two-dimensional flow with a variety of impermeable barrier configurations. This work should lead to a better understanding of soil moisture movement which has many important applications such as: infiltration and its effect on runoff, the operation of underground drainage fields, the disposal of waste water through surface spreading, groundwater recharge, and other environmental problems.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1184, NITRIFICATION AT LOW TEMPERATURE

P.L. MCCARTY, Stanford University, School of Engineering, *Palo Alto, California* 94305

The object of this proposal is to develop a process for the efficient nitrification of effluents from municipal wastewater treatment plants. This is a necessary first step in the biological removal of ammonia nitrogen which may result in eutrophication, or excessive oxygen demand in receiving waters. The proposed process, termed the submerged filter, is to operate at wastewater temperatures from 5 degrees to 25 degrees C. The system has demonstrated effectiveness for efficient biological solids capture, especially where biological solids production is low and long generation times are encountered. Waste oxygenation using pure oxygen or other efficient methods of aeration will be required. The study will determine required detention times and operating procedures for efficient operations.

This project will begin on June 1, 1970 and is expected to be completed on May 31, 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1185, MYCOLOGICAL PHENOMENA IN SEWAGE SPREADING BASINS

J.E. MCKEE, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

It is the general objective of this project to investigate the occurrence, concentration, and significance of various species of fungi in a well-ripened soil system that has been, and will continue to be, dosed daily with two feet of highly oxidized effluent from an activated- sludge plant handling municipal wastewater. Within this general objective, it is a specific aim to determine the role of major fungal species in biochemical degradation. Insofar as possible, reaction rates as well as pathways will be investigated. Special attention will be given to synergism among fungi and bacteria.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1186, BIOLOGICAL REMOVAL OF NITRATE ION ON BEDS OF ACTIVATED CARBON OR SAND

A.N. MASSE, Los Angeles Co. San. Dist. 21, *Pomona, California*

It has been discovered that denitrifying bacteria can be made to flourish on beds of granular media and that these bacteria can reduce the oxidized inorganic nitrogen forms to gaseous nitrogen. Methanol is added to the feed stream to serve as a food source to the bacteria. About 1 milligram of nitrate-nitrogen is reduced by 2 milligrams of methanol. NO3-N can be reduced to less than 1 mg/l by addition of the proper amount of methanol. Studies have been underway using both activated carbon and sand as the media. Contact times less than 10 minutes have proven adequate. The media must be backwashed frequently, but backwashing does not disturb the denitrifying properties of the media. Other studies are in progress to determine the suitability of waste products in place of the methanol.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1187, EXTENDED AERATION WASTEWATER TREATMENT SYSTEM FOR NAVAL ADVANCED BASES

J.P. COSENZA, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Technical Objective: Develop a packaged sewage treatment system that has the capability to effectively and economically treat all wastewaters from a 1,000-man naval advanced base. This development will provide improved wastewater treatment facilities in the ABFC (Advanced Base Functional Component) system.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.1188, VACUUM WASTEWATER COLLECTION SYSTEMS FOR NAVAL ADVANCED BASES

C.R. HOFFMAN, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Technical Objective: Develop a vacuum waste water collection system for worldwide naval advanced base application.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.1189, ECOLOGICAL AND PHYSIOLOGICAL IMPLICATIONS OF GREENBELT IRRIGATION

J.R. GOODIN, Univ. of California, School of Agriculture, *Riverside, California* 92502

The proposed research involves utilization of reclaimed municipal sewage effluent to irrigate a greenbelt for fire protection, recreation, groundwater recharge, improved wildlife habitat, and

increased forage production for livestock. The ecological and physiological implications of applying unusual quantities of water and nutrients to Mediterranean- type vegetation in attempting to bring about these benefits will be a prime consideration.

The Maloney Canyon project area is located near Lake Arrowhead in the San Bernardino Mountains. Reclaimed sewage effluent goes through final settling in basins located at the upper level of the project area. We propose to construct an irrigation system, experimental in design, with a main line extending approximately two miles from the effluent ponds along natural contours so that all water flow will be gravitational. Gate valves along this main will control individual replications for irrigation treatments, allowing the application of 1, 2, and 4 inches of supplementary water each week.

In addition to ecological changes brought about by the new environment, we propose to study the imposition of this changed environment upon introduced grasses, trees, and shrubs which may have fire protection, recreational, and wildlife value.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1190, TREATMENT OF PEAK WET WEATHER WASTEWATER FLOWS, AND RATE CONTROL OF ALL WASTEWATER DISCHARGES TO INTERCEPTOR SEWERS
J.A. VOEGTLE, Rohnert Park City Government, *Rohnert Park, California* 94928

Problem - The abandonment of existing wastewater treatment facilities and their connection to regional facilities is often economically infeasible due to the high cost of large interceptors. The problem is aggravated for combined collection systems or systems with excessive infiltration. The problem of treating peak wet flow at the regional facility is also perpetuated unless upstream remedial action is taken.

Plan of procedure - It is proposed that by utilizing a sedimentation - surge facility at the local plant, the underflow, throughout the year, can be controlled to discharge to the interceptor sewer at a rate slightly in excess of average dry weather flow. Existing plant facilities may be utilized as storage and treatment facilities for peak wet weather flow rate.

Techniques and Special materials - It is proposed that a sedimentation basin of broad dimensions (earth embankments with lining) be designed utilizing a hydraulic system of sludge and scum collection, to provide the controlled underflow rate at periods of peak wet weather flow. At normal flow rate the sedimentation basin (provided with aeration) can act as a conventional flow equalization (surge) facility.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1191, A PRELIMINARY BASELINE STUDY OF DILUTED POLLUTANTS IN THE PACIFIC OCEAN
J. MCGOWAN, Univ. of California, Graduate School, *San Diego, California* 92038

This program is composed of three identifiable efforts as follows: (a) Samples from the ocean including zooplankton, squid, and fish will be analyzed for pollutants (heavy and transition metals, chlorinated hydrocarbons and polychlorinated biphenyls). The samples will be from suitable existing collections and from transects across the Pacific (southwest to northeast) during 1971. (b) Similar measurements will be made on samples from coastal waters (Mexico to Washington and north) to define distribution of pollutants in the food chain, sediments, and suspected source areas. (c) The results of those measurements will be studied by an interdisciplinary group of West Coast oceanographers, later meeting with a similar East Coast study group to design a scientific plan for a long-term research effort in the Environmental Quality of the Oceans.

SUPPORTED BY U.S. National Science Foundation

2.1192, ECONOMIC AND INSTITUTIONAL ANALYSIS OF A WASTE WATER RECLAMATION AND REUSE PROJECT
H.O. BANKS, Leeds Hill & Jewett Inc., *San Francisco, California* (C-1912)

The objectives of the investigation are to develop concepts and methodology for the economic and financial evaluation of waste water reclamation and reuse as a source of supplemental water supply; to evaluate the financial impact of reclamation on the waste disposal system and to formulate the institutional arrangements necessary to make a reclamation and reuse system work.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1193, BOD, SOLIDS AND NUTRIENT REMOVAL FROM SECONDARY EFFLUENT BY FOAM FRACTIONATION
F. BELICK, San Jose City Government, *San Jose, California*

The objective of this project is to demonstrate the effective removal of secondary effluent solids, Biochemical Oxygen Demand, and nutrients such as nitrates and phosphates by a Foam Fractionation System, to be located at the San Jose - Santa Clara Water Pollution Control Plant. The aim is also to determine full-scale design and operating criteria in order to comply with required BOD and solids reduction and to attain optimum phosphate and nitrate removal. The successful demonstration of the System will provide one of the first systems that will economically remove solids; BOD, and nutrients from a waste water facility in one continuous process. Such a system would be applicable to a wide range of waste discharge volumes.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1194, THE IMPACT OF MUNICIPAL SEWERAGE CHARGES
J.A. JOHNSON, Mcmaster University, *Hamilton, Ontario, Canada*

The chief objective of the study is to describe the consequences of employing different types of sewerage charges. The study is divided into four parts. In part one the current position of sewerage charges are described. This description will be based on an analysis of mail questionnaires completed by approximately 2,000 municipalities. The relationship between size of municipality and factors like types of charge, proportion of sewerage costs covered, and proportion of businesses included in the sewerage system will be given special attention. The second part of the study is an evaluation of sewerage charges according to generally accepted tax criteria. The third part of study attempts to estimate the costs to various industries of employing different charges. This involves allocating costs under different sewerage formulas, among the industrial, commerical and residential categories and then within the industrial category. In part four, the impact of sewerage changes on industrial waste practices is investigated. An attempt is made to measure the responsiveness of business to different types of changes.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1195, WATER TREATMENT BY REVERSE OSMOSIS METHOD
A. PAKALNINS, Mcgill University, School of Engineering, *Montreal, Quebec, Canada*

(a) Proposed Research: To develop 1. a membrane with high yield characteristics, suitable for fresh water treatment; 2. a water treatment unit on a pilot plant scale.

(b) Objective: To investigate the technical and economic aspects of such a unit; and its applicability to reclamation and waste treatment.

SUPPORTED BY Canadian Government - Ottawa

2.1196, ECONOMIC FEASIBILITY OF PRODUCING DEPOLLUTANTS FROM AGRICULTURAL & INDUSTRIAL WASTE PRODUCTS TO USE IN WATER PURIFICATION (ABBREV)
J.W. PARLOUR, Univ. of Manitoba, *Winnipeg, Manitoba, Canada*

It would seem that a significant contribution to the conservation of water quality could be made by research into means whereby certain waste products (agricultural and industrial) might be utilized to provide a product or products which could in turn be employed in reducing present and future levels of water pollution.

Research is at present in progress in the Department of Food Science, University of Manitoba, under the direction of Dr. R. A. Gallop to investigate the conversion of certain agricultural solid wastes such as fibrous residues from grains, oilseeds, and food processing crops (e.g. cull potatoes) into potentially useful forms of activated charcoal. The possible conversion of waste paper, cardboard and other materials into this product is also being considered.

Activated charcoal is an extremely efficient de-pollutant and is essentially permanent in that it can be recycled with only a marginal loss of potency at each 'regeneration'. One of the possible future uses of this product which this study could investigate would be the efficient filtration of human and industrial effluent which might otherwise enter and pollute natural water resources, i.e. lakes and rivers, and underground water supplies.

Any large scale projects for the possible future production of de- pollutants from waste products must be based upon estimates of (1) likely costs of collection and processing of waste products and the actual costs of production, and (2) the benefits which might result from both the removal of waste products to produce a useful product and the employment of this product in subsequent reduction of environmental contamination as a result of large scale applications of the product.

It is recognized that the removal of certain waste products and their subsequent conversion to useful (but not necessarily economically profitable) products which can find application in the reduction of pollution may have definite social benefits which may not be readily defined in terms of dollars and cents. These social costs and benefits will also have to be considered in any evaluation procedure.

SUPPORTED BY University of Manitoba

2.1197, EVALUATION OF TREATMENT FOR URBAN WASTEWATER REUSE

K.D. LINSTEDT, Univ. of Colorado, School of Engineering, *Boulder, Colorado* 80302

The idea of renovation of wastewater for direct reuse applications has recently become of great interest to officials in the City of Denver. This interest has developed in large part because of the high cost associated with water development by transmountain diversion as it is practiced in this area. The successive use of water in the Denver Metropolitan area offers a method of significantly extending the available appropriated supplies.

The objective of the proposed project is to utilize the pilot plant developed in the first phase of this study to evaluate the technical feasibility of several treatment processes for renovating secondary effluent from the Metro Denver Sewage Treatment Plant. Specifically, efficiency data will be developed on the processes of biological nitrification, wastewater coagulation, and filtration as they are affected by variations in wastewater characteristics. The quality and cost data collected in this study will be useful in defining economic uses for renovated wastewater from the Metro Denver Waste Treatment Plant.

The project commenced June 1, 1969 and is planned for completion May 31, 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1198, PRACTICALITY OF CHLORINATING ALGAE-LADEN EFFLUENTS FROM STABILIZATION PONDS

S.E. SCHULTZ, U.S. Air Force, Frank J. Seiler Res. Lab., *Colorado Springs, Colorado* 80840

Technical Objective: AF function - environmental support of base operations (sewage treatment). Deficiency - means of disinfecting sewage stabilization ponds having high organic loading at air bases required by the Air Mobility Plan. Research - determine the disinfecting power of chlorine and its compounds in algae-laden sewage pond effluents. How research contributes - establishes criteria for disinfecting pond effluent by chlorination and establishes testing procedures to measure the effectiveness of disinfection. The objective of this research is to investigate the effectiveness of chlorination for disinfecting algae-laden pond effluents prior to release. Existing techniques for determining the concentration of indicator organisms may require modification due to high algae content in effluent water. Results of the research will establish design criteria for disinfecting stabilization pond effluent by chlorination and establish testing procedures to measure the completeness of disinfection. This is required so the effluent of stabilization ponds may be released without hazard in areas where the Air Mobility Plan is in effect such as the sea environs.

SUPPORTED BY U.S. Dept. of Defense - Air Force

2.1199, CONCENTRATION OF SUGAR BEET WASTES FOR ECONOMIC TREATMENT WITH BIOLOGICAL SYSTEMS

J.H. FISCHER, Beet Sugar Development Found., *Fort Collins, Colorado* 80521

The project is one phase of research to find an economic chemical or biological system to treat high volumes of sugar beet factory waste. One or more successful processes are necessary to satisfy effluent standards in States where sugar beets are processed.

The objective of the project is to concentrate sugar beet factory wastes by chemical precipitation and reuse of the decanted solution in a closed recirculation system. The excess water accumulated during the operation will be treated by anaerobic and/or aerobic processes to remove BOD prior to discharge. The bioactivity will be studied concurrently.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1200, NAVY ENVIRONMENT - THE MICROBIOLOGY OF THE MIDDLE SALT LAGOON AS RELATED TO SEWAGE DISPOSAL

W.L. BOYD, Colorado State University, School of Veterinary Medicine, *Fort Collins, Colorado* 80521 (N00014-67-A-0299-0015)

Technical Objective: Naval shore facilities, and in particular the Naval Arctic Research Laboratory, require knowledge of the effects of their sewage disposal on the environment in order to plan sewage treatment facilities most efficiently. The objective is to obtain and analyze biological data in order to assess the value of a large lagoon as a settling pond for sewage in the arctic environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.1201, COMBINED COOLING AND BIO-TREATMENT OF BEET-SUGAR FACTORY CONDENSER WATER EFFLUENT

G.O. LOF, Colorado State University, Environmental Resources Center, *Fort Collins, Colorado* 80521

The objective is to establish the feasibility of reducing thermal and organic pollution from beet-sugar factories by cooling towers in a closed system in which biological oxidation of sugras and other organics is induced and maintained.

The primary procedure will be laboratory determination on actual and synthetic samples of beet-sugar condenser water effluents under various conditions of termperature, concentration, recirculation rate, separation of sludges, etc. After batch experiments have yielded the necessary data, a small-scale flow apparatus will be assembled and will be operated to determine the extent to which the primary data can be applied in practical design.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1202, THE MECHANISMS OF WASTE WATER TREATMENT AT LOW TEMPERATURE

S.M. MORRISON, Colorado State University, Environmental Resources Center, *Fort Collins, Colorado* 80521

The primary purpose of the study is to identify and evaluate the biological, chemical, and physical factors that affect waste water treatment in areas and communities with prolonged periods of low temperature. This information, unknown at present, is essential to provide the criteria for the ultimate objective of waste water treatment plant design for cities at higher altitude in Colorado, as well as cities at high latitudes of the United States.

2. WATER QUALITY

The study will consist of three phases: (a) the evaluation of the biological, chemical and physical factors, (b) laboratory bench top treatment systems, and (c) the development of design criteria to incorporate new information developed under (a) and (b).

Under Phase (a), the following studies will be initiated: 1) Isolation, identification, modification, and adaptation of sewage treatment microorganisms to the cold environment; 2) Determine the optimal microbial flora for waste digestion at temperatures between 0 degrees - minus 20 degrees C; 3) Modification of the waste water as a microbial substrate to provide optimal digestion rates; and 4) Determine action of chlorine or other final disinfectant agents on potential pathogens at low temperatures.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1203, WASTE WATER DISPOSAL SYSTEMS FOR DEVELOPING UNSEWERED AREAS

R. LAAK, Univ. of Connecticut, School of Engineering, *Storrs, Connecticut* 06268

The present septic tank leaching field or seepage bed method of waste water disposal restricts development in the State of Connecticut. New methods must be developed to increase septic tank leaching fields' service life.

It is proposed to develop a backwashable leaching field that can be cleaned in place and to provide improved drainage from the seepage bed with less land area than with current methods. In addition, the suitability of soil for leaching areas will be investigated in order to achieve greater reliability in predicting the soil's capacity to accept waste effluent.

The backwashable leaching field proposed consists of a synthetic fibre bag supported by a plastic corrugated wall. The moisture content of soils and their non-capillary pores appear to correlate to leaching field performance.

The project was started in 1970 and will be completed in 1972.

SUPPORTED BY Connecticut State Government

2.1204, AIR OXIDATION OF ORGANIC COMPOUNDS IN AQUEOUS SYSTEMS

D.W. SUNDSTROM, Univ. of Connecticut, School of Engineering, *Storrs, Connecticut* 06268

Organic compounds can be oxidized chemically in an aqueous system by heating under pressure in the presence of air. When applied to the disposal of aqueous wastes, the technique is referred to as wet oxidation. Under the usual operating conditions, the organic wastes are not completely destroyed during oxidation. The method is of particular interest since the wastes are removed by chemical rather than by biological action.

The purpose of the project is to determine the reaction kinetics of several organic compounds during wet oxidation. The rate and extent of oxidation of several organic compounds will be examined over a range of temperatures, pressures and concentrations. Since simultaneous mass transfer and chemical reaction occur during wet oxidation, the relative magnitudes of these rate processes will be established. Initial experiments will emphasize the destruction of an insoluble organic compound in a flow reactor. The results of this study should provide a better understanding of the wet oxidation process.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1205, INDIVIDUAL WASTE DISPOSAL SYSTEMS

W.C. WHEELER, Univ. of Connecticut, School of Agriculture, *Storrs, Connecticut* 06268

The objective of this study is to investigate oxygen and temperature levels in the disposal fields of individual septic systems and its effect on the over-all disposal system.

Experiments will be conducted to determine the effect of temperature and oxygen on the effluent leaving the septic tank with provisions to inject air into the drainage tile lines. The evaluation of these effects will be based upon field observations.

Both laboratory and field studies are planned. The field measurements will be made at selected locations in the state.

Instrumentation will include the use of multi-point recorders for temperature measurements, pH meter, dissolved oxygen analyzer, and the standard biological and sanitary engineering tests as an aid in the evaluation of the effluents of the tests.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1206, WATER QUALITY CONTROL WITH SYNTHETIC POLYMERIC FLOCCULANTS - EFFECT OF MG, CA, CU, & ZN IONS ON BACTERIA & ALGAE (ABBREV)

J.K. DIXON, Univ. of Connecticut, Graduate School, *Torrington, Connecticut* 06790

1. The control of the quality of water with synthetic polymeric flocculants has been studied in 1967-1968 and 1968-1969 under grants from the Institute. The practical value of these polymers for the flocculation of bacteria and algae has been investigated in detail, suggesting their use in flocculating, settling, and filtration of bacteria in sewage plant effluents and other polluted waters, as well as the treatment of inland lakes with polymeric flocculants for the removal of algal contamination. 2. The optimum characteristics of the polymers have been determined. Their molecular weights and ionic character has been somewhat established, and their effectiveness at different pH values has been examined. 3. The concentration of trace metals has been reported to be a factor in flocculation experiments with silica. It is proposed that Mg plus plus, Ca plus plus, Cu plus plus, and Zn plus plus be employed in varying concentrations in a study of the flocculation of algae and bacteria. The effect of these trace metals on the kinetics of flocculation would be studied at different pH values. 4. The results would be correlated with earlier work on flocculation of solids, including bacteria and algae, in sewage plant effluents, potable water supplies and other water systems, thus broadening basic understanding of the action and the practical application of synthetic polymers for water quality control.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1207, OILY WATER SEPARATOR

W. WILSON, A M F Incorporated, *Uncasville, Connecticut* 06382 (MA-4152)

Purpose: To develop an effective shipboard oil-water separation system as a means to prevent pollution of the seas by oil discharged with bilge and ballast water.

Description: A land-based pilot system was built and tested at the contractor's seawater test laboratory. Results were limited, and were significantly lower throughout than designed. The filters were modified to increase separation efficiency at higher flow rates.

Further investigations and tests examined effects of oil concentrations, oil viscosity, flow rates, differential pressure, temperature, and filter cleaning speed. It was found that oil concentration, mixture, flow rate and differential pressure across the filters are the major considerations in the separator development. A 600-800 gpm unit was designed during Phase II. Because of excessive physical size of the larger capacity unit, the 100 gpm laboratory system was packaged and final land-tested during Phase III to establish complete operating and performance characteristics.

The unit did not perform well when fed with finely dispersed oil but was effective, yet not totally satisfactory, when oil was injected downstream of the seawater circulation pump.

The contract expired 12-31-70. Final report will be available in September, 1971.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

2.1208, TREATMENT OF BRASS MILL EFFLUENTS

O.P. CASE, Anaconda American Brass Co., *Waterbury, Connecticut* 06720

The brass industry is one of the principal industries in Connecticut affected by current efforts to reduce water pollution. Accordingly this project was undertaken on behalf of the whole industry. The project staff met regularly with an advisory committee made up of representatives from three other large brass companies.

The principal discharges requiring treatment are the spent pickle liquor and rinse water. Removal of dissolved copper is complicated by the presence of about the same concentration of chromium. In the process developed, the copper is removed by plating it out on scrap iron--so called 'cementation.' Then, the remaining liquid, which is highly acidic, is neutralized with lime causing the formation of a sludge. The sludge is removed in a clarifier and then partially dewatered in a centrifuge.

The variables affecting the efficiency of this process were studied in laboratory experiments and on a pilot plant basis. Parallel investigations were made of effluent sampling, copper recovery, oil removal and disposal, and the removal of carbon black from casting shop water. An effort was made to process the sludge into a product having intrinsic value, but no economically feasible process was found. The primary effluent resulting from the process was demonstrated as harmless to fish and the value of recovered copper represented a significant offset to the cost of the treatment.

The process for treating brass mill effluents developed in this project was described to representatives of brass companies from all over Connecticut at a special seminar held in October, 1969.

SUPPORTED BY Connecticut State Government

2.1209, INVESTIGATION OF AMPHIPATHIC WATER-SOLUBLE POLYMERS AS FLOCCULANTS AND FLOTATION AIDS IN DOMESTIC WASTEWATER TREATMENT
R.R. BROWN, Standard Brands Chem. Indus., *Dover, Delaware* 19901

New, commercially feasible, synthetic polyelectrolytes or nonionic polymers with improved flocculation ability for suspended matter in domestic wastewater will be synthesized and tested. The incorporation of surface active groups into the basic polymeric flocculant will be studied as a possible approach to enhancing the flocculating ability of polymers. Polymers will be analytically characterized as to composition, molecular weight, surface activity, charge type, density, and active group content for evaluation as flocculants and flotation aids in wastewater treatment.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1210, ROTATIONAL STABILITY IN DILUTE POLYMER SOLUTIONS
M.M. DENN, Univ. of Delaware, School of Engineering, *Newark, Delaware* 19711

The research is an investigation of the stability of rotation and parallel flow of dilute polymer solutions and the nature of resulting secondary motions. Theoretical and experimental studies suggest that the flow stability can be used as a means of determining rheological properties of systems too dilute for study by conventional measuring techniques. The ultimate goal is to obtain improved understanding of mechanisms of changes in mass and momentum transport in polymeric systems for application to one and two phase water treatment systems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1211, THE CATALYTIC OXIDATION OF ORGANICS IN WASTEWATER
J.R. KATZER, Univ. of Delaware, School of Engineering, *Newark, Delaware* 19711

Many wastewater streams, particularly those originating in the chemical and petroleum industry, contain undesirable organic materials which degrade very slowly biologically and which thus must be removed from the water by other means. Catalytic oxidation, possibly preceded by a concentration step, represents a potential method of removing such materials which have not yet been studied. It is proposed to study the catalytic oxidation of organics in aqueous solution using phenol oxidation as a model reaction. The objective of the work is to determine the kinetics and mechanism of the catalytic phenol oxidation reaction in aqueous solution and thus to begin to develop a fundamental understanding of the mechanisms of reaction and modes of action of an oxidation catalyst in aqueous solution.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1212, ANAEROBIC TREATMENT OF STARCH WASTE-WATERS
G.P. RASMUSSEN, Univ. of Delaware, School of Engineering, *Newark, Delaware* 19711

The proposed research is a determination of the BOD and solids uptake of starch wastes on contact with digested solids, the subsequent concentration of the MLSS by sedimentation and flotationand finally a material balances and kinetics study of the concentrated starch waste digestion process.

The study would involve construction of both continuous batch fed, treatment processes consisting of a complete mixed contact stage, alternate sedimentation and flotation concentration stages and a final anaerobic digestion stabilization stage. In addition , the study will be conducted at various loading rates and detention times in order to assess the effect of these parameters upon treatment performance.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1213, ECONOMIC AND ENGINEERING ASPECTS OF WATER IN DELAWARE'S AGRI-BUSINESS INDUSTRY
R.C. SMITH, Univ. of Delaware, School of Agriculture, *Newark, Delaware* 19711

Delaware's agri-business industry is a major user of water. Wise and economic use of water for food processing and waste disposal requires long-range planning now for optimum development of water resources in the State.

Waste flow measurements and composite waste samples will be taken for vegetable and for poultry processing plants. The amount of recirculated water in each plant for each product will be estimated. The waste samples will be analyzed to determine the level of BOD COD, total suspended solids and pH.

Data will be obtained from each plant to determine the existing fixed and variable costs of water requirements, waste treatment and waste water disposal. The relationship between the cost of waste disposal, the method of disposal used and the level of waste in disposal water will be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1214, ECONOMIC AND ENGINEERING ASPECTS OF WATER IN DELAWARE'S AGRI-BUSINESS INDUSTRY
R.C. SMITH, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00760)

OBJECTIVE: Determine the effect of product mix upon the level of waste and upon the efficiency of water utilization. Determine the gains that would accrue in the form of increased efficiency of water utilization and reduced waste flow per case from operating plants at maximum capacity rate.

APPROACH: Waste flow measurements and composite waste samples will be taken for vegetable and for poultry processing plants. The amount of recirculated water in each plant for each product will be estimated using the Bernouilli equation. Data will be obtained from each plant to determine the existing fixed and variable costs of water requirements, waste treatment and waste water disposal. These data will be analyzed to determine the level of waste associated with processing various products. The relationship between the cost of waste disposal, the method of disposal used and the level of waste in disposal water will be determined. The economics of recirculation of water will be determined.

PROGRESS: Water use and waste disposal data have been collected for Delaware poultry processing plants. Samples of waste water collected from various stations in the plants have been analyzed for BOD and COD. There is considerable variation in waste treatment by the various poultry plants. The level of BOD tends to vary from 400 to 1,000 parts per million in the main effluent from the plants. Several plants have added waste treatment facilities in order to reduce the strength of the waste as it enters a stream or municipal system.

2. WATER QUALITY

SUPPORTED BY Delaware State Government

2.1215, SORPTION BEHAVIOR OF ORGANIC PYROPOLYMERS IN AQUEOUS SOLUTION
S.D. BRUCK, Catholic University of America, School of Engineering, *Washington, District of Columbia* 20017

The investigation of the sorption behavior of organic pyropolymers is proposed with special reference to the removal of organic materials (including pesticides), radioactive substances and ions, such as NH4 plus, from secondary effluents. These pyropolymers can be readily prepared from commercially available heterocyclic/aromatic polyimides and, unlike activated carbons, are characterized by the presence of a large number of nitrogen and oxygen atoms, lesser quantities of hydrogen, and depending on the starting material, ionic groups. These properties, plus the fact that the microporosity of the pyropolymers can be altered by varying the preparative conditions and thermal treatment, make these systems attractive candidates for the study of the sorption- desorption processes and for the elucidation of the physico-chemical parameters that enhance these processes. Direct comparison will be possible between the sorption-desorption properties of the pyropolymers and those of activated carbons studied by other workers.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1216, STABILIZATION POND OPERATION IN TROPICAL AREAS
M.D. YOUNG, Gorgas Memorial Institute, *Washington, District of Columbia* 20006 (DADA17)

Technical Objective: Objective - to investigate and define - A. The roles of physical, chemical, and microbiological parameters in relation to operation of stabilization ponds in tropical areas with particular emphasis placed upon waste material, characteristics and loadings, dissolved oxygen, algae classification and production, and the relatively high intensity sunlight of tropical areas, B. The effects of various detention periods, water depths, and loading fluctuations upon the operation and performance of stabilization ponds in tropical areas, C. Maximum loading limits, in terms of 5-day, 20 degree C biochemical oxygen demand (BOD) in relation to design and operating parameters.

SUPPORTED BY U.S. Dept. of Defense - Army

2.1217, RECONDITIONING AND REUSE OF FOOD PROCESSING BRINES
W.A. MERCER, Natl. Canners Association, *Washington, District of Columbia* 20036

Briefly the proposal is to conduct a pilot scale study to determine the feasibility of re-using spent brines from storage and processing operations in olive packing by reconditioning the brine through a charcoal absorption and filtration column. The portable filter will be operated throughout the duration of the two year project at each of four locations in the California Central Valley area.

The supporting collection, reduction and analysis of data will be directed toward eliminating the present tie-in to municipal sewage system as well as lagoon systems used by olive processors and develop economic and effectiveness data for full scale development.

SUPPORTED BY U.S. Environ. Protect. Agency O.O.W.P

2.1218, INTEGRATED TREATMENT OF LIQUID WASTES FROM FOOD CANNING OPERATIONS
W.A. MERCER, Natl. Canners Association, *Washington, District of Columbia* 20036

The objectives of this proposal are as follows: (1) to determine the feasibility of employing a high rate trickling filter in the San Jose, California canning plant to treat strong organic wastes encountered in vegetable and fruit processing operations, which although low in volume (approx. 20% of total), contribute as much as 60% to the total BOD load. The filter will be 14 ft in diameter and 21.5 ft. high, employing synthetic media and operating in a range between 100 and 200 gpm. It will be subjected to variations in flow, pH control and nutrient addition to determine its optimum working parameters. (2) To determine the effectiveness of using an air flotation process with and without addition of flocculants in removing suspended solids prior to secondary treatment. (3) To evaluate the center discharge solids separation techniques and its effect on the total BOD content.

A study will also be made of the usage of edible acids as a bacteriostatic agent to prevent growth in recirculated flume water. Following the one year testing operation, it is proposed to select units to be incorporated in full scale plant operations for a further demonstration project. The reason for the low project cost is due to NCA already having on hand several pieces of equipment required to test these processes.

STATUS: Received worthwhile information on operation of units during last fall's processing operations. Will continue with evaluation of the various units this fall.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1219, IMPACT OF CHANGES IN TECHNOLOGY ON WATER USE
C. HOWE, Resources for the Future Inc., *Washington, District of Columbia* 20036

The objectives of the study is to determine the impact of future technological changes on water use. Alternative rates of water use by typical establishments in various sectors of the economy (e.g., residential, selected industrial, and agricultural) will be developed for several future dates as influenced by technological changes. This will be done under alternative assumptions regarding the incentives induced by (1) specific government policies (e.g., water quality standards, agricultural price policy, public water project reimbursement policy, etc.) and (2) incentives likely to occur independently of specific government policy.

Insofar as possible, water use rates will be specified in terms of rates of withdrawals, consumptive use and the disposal of water borne wastes.

The report on the investigation is nearing completion. The project was initiated in Fiscal Year 1969 and will be completed in fiscal year 1971.

SUPPORTED BY U.S. National Wtr. Comm. - Arlington, Va

2.1220, PRODUCTION OF WATER AND WASTEWATER TREATMENT EQUIPMENT
K.L. KOLLAR, U.S. Dept. of Commerce, Bureau of Domestic Commerce, *Washington, District of Columbia* 20230

Water Quality Management and Protection. A survey has been completed of some 180 manufacturing establishments engaged in the production of water and wastewater treatment equipment. The number and value of treatment equipment produced in 1968 and the production capacity for 24 major product categories will be published in a report 9/1970. Among the products the report will cover are chemical feed equipment, filtration equipment, sludge digestion and disposal equipment and package treatment plants.

SUPPORTED BY U.S. Dept. of Commerce - Bur. of Dom. Com.

2.1221, TERTIARY TREATMENT RESEARCH AT THE JOINT FWPCA DISTRICT OF COLUMBIA PILOT PLANT
D.F. BISHOP, U.S. Dist. of Columbia Govt., Dept. of Sanitary Engin., *Washington, District of Columbia*

The engineering research will provide design data and cost quality relationships for a combination of tertiary processes applied to the DC secondary influent. The research contributes to the engineering development of advanced waste treatment processes and specifically to the development of pollution control techniques for water sources such as the Potomac River. It includes evaluation of nutrient removal and wastewater renovation processes using the treatment series: chemical (lime, alum, or iron salts) clarification for phosphate and particulate removal, air

stripping for ammonia removal, pH controlled by decarbonation for removal of excess Ca , gravity filtration for final turbidity removal, granular carbon treatment for dissolved organic removal, and chlorination for product disinfection.

The pilot plant (100 gallons per day capacity) features automatic control systems which include measurement and control of: flow, pH conductivity, pressure and turbidity, and an automatic filter backwashing system. The filtration system also includes automatic differential pressure measurement through the length of filter media to permit evaluation of various media.

Chemical clarification is being evaluated first, with preliminary results: CaO dose - 250-350 mg/l; residual turbidity - 5-7 J.U.; residual phosphate - less than 0.5 mg/l.

The remaining processes will be added stepwise to the treatment series, following satisfactory development of the preceding processes.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1222, CHEMICAL SLUDGE DISPOSAL AND CHEMICAL RECOVERY AT THE JOINT FWPCA DISTRICT OF COLUMBIA PILOT PLANT

D.F. BISHOP, U.S. Dist. of Columbia Govt., Dept. of Sanitary Engin., *Washington, District of Columbia*

The research will provide engineering design data for the handling and disposal of chemical sludge products in the joint FWPCA District of Columbia tertiary treatment pilot plant. These sludges may include calcium carbonate, aluminum hydroxide, and ferric hydroxide sludges. It will also determine the feasibility of recalcining calcium carbonate sludges and removing lime for reuse in chemical clarification of wastewaters.

The research will contribute to the general development of techniques for ultimate disposal of sludge produced by advanced waste treatment process and specifically will attempt to improve the economics of lime clarification by recovery and reuse of the lime. The processes and the chemical sludge disposal system include sludge thickening, sludge dewatering (vacuum filtration, incineration and/or recalcination of the chemical sludge). The system features a pilot scale vacuum drum filter with continuous washing of the filter belt. Automatic weight of the dewatered sludge takes continuous feeding of cake to a 30-inch diameter, six-hearth furnace. The maximum furnace temperature is approximately 1900 degrees F with individual temperature control for each hearth.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1223, TREATMENT OF WATERCRAFT WASTES FROM SMALL VESSELS TO SHORE TREATMENT FACILITIES

H.G. QUASE, Underwater Storage Inc., *Washington, District of Columbia* 20036

The design, construction and operation of a pilot plant to show the feasibility of providing a facility for the collection, storage and disposal of waste from recreational watercraft.

An on-board holding tank was installed in each of ten boats for total impoundment of all effluent and for the connection to a dockside sewage collection system through a quick-connect coupling. Each boat is provided with a pump, tank and macerator. At dockside, each boat will pump directly into a piped collection system.

The dockside collection system is installed with a flexible hose connector at each ship for attachment to the respective boat. The collection system is installed for gravity flow to an underwater storage tank fabricated of synthetic rubber, impregnated with nylon fibers and fastened to the river bed by a system of patented anchors. The underwater storage tank will receive and hold the effluent for periodic discharge by an onshore pump station to sewage trucks for delivery to a sewage plant.

Flow meters are provided for recording daily and weekly waste flow. Samples of waste material leaving underwater storage tank are taken for laboratory analysis.

The facility will demonstrate that by the storage of watercraft waste, both on board and at dockside, discharge of sewage from boats into rivers will be eliminated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1224, WATER RESOURCE PLANNING IN URBAN REDEVELOPMENT

B.J. WACHTER, Water Pollution Res. & Appl., *Washington, District of Columbia* 20036

The needs for integration of efforts in water resource planning have been clearly stated. The proposed research will explore the extent to which this integration occurs in planning water resources facilities in Urban redevelopment areas.

Step 1 - The determination of how urban redevelopment in the southwest District of Washington, D.C. has affected the patterns of water use and wastewater disposal and the basis by which these changes were anticipated in the design for water and sewer utility rennovation.

Step 2 - Analysis of the extent to which water resource planning was integrated with redevelopment plans - the timing, mechanics and institutional considerations involved in coordinating plans with agencies responsible for water supply, storm drainage, sewage disposal and pollution control.

Step 3 - Determination of the relationship between information developed in (1) and (2) with comparable data from a minimum of ten other redevelopment projects in other cities.

Step 4 - The development of a manual of guidelines for consideration in water resource planning as it applies to urban redevelopment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1225, REVERSE OSMOSIS DEVELOPMENT FOR ACID MINE DRAINAGE CONVERSION

L.W. WEINBERGER, Zurn Environmental Engineers, *Washington, District of Columbia* 20037

The overall objective of this program is to determine the technical feasibility and economics of employing a reverse osmosis process for conversion of acid mine drainage to municipal and industrial water supplies. Primary emphasis in this program will be placed on field evaluations of reverse osmosis pilot plants and associated pretreatment equipment to develop design, operation and economic data for multimillion gallons per day acid mine conversion reverse osmosis plants.

The contractor will provide facilities, personnel and materials to conduct a field evaluation of reverse osmosis process for conversion of acid mine drainage to municipal and industrial water supplies. The program will be performed in three phases. The work will include, but not be limited to the following: (1) Phase I - Field Evaluation Tests at Norton, West Virginia - Analyze the field test data obtained under previous OSW contracts with the Fulf General Atomic 10,000 gpd spiral design reverse osmosis unit on acid mine drainage waters and determine alternate modes of equipment operation to obtain over 95% product recovery. (2) Phase II - Field Evaluation Test At Another OSW Designate - Operate the test equipment at the second site to verify the applicability of the operating parameters determined to be the most economic optimum at Norton, West Virginia. (3) Phase III - Preparation Of Cost Estimates - Based on information obtained in Phases I and II, prepare capital and operating cost estimates for conversion of acid mine drainage waters to municipal and industrial water supplies.

SUPPORTED BY U.S. Dept. of Interior - Off. Saline Water

2.1226, DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON AN OCEAN SHELF

R.F. MCALLISTER, Florida Atl. University, Graduate School, *Boca Raton, Florida* 33432

The purpose of this project is to learn the existing ecological regimen of an area subject to waste injection, and the effect of waste injection on an ocean shelf through a combined oceanographic and biological survey. It is further intended to learn how, by knowledge of local currents, to optimize the location of sewage outfalls. Studies will include the analysis of water and bottom samples and classification of the fauna and flora.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1227, SYSTEMS FOR TILE DRAIN SLUDGE CONTROL FOR CITRUS WITH HIGH WATER TABLE IN FLORIDA
D.V. CALVERT, Indian River Field Laboratory, *Fort Pierce, Florida* (FLA-RL-01478)

OBJECTIVE: Evaluate systems of soil modifications and tile installation in the prevention of sludging in tile drains. Evaluate the response of citrus rootstock-scion combinations to drainage systems and soil modifications. Develop prediction factors on drainage of flatwood soils.

APPROACH: This study is designed to evaluate some experimental soil management practices and drainage systems for preventing clogging of drain tiles in citrus groves planted on poorly drained soils. Twelve different citrus rootstock-scion combinations will be used as indicator plants for this evaluation. Three non-conventional grove practices will be tested singly and in various combinations: deep tillage and mixing of soil profile to a depth of 42 inches. Neutralization of the mixed soil profile with lime to a depth of 42 inches. Submergence of the tile drainage lines below the water table by maintaining water above the outlet ends of the tiles in the open perimeter ditch.

PROGRESS:

SUPPORTED BY Florida State Government - Tallahassee

2.1228, SYSTEMS FOR TILE DRAIN SLUDGE CONTROL FOR CITRUS WITH HIGH WATER TABLE IN FLORIDA
J.G. FISKELL, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-SL-01478)

OBJECTIVE: Evaluate selected systems of soil modification and tile installation for prevention of drain sludging and for growth of citrus rootstock-scions; predict drainage, sludge formation, and root viability in flatwood soils.

APPROACH: Modify acid, sandy flatwoods soils by profile mixing (42 in.) of spodic and clay layers, liming, and installation of tile drains with open and submerged outlets at 42 inches; grow six citrus rootstocks with two scion varieties on the area. Time-dependent observations of physical and chemical characteristics of soil and water will include sludge composition and formation, tile effluent flow and composition, three-dimensional distribution of soil-water potential, energy budget and water balance, and citrus rooting.

PROGRESS: Soil samples of pedons from the site for the field study at Fort Pierce were found to have most of the CEC and water-retention capacity in the spodic horizon and underlying clay. The spodic material was unusually dark, dense, and impermeable as well as highly acidic. Since deep mixing for tile drainage was to be a depth of 36 inches, it was calculated that 29 tons of lime were needed to maintain a pH above 6.5 for 20 years in the profile. This system for controlling sludging of tile drains is to be compared to deep mixing of acid soil and to shallow tillage. The equipment acquired within the department for this project has undergone tests. This included specific ion electrodes, continuous particle electrophoresis, and data acquisition system for the gamma-ray attenuation devices. Hydraulic conductivities and soil water characteristic curves were determined on undisturbed soil cores from pedons at the site.

SUPPORTED BY Florida State Government - Tallahassee

2.1229, SYSTEMS FOR TILE DRAIN SLUDGE CONTROL FOR CITRUS WITH HIGH WATER TABLE IN FLORIDA
J.M. MYERS, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-AG-01478)

OBJECTIVE: Measure the influence of sludge formation, drain efficiency and growth of citrus trees for submerged and vented outlets for subsurface drains.

APPROACH: Main plots will be 300 X 360 in size. Plots will be split into two parts and three drain lines 300 ft. in length and 60 ft. on centers will be installed in each split plot. Drain outlets from one half of the split plots will be submersed and the remainder will be vented to the atmosphere. Rate and time of outflow from the center line of each split plot will be measured and recorded. Measurements will be made to depth of water table for each of the drainage treatments. Response will also be measured in terms of chemical content of drain effluent, quantity of sludge formation, growth of plants, and fruit yield.

PROGRESS: Precipitation of ferrous sulfide sludge in and around drain lines in certain flatwood soils has rendered the drains ineffective in a relatively short period of time. Sustained economical citrus production on these soils is dependent upon effective profile drainage and water table control. Under this project, two approaches will be investigated as means of preventing the clogging of drain lines. One will be to neutralize the soil profile by mixing lime in the soil above the drain line. This should immobilize the iron in solution and greatly reduce its movement toward the drain lines. The other approach will be to install the drain lines in a manner that they must function below the water table. This will create an anerobic environment in and around the tile line. Under this regime, ferrous iron and sulfides will not be precipitated or oxidized and will leave the system in solution. A tract of land at the Indian River Field Laboratory is being developed for these and other studies relating to citrus production on flatwood soils. The perimeter ditch, dikes, roadways and part of the deep plowing - mixing has been completed. All other components of the experimental layout, with the exception of the irrigation system, have been designed. Construction on the facility will continue during the year. Tentatively planting time has been set for the fall of 1970.

SUPPORTED BY Florida State Government - Tallahassee

2.1230, INDUSTRIAL COMPLEX OF AL KHARDJ
UNKNOWN, Sogreah, *Grenoble, France*

Construction of an installation for treatment of water from the industrial complex of Al Khardj. (flash evaporation, cooling, and demineralization by mobile bed exchange of ions.)

SUPPORTED BY Thomson Houston Company - Manurhin, Arabia

2.1231, IMPROVED EQUIPMENT AND OPERATING METHODS FOR POULTRY PROCESSING TO REDUCE WATER REQUIREMENTS
R.E. CHILDS, U.S. Dept. of Agriculture, Transportation & Facil. Div., *Athens, Georgia* 30604 (TF2-115A)

OBJECTIVE: Reduce quantity of water being used to process poultry through equipment and process modifications and redesign facilities to permit water reuse where potable quality is not required.

APPROACH: Determine water demand for principal processing steps in typical commercial plants. Redesign water dispensing and run-off facilities to permit a lower operating volume. Develop and test equipment for reconditioning water for reuse in operations that do not require potable quality. Prepare recommendations and guidelines for modifying equipment and process designs that reduce water use requirements without creating hazards to product quality and minimize facility and equipment modification.

PROGRESS: Investigations of water use rates were continued in selected case study poultry processing plants to determine the quantity of water used for various processes, pieces of equipment, and overall plant operation. Measuring devices and pressure gauges were installed on water supply lines to bird washers in three case study plants. Basic data collected on bird washers currently in use include bacteria counts before and after washing, water pickup in bird washer, and volume of water used at various pressure levels. An experimental bird washer that allows an infinite number of nozzle positions and pressure adjustments was designed and constructed. Interchanging various types and sizes of nozzles made possible the study of the effects of water pressure, water flow rates, and nozzle types and position on bacteria removal and water pickup of an eviscerated broiler carcass.

SUPPORTED BY U.S. Dept. of Agriculture

2.1232, MICROBIAL TRANSFORMATION OF POULTRY LITTER AND ITS RELATION TO WATER POLLUTION
J.E. GIDDENS, Univ. of Georgia, School of Agriculture, *Athens, Georgia* 30601

The proposed research plan involves laboratory, greenhouse and field investigations directed at determining how microbial changes in poultry litter may influence the pollution of ground and runoff water. The breakdown products of the litter, especially ammonia and nitrates and the relationship of ammonia to nitrifiers and coliform bacteria will be determined.

Laboratory investigation will include; (1) Determination of microbial population of poultry litter at various stages of decomposition. (2) Analysis for ammonia at various stages and relationship of changes in chemical properties, especially ammonia accumulation to changes in nitrifiers, coliform bacteria and others.

Field and greenhouse experiments will show the effect of methods of litter application on volatile ammonia losses and movement of organic and inorganic constituents by surface and percolating water.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1233, ABSORPTION OF CHROMIUM BY CLAYS
T.F. CRAFT, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332

The effectiveness of various clays and clay materials in the removal of chromium from dilute solution is to be evaluated. Chromium can be removed effectively from concentrated solutions such as certain industrial wastes, but the methods used are not satisfactory for treatment of dilute solutions. Specialized treatment methods are not usually available at municipal water treatment plants. Clay is stocked by many plants or is readily available and could be utilized in emergency situations if it reduces significantly the concentration of dissolved chromium.

Clays will be exposed to dilute chromium solutions and the equilibria and kinetics of sorption will be studied. Analysis of both the liquid and solid phases of the systems will be neutron activation.

SUPPORTED BY Georgia Institute of Technology

2.1234, WASTE TREATMENT AND ANALYSIS FOR THE CITY OF MACON, GEORGIA
R.S. INGOLS, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332

The City of Macon has a major outfall sewer discharging into the Ocmulgee River without treatment. Directly adjacent to the outfall are two major industries also discharging untreated process waste water. While the city's waste water can be treated readily the chemical character and strength of the waste water from the Georgia Kraft Company and Armstrong Incorporated are not readily treated separately. Laboratory scale experiments have indicated that the three waste waters can be successfully treated after mixing.

A pilot plant has been developed for studying the size of a treatment plant required and for choosing the best technique of disposing of the byproduct sludges. The activated sludge process is being used in the pilot plant operation. The need for added mineral nutrients will be studied as well as possible sensor use for possible computer control.

Part of the study will involve information necessary to develop an equitable base for charging the industries for the cost of treating their waste water.

SUPPORTED BY Macon City Government - Georgia

2.1235, INTERACTION OF WATER WITH ORGANIC SPECIES
C.L. LIOTTA, Georgia Inst. of Technology, Water Resources Center, *Atlanta, Georgia* 30332

The objectives of this research are to determine the enthalpies (delta H), entropies (delta S), volumes (delta V) heat capacities (delta Cp) of ionization and dissolution in water of a series of representative organic acids and bases (phenols, carboxylic acids, thiols, amines and pyridines). These thermodynamic data have been shown to be useful in the ellucidation of the structure of water and the understanding of the nature of the interaction of water with charged and uncharged organic species. The free energies of ionization and dissolution will be determined from pKa, solubility and vapor pressure measurements. The corresponding enthalpy and heat capacity changes will be derived from high precision solution calorimetry data. Entropy changes may be calculated from the Gibbs relationship. The volume changes on ionization and dissolution will be calculated from density data derived from a high precision magnetic flow densitometer. The thermodynamic data derived from the above measurements will provide a basis for engineering calculations for the development of future designs for waste treatment projects and water contamination control.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1236, THE FINITE ELEMENT METHOD IN FLUID MECHANICS
P.G. MAYER, Georgia Inst. of Technology, School of Civil Engineering, *Atlanta, Georgia* 30332

The finite element method is a powerful analytical tool in solving engineering problems. The present study is undertaken to explore the applicability of this method to hydraulic engineering.

Successful solutions have to be found in steady saturated subsurface flows. The application is to be extended to time-dependent problems. Its immediate usefulness may be in problems involving heat dissipation and the disposal of biologically or chemically degradable liquid wastes.

SUPPORTED BY Georgia Institute of Technology

2.1237, MEASUREMENT OF ACTIVE BIOMASS CONCENTRATIONS IN BIOLOGICAL WASTE TREATMENT PROCESSES
F.G. POHLAND, Georgia Inst. of Technology, School of Civil Engineering, *Atlanta, Georgia* 30332

The purpose of the proposed research is to define the applicability and limitations of the dehydrogenase test for measurement of the active biomass used during treatment of domestic and industrial wastewaters. The specific objectives of the project are: (a) to study the effects of nutritional deficiencies and varying the organic content of wastewaters on the dehydrogenase activities of biological sludges, (b) to study the relationship between the active biomass concentrations and dehydrogenase activities of biological sludges undergoing endogenous metabolism; and (c) to develop a laboratory procedure for correlating dehydrogenase activities with the active biomass concentrations of biological sludges obtained from prototype domestic and industrial treatment processes.

The research effort will be divided into four parts including batch and continuous flow studies with pure and heterogeneous cultures. Pure culture studies will be conducted with E. coli and P. aeruginosa whereas the mixed cultures used will be derived from conventional wastewater treatment processes. Special complete mix batch and continuous flow reactors will be employed with selected substrates. Correlation of dehydrogenase activity with active biomass concentration will be obtained by standard plate and Coulter Counter enumeration, solids determinations, and enzymatic assays for dehydrogenase and substrate concentrations. The research results should provide a more reliable procedure for measurement of active biomass in both the process culture and recycle streams of conventional wastewater treatment processes including limits of its applicability to process design and control under the influence of changing environmental stresses.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1238, TREATMENT OF SELECTED INTERNAL KRAFT MILL WASTES IN COOLING TOWERS
R.B. ESTRIDGE, Georgia Kraft Company, *Rome, Georgia* 30161

The objectives of this project are to determine the technical and economic feasibility of using cooling towers to reduce BOD

and heat content of kraft mill wastes and to reduce water usage in kraft mills. Studies will be carried out on both a pilot scale cooling tower and a large scale cooling tower.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1239, POLLUTION AND REUSE OF WASTEWATER EFFLUENTS AND STORMWATER IN HAWAII

L.S. LAU, Univ. of Hawaii, Water Resources Research Ctr., *Honolulu, Hawaii* 96822

The proposed research will determine the physical, chemical, and microbiological characteristics of the wastewater effluents and stormwater runoff from representative areas on Oahu, Hawaii. Further, it is proposed to relate the characterization to the Hawaii Water Quality Standards, to determine treatment required, and to evaluate suitability for reuse such as irrigation and artifical recharge.

The stormwater study will be conducted in representative land-use areas, such as, prime agricultural, residential, and industrial. Both the yields of stormwater from storm drains and streams will be studied. The wastewater effluents will be sampled from existing treatment facilities, including primary treatment plants and secondary treatment plants using activated sludge, trickling filter, and extended aeration processes. The quality constituents under study will reflect the concern in the Hawaii Water Quality Standards. All sampling will be conducted over a 12-month period. Wastewater effluents will be studied in f.y. 1970 followed by stormwater study for industrial and residential areas in F.Y. 1971, and by stormwater study for agricultural areas in F.Y. 1972.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1240, HYDROLOGY OF SUBSURFACE WASTE DISPOSAL - NATIONAL REACTOR TESTING STATION, IDAHO

J.T. BARRACLOUGH, U.S. Dept. of the Interior, Geological Survey, *Idaho Falls, Idaho* 83401

Objectives of this project are to acquire information on the geohydrologic and geochemical environment of the National Reactor Testing Station, requiring a study of the composition and structure of the earth materials underlying the plain, the inventory and continued evaluation of the water resources, the dynamics of the hydrologic cycle, and relevant geochemical processes. This information will help to determine within the environment the concentration of any increment of aqueous waste disposed and to define it qualitatively in time and place.

Attempts will be made to determine the direction and rates of vertical and lateral ground water movement within the basalt aquifer system, movement and dispersion of radioactive wastes, the volume of regional ground water movement and storage, and to apply the techniques of radioactive dating of the quaternary basalt and Tertiary rocks exposed in the area to the solution of structural problem significant in the geohydrology of the Station.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1241, THE FEASIBILITY OF REUSE OF CHLORINATED SEWAGE EFFLUENT FOR FERTILIZATION AND IRRIGATION IN IDAHO

R.E. WILLIAMS, Univ. of Idaho, Graduate School, *Moscow, Idaho* 83843

The objective of this study is the evaluation of the feasibility of statewide reuse of sewage effluent. The steps to be taken consist of: 1. Location of communities in Idaho producing sufficient volumes of effluent to merit construction. 2. Determination of average annual volume of effluent of reuse facilities produced by each community -- minimum usable volume will have to be determined during the course of the study. 3. Determination of type of treatment employed by each community. 4. Determination of type and thickness of soils and geologic formations in each community. 5. Determination of distance from each community to irrigated crop land or to a forested area which might receive effluent. 6. Determination of types of crop grown in each irrigated area. 7. Determination of type of irrigation system employed in each area. 8. Estimation of cost of introducing sewage effluent from each locality into the existing irrigation system. 9. Estimation of cost of chlorination of effluent. 10. An analysis of existing devices in each locality which may be used for the monitoring of the quality of waters moving downward toward the ground-water table. 11. Determination of distance from ground surface to ground-water table in each locality. 12. When possible an interpretation of the direction of movement of ground water at each locality. 13. Determination of annual volume of phosphate and nitrate currently applied to the irrigated land in each locality investigated -- the volume of effluent required to duplicate this application rate can subsequently be estimated.

Once these data have been collected and analyzed, it will be possible to define those areas in Idaho wherein the addition of sewage effluent to streams can be eliminated and safely and beneficially applied as fertilizer and irrigation waters to crop or forest lands.

SUPPORTED BY Idaho State Government

2.1242, STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES

R.H. SULLIVAN, Amer. Public Works Assn., *Chicago, Illinois* 60637

Pollution of storm water in urban areas is a result of contact with features which can be controlled to some degree by man. This study is designed to identify the relative importance of features which may contribute to the pollution such as litter, air pollution, chemicals used for control of ice and snow, and pesticides. In addition operation and maintenance practices for combined sewer systems will be investigated to determine means of reducing pollution from overflow.

Public Works practices will be reviewed and procedures outlined which would affect a reduction in storm water pollution.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1243, ARMOUR INDUSTRIAL CHEMICAL SECONDARY WASTEWATER TREATMENT

E.F. HARP, Armour & Company, *Chicago, Illinois* 60611

The waste water from Armour Industrial Chemical Co.'s plant consists of a mixture of fatty acids and nitrogen derivatives of fatty acids such as nitriles; primary, secondary and tertiary amines; diamines; quaternary salts; and ethoxylated compounds. The pollutants are in part dissolved and emulsified and cannot be completely removed by a primary clarifier which is currently in use. Laboratory tests by Hydroscience, Inc. have indicated that aerobic biological treatment of the effluent from the clarifier is effective in reducing the COD, BOD, and hexane solubles of the waste stream. A pilot operation is currently being conducted to demonstrate the effectiveness of biological treatment on a larger scale and over a prolonged period of time to determine the effect of changes in flow rate and composition. The effectiveness of the secondary treatment is determined by measuring hexane solubles and the goal is to get down to 100 ppm or less in order to satisfy the Metropolitan Sanitary District of Chicago which has jurisdiction over the effluent leaving the plant.

If the pilot operation is successful, then a full scale aerated biological treatment system will be built to handle the entire effluent flow from the primary clarifier and a one year demonstration will be conducted under this grant.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1244, WHITE WATER CLARIFICATION AND REUSE

E.G. FOCHTMAN, I I T Research Institute, *Chicago, Illinois* 60616

Work is directed toward the determination of preferred methods of using retention aids in the paperboard process. Flocculation of cellulose fibers is being monitored by electrokinetic measurements. The many retention aids which are currently commercially available are being evaluated to determine their cost-effectiveness and the conditions for optimum use.

SUPPORTED BY Boxboard Research & Development Assn.

2.1245, PHOTOLYSIS MECHANISMS FOR POLLUTION ABATEMENT
L.C. KINNEY, IIT Research Institute, *Chicago, Illinois* 60616

To determine the feasibility of oxidizing the soluble organic materials in wastewater by contacting the water with photoreactive materials. The photoreactive materials for this application would be those capable of producing active oxidizing species upon exposure to sunlight or the light from inexpensive artificial sources.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1246, AMMONIA STRIPPING MATHEMATICAL MODEL FOR WASTE WATER TREATMENT
R.H. SNOW, IIT Research Institute, *Chicago, Illinois* 60616

To develop a mathematical model of air stripping of ammonia from waster water. Variables to be considered are: pH, post-precipitation, operating temperature ranges, distribution of capital and operating costs. The model will be written in a FORTRAN language applicable to an IBM 360/65 computer.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.1247, USE OF COAGULATION IN THE FLOTATION OF WASTEWATER
C.F. GURNHAM, Illinois Inst. of Technology, School of Engineering, *Chicago, Illinois* 60616

'Gross flotation' is the removal from a water medium of all species of particulate matter, including oily droplets, by attachment to the particles of freshly nucleated gas bubbles, followed by gravity separation and skimming. This process is currently in use for the treatment of industrial and municipal wastewaters, and serves to remove suspended matter including much that is not removable by the more conventional operations of primary treatment. Along with the suspended matter removal, the biochemical oxygen demand and other parameters of stream pollution are simultaneously reduced.

The process of gross flotation would be more widely used, to the benefit of the nation's waterways, if some of the present operating difficulties were better understood and could be removed, and if the operating efficiency of the process could be improved. The use of chemical coagulation in conjunction with gross flotation is an obvious means for improvement. Some waste treatment facilities have successfully employed this technique; other attempts have failed completely. Recycle ratio is undoubtedly a significant variable; zero recycle gives the maximum yield of bubbles and the opportunity for nucleation on the dispersed particles, but damages or destroys the coagulant floc by the necessity of passing it through a pump and other constrictions. Increasing recycle ratios can eliminate the latter problem, and may still produce an adequate bubble yield. Nucleation, however, is an essential and little understood aspect. The hypothesis of time lag in nucleation and of a possible very significant distinction between nucleation in homogeneous and heterogeneous fluid media are to be investigated in the project.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1248, FEASIBILITY OF SUBSURFACE LIQUID-WASTE DISPOSAL IN PENNSYLVANIA
N. RUDD, Geoengineering Labs. Inc., *Mount Vernon, Illinois* 62864

To provide: (1) a comprehensive review of the principles involved in subsurface liquid-waste disposal and possible effects upon the rock/fluid system; (2) a review of available techniques for site selection, control, and monitoring; and (3) a study of the regional geology of Pennsylvania drawing attention to factors favoring or inhibiting the development of disposal facilities. The study is intended primarily to provide a background for non-geological personnel concerned with liquid-waste-disposal operations.

The study was based on extensive review of pertinent literature, investigation of governmental and industrial records, and conventional sources of regional geological information.

SUPPORTED BY Pennsylvania State Government

2.1249, LOWER COST PROCESS FOR REFINING SOYBEAN OIL WITH REDUCTION OF WATER POLLUTION
R.A. EISENHAUER, U.S. Dept. of Agriculture, Northern Utilization Res. Div., *Peoria, Illinois* 61604 (N4-2-120)

OBJECTIVE: Develop a lower cost process for refining soybean oil and reduce stream pollution by minimizing refinery waste.

APPROACH: Investigate various types of ion-exchange resins as to particle size, type of functional group ion-exchange capacity, and ease and cost of regeneration, and relate these factors to effectiveness of sodium ion removal from a refined soybean oil. Determine variables such as feed material, regenerants, water rinses, wastes, operating temperature, and methods of analysis. Study both batch and continuous countercurrent processes. Determine if heat bleaching, which occurs during deodorization, can be made adequate to produce high-quality salad oil. Scale up the most promising process to pilot-plant size and make cost analyses.

PROGRESS: Water-recycle washing of alkali-refined, unwashed soybean oil was further investigated in a vertical rotating disc, countercurrent contactor, and in a cocurrent mixer and centrifuge with about equally satisfactory alkali reduction in both types of equipment. The cocurrent mixer-centrifuge is the type of system employed in commercial refineries for washing alkali-refined vegetable oils. Therefore, with only the addition of ion-exchange equipment and accessories, washing equipment now in use can be converted to water- recycle operation with the expectation of satisfactory results in terms of adequate sodium removal and complete recycle and reuse of wash water.

SUPPORTED BY U.S. Dept. of Agriculture

2.1250, BIOLOGICAL ASPECTS OF TERTIARY PONDS
R.L. EVANS, State Water Survey, *Urbana, Illinois* 61801

Tertiary ponds of relatively short detention periods (2-5 days) have successfully demonstrated their value in improving the effluent from secondary units of sewage treatment works. Field observations of a 23-acre pond complex, with depths varying from 10-16 feet receiving treated sewage at an average flow of 2.5 mgd revealed the major biological organisms, other than bacteria, to be protozoa. An investigation has been undertaken to monitor the phytoplankton population in the ponds and associated environmental conditions for an 18-month period.

SUPPORTED BY Illinois State Government - Springfield

2.1251, DIATOM REMOVAL BY FLOCCULATION
R.L. EVANS, State Water Survey, *Urbana, Illinois* 61801

Plankton examinations suggest the principal forms of algae in Peoria Lake (on Illinois River) are diatoms. Studies indicate that some of the abudant genera are those associated with sand filter clogging. An existing water treatment plant pumping 5 mgd from Peoria Lake provided a means for determining the removal efficiency of plankton in a clarifier preceded by a flocculation unit. A bench study is under way for the purpose of gaining some insight into the relationship of alum dosages and plankton removal as well as the effects of other additives such as potassium permanganate.

SUPPORTED BY Illinois State Government - Springfield

2.1252, NUTRIENT REMOVAL IN A WATER TREATMENT PLANT
R.L. EVANS, State Water Survey, *Urbana, Illinois* 61801

The Illinois River with a total phosphorus concentration ranging from 0.5 - 3.0 mg/l (as P) serves as a source of water for the city of Peoria. Treatment units consisting principally of a flocculator, clarifiers, and sand filters produce potable water. The

uses of chemical coagulants, filtration, and biological stripping have been demonstrated as possible avenues for phosphorus removal. This study involves the collection and analyses of water samples for the purpose of determining the extent of phosphorous and ammonia-N removal as well as changes in COD, BOD, total residue, and others and the role each treatment unit contributes to such removal or changes in concentration.

SUPPORTED BY Illinois State Government - Springfield

2.1253, WATER TREATMENT PLANT WASTES
R.L. EVANS, State Water Survey, *Urbana, Illinois* 61801

A study is under way to determine the effect, if any, that wastes generated by water treatment plants may have on potential or existing water supply sources, as well as other legitimate users of water. An effort has been made on a statewide basis to determine 1) existing methods of water treatment wastes disposal; 2) types and quantities of waste generated per unit quantity of water treated; and 3) chemical, physical, and biological characteristics of the wastes.

That phase of the project involving classification units and water softening is complete. Current efforts are devoted to investigating municipal ion-exchange units involving principally brine wastes.

SUPPORTED BY Illinois State Government - Springfield

2.1254, PILOT SCALE INVESTIGATIONS OF WELL RECHARGE USING CORED SAMPLES
H.F. SMITH, State Water Survey, *Urbana, Illinois* 61801

Purpose of this study is to determine the feasibility of recharging treated sewage effluent into the Cambrian-Ordovician (deep sandstone) aquifer in northeastern Illinois.

The physical, chemical, and biological factors affecting rates at which the effluent can be injected into the aquifer are being investigated. The effectiveness of the filtering action of the aquifer is being studied. Methods of further treatment of secondary or tertiary treated sewage effluent are being investigated so that effluent can be successfully used to recharge the aquifer system. Some success was had in maintaining constant recharge rates at constant heads through sandstone cores.

One objective of further study will be to maintain constant recharge rates for longer periods of time.

SUPPORTED BY Illinois State Government - Springfield

2.1255, THICKENING AND DEWATERING OF WATER TREATMENT SLUDGE
R.I. DICK, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

Laboratory and full scale plant investigations are being conducted to develop operational parameters for a gravity thickener to yield optimum volume reduction and solids concentration. Further dewatering investigations have involved the use of various polyelectrolytes to improve the filterability of the softening-clarification sludge by an existing vacuum coilfilter.

SUPPORTED BY Decatur City Government - Illinois

2.1256, MECHANISMS OF SLUDGE THICKENING
R.I. DICK, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

It is proposed to continue previous work which has shown present criteria for evaluating the solids loading capabilities of settling tanks to be inadequate when applied to activated sludge because of their failure to consider the rheological properties of the material. Attempts will be made to define the fundamental mechanisms which control the behavior of the sludge. The techniques for examining the thickening properties of activated sludge will be extended to other suspensions which are troublesome in water and wastewater treatment because of their failure to consolidate into compact masses. Results of laboratory batch settling tests will be compared to the performance of continuous processes in the laboratory and the field. Knowledge of the basic properties of the suspensions will be employed to evaluate possible chemical physical or biological processes or alterations of conventional processes which might improve the effectiveness of sludge thickening. Rational bases of design of the thickening portion of settling basins, as suggested by results of the fundamental studies, will be proposed.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1257, UPTAKE AND RELEASE OF SOLUBLE ORTHOPHOSPHATE BY ACTIVATED SLUDGE
R.S. ENGELBRECHT, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

A laboratory study of the effectiveness of the activated sludge process to remove phosphorus from liquid wastes has been carried out. The overall objective of the investigation was to examine the parameters that are involved in optimizing the uptake of soluble orthophosphate, and minimizing the release of soluble orthophosphate by activated sludge mixed liquor suspended solids. The variables considered were temperature, pH, food to microorganisms (F/M) ratio, contact time, aeration rate, concentrations of orthophosphate, dissolved oxygen, and degree of mixing.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1258, NEW MICROBIAL INDICATOR OF WASTE-WATER CHLORINATION EFFICIENCY
R.S. ENGELBRECHT, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

The primary objective of this research is to find a suitable and reliable indicator of the destruction of enteric pathogens by chlorine and to develop a simple and rapid means of determining the numbers of such an indicator in chlorinated wastewater effluents. Screening by chlorinating effluents from several types of present-day wastewater treatment facilities will be employed initially to provide isolates which are chlorine resistant. Media and growth conditions will be varied so as not to eliminate from consideration organisms of high chlorine resistance which may fail to proliferate under commonly used growth conditions. The chlorine resistance of successful isolates will then be studied in detail under controlled laboratory conditions both in pure and mixed cultures and under varying concentration and different chemical species of chlorine. When acceptable chlorine resistance of several organisms has been established, these will be compared to the resistance of selected enteric pathogens as well as coliform bacteria, the presently accepted indicator organism. At the same time rapid and simple means of quantitative detection of the proposed indicator will be developed.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1259, CHLORINATION OF WASTE WATER EFFLUENTS
R.S. ENGELBRECHT, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

The objective of this study was to investigate the effect of a chlorinated waste effluent on the bacteria population of a small, receiving stream. The effluent from the activated sludge treatment plant at Paxton, Illinois, discharges into a small stream which was sampled above and below the outfall. Effluent and the steam samples were analyzed for total coliform, fecal coliform, and enterococcus bacteria in the absence of and during chlorination of the waste effluent.

SUPPORTED BY University of Iilinois

2.1260, BIOMASS PRODUCTION FOR THE IMPROVEMENT OF THE QUALITY OF FOOD PROCESSING PLANT EFFLUENTS
Z.J. ORDAL, Univ. of Illinois, School of Agriculture, *Urbana, Illinois* 61801

The main objective of the proposed research is to develop a system for the improvement of the quality of food processing plant effluents. The thesis is that if the carbon to nitrogen ratio of the raw wastewater is properly adjusted, conditions can be

established which will produce a maximum biomass. Removal of the biomass will yield an effluent low in organic matter and low in nitrogen and the associated eutrophic elements. A composite wastewater from a dairy processing plant will be evaluated.

The laboratory investigation will include the following: 1. Develop an inocula by batch culture studies. 2. Evaluate a continuous culture system based on: a. The nutritional requirements for maximum biomass production. b. Manometric techniques for the determination of operational parameters. c. Modification of the system to determine practical operating parameters. 3. Removal of the biomass and analysis of the supernatant fluid (effluent) for BOD, COD, pH, N, P, and K.

Further studies will involve the evaluation of the biomass for its value as a feed supplement.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1261, RECLAMATION OF ENERGY FROM ORGANIC REFUSE

J.T. PFEFFER, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

The study is currently investigating the energy yield from anaerobic fermentation of organic refuse from systems operating at 35 degrees C. The systems are receiving shredded domestic refuse at loadings of 0.1 and 0.2 lbs volatile solids per cubic feet per day. The retention time is controlled by varying the solids content of the slurry from 5 percent to 40 percent. Efficiency of conversion is measured by the quantity of gas generated and the degree of solids destruction. Also the stability and dewatering characteristics of the residue is being evaluated.

Conversion of the organic carbon to methane by anaerobic fermentation is widely used in the treatment of waste sludges from wastewater treatment plants. This conversion reclaims a significant portion of the energy of this waste material as well as reduces the quantity of the solids by converting them to the gaseous end product.

The technology of anaerobic fermentation has advanced greatly in the past decade. These systems can be loaded at high loading rates and achieve nearly complete conversion of the organic solids to gases if the retention time is sufficiently long. The water content of the feed slurry markedly affects the size of the reactors required to obtain the degree of conversion desired. Since organic solid wastes have a low water content in comparison to wastewater sludges that are currently used in these systems, it will be possible to obtain the desired conversion without the need for excessively large reactors.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1262, EFFECT OF CHLORINATION ON CILIATE PROTOZOA AND THEIR ROLE AS A BARRIER TO STREAM POLLUTION

E.B. SMALL, Univ of Illinois, Graduate School, *Urbana, Illinois* 61801

This investigation will study two significant relationships of the ciliate protozoa present in a heavily, biologically polluted portion of the Saline Ditch in Champaign County, Illinois. One relationship is the role played by the ciliates as a natural barrier to the biological pollutants of the Champaign-Urban sewage effluent. To be investigated here will be (1) the nature of the ciliate flocculating process and (2) the chemical and physical factors (e.g. dissolved oxygen and temperature) which may control the density of the protozoan population. The second relationship is the effect, either direct or indirect, that chlorine in various representative dilutions may have upon the protozoan populations. In the laboratory, field samples of controlled temperature circulating growth chambers where the ciliate population as well as temperature, dissolved oxygen and other factors will be monitored by electronic sensors and time lapse microcinematography. These results will be compared to the chlorine effects noted when this chemical sterilant is added to the effluent.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1263, COMPETITIVE ADSORPTION IN THE REMOVAL OF ORGANIC POLLUTANTS FROM AQUEOUS SOLUTION

V.L. SNOEYINK, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

This research involves a study of the competitive interactions of adsorbates in multi-solute systems on the extent of adsorption of these adsorbates. The adsorbent of interest is activated carbon. Bi-solute, batch systems will be used. Parameters of interest include molecular size and configuration, charge and type of molecule. The objective of this research is to develop a model which can be used to predict the competitive effects.

SUPPORTED BY University of Illinois

2.1264, DISINFECTION OF SEWAGE EFFLUENTS

F.W. SOLLO, Univ. of Illinois, State Water Survey Division, *Urbana, Illinois* 61802

A study is being made of the effectiveness of bromine as a disinfectant for treated sewage effluents under varied conditions of temperature, pH, and bromine concentration in parallel with a study with chlorine as the disinfectant. Disinfection is being measured in terms of coliform, fecal coliform, and total bacterial numbers.

In addition, two streams receiving treated effluents, one chlorinated and the other to be chlorinated in the near future, are being surveyed to determine the effect of chlorination on both bacterial counts and general stream chemistry.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1265, EAST CHICAGO TREATMENT LAGOON

C. LEAHU, East Chicago Sanitary District, *East Chicago, Indiana*

The project will evaluate the effectiveness of treating combined sewer overflows in a very deep detention basin having aerobic and anaerobic levels of treatment. The aerobic treatment is accomplished by large oxygen transfer units suspended on surface of basin waters.

The major features of this project are: 1. One 20-acre, 40-foot deep, 200 million-gallon capacity detention basin. 2. Nine 50-HP, oxygen transfer units. 3. 2500 lineal-feet of prestressed concrete pressure pipe, 84 inches in diameter. 4. Chlorination equipment necessary for treating effluent from detention basin. 5. Necessary water quality and quantity monitoring equipment. 6. Necessary evaluation required to meet demonstration program objectives.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1266, MICROBIAL INTERACTIONS IN WASTE TREATMENT SYSTEMS

D.J. KIRSCH, Purdue University, School of Engineering, *Lafayette, Indiana* 47907

The growth and metabolic activity of methane-producing bacteria grown in association with both selected pure and mixed cultures of predominant bacterial types isolated from anaerobic digesters are being evaluated. A simulated mixed culture digestion system is being used; it employs semi-permeable membranes to effect physical separation of the cultures under investigation.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1267, EFFECTS OF DOMESTIC POLLUTION ABATEMENT ON A EUTROPHIC LAKE

M.W. TENNEY, Univ. of Notre Dame, School of Engineering, *Notre Dame, Indiana* 46556

The primary objective of this project is to demonstrate changes in a eutrophic lake following complete removal of all domestic pollution. Project results will then be used as a basis for suggesting possible external manipulation of the lake that may accelerate or promote beneficial natural changes. Initial studies will

include physical, chemical and biological studies of the existing source of pollution and lake conditions. After removal of the source of pollution the same studies will continue on the lake basin.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1268, REMOVAL OF ORGANIC AND EUTROPHYING POLLUTANTS BY COMBINED CHEMICAL AND BIOLOGICAL TREATMENT

M.W. TENNEY, Univ. of Notre Dame, School of Engineering, *Notre Dame, Indiana* 46556

The object of this project is to demonstrate by pilot plant techniques the operational feasibility and economic aspects of a combined biological and chemical treatment scheme for the removal of organic, nitrogenous and phosphatic pollutants from industrial and municipal wastewater. The project was started in fiscal year 1968 and it is anticipated that it will be completed in fiscal year 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1269, AMES DESIGN PARAMETERS

E.R. BAUMANN, Iowa State University, School of Engineering, *Ames, Iowa* 50010

Over the years the City of Ames and the Sanitary Engineering Section of the Engineering Research Institute have cooperated in conducting a number of full-scale studies at the Ames water treatment and water pollution control plants. Studies of the sand filters and treatment processes at the water treatment plant built in 1928 permitted the expansion of plant capcity from 2.6 to 8.0 mgd with a savings of more than $1,000,000 in construction costs.

The City of Ames is scheduled to put into operation an expanded water pollution control facility by 1972. This study is evaluating the design parameters which should be used for the expansion of the pollution control plant. The location of the City of Ames on a relatively small river, which is periodically dry poses design considerations similar to those encountered frequently in Iowa. The evaluation of the design parameters for a pollution control plant at Ames will provide a basis for evaluation of many similar plants in the state.

SUPPORTED BY Ames City Government - Iowa

2.1270, DEVELOPMENT OF PULSATING ADSORPTION FILTER FOR TERTIARY TREATMENT OF WASTE WATERS

R.L. JOHNSON, Iowa State University, School of Engineering, *Ames, Iowa* 50010

In the near future, many of the effluents from conventional sewage treatment facilities will need further tertiary treatment to reduce the organic pollution load entering our waterways. The proposed research will determine the design and operating parameters for a new type of tertiary treatment process, first through laboratory scale investigations using synthetic sewage and second by pilot plant operation of the process on actual secondary sewage plant effluent.

The new process will utilize the adsorption phenomenon of the organic materials onto sand, coal and other media, with the adsorption providing a concentration effect. This concentration of the organic material in the presence of oxygen and biological life allows further bio-degradation of the organic material. The air supply to the process provides the required oxygen for the biological life as well as the pulsating effect needed to prevent clogging of the media beds.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1271, TREATMENT OF AQUEOUS AGRICULTURAL WASTES FOR CLEAN WATER AND FOR MICROBIAL PROTEIN PRODUCTION

G.T. TSAO, Iowa State University, School of Engineering, *Ames, Iowa* 50010

The present proposal concerns a study of a biological engineering process for treating extremely high BOD (biological oxygen demand), heavily contaminated, aqueous agricultural wastes to produce microbial cells, in an unusual culturing vessel known as the Waldhof fermentor. Because of their content of surface active agents, agricultural wastes usually foam excessively when bubbled with air for oxygen supply. Ordinary sparger-agitator type of culturing vessels cannot be used for this purpose due to the high antifoaming demand. The Waldhof fermentor actually makes a virtue of extreme foaming properties and accomplishes high degree of aeration by making use of foam which has a large air- liquid contacting interface. The foam is continuously recycled in the system.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1272, LIMNOLOGICAL INVENTORY OF IOWA LAKES AND STREAMS

UNKNOWN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01564)

Progress: Major emphasis was placed on studies of tertiary treatment ponds for the improvement of water quality in the effluent of municipal waste treatment plants. In a series of four ponds at Ames, Iowa it was found that during the warm months of the year, such ponds were effective in reducing concentrations of ammonia, inorganic phosphorus and nitrates. In addition by stocking channel catfish in the four ponds, it was found that the ability of the effluent to support fish populations was improved by passage through the ponds and that a profitable harvest of fish for restocking could be obtained from the last two ponds in the series. A graduate thesis was completed on the limnology of DeSoto Bend Lake. It was found that the prevalent lake bottom material was sand. Lake water levels appeared to be dependent on the ground water level and the Missouri River water levels. Intermittent thermal stratification occurred in the summer. The bottom fauna consisted mainly of chironomids and oligochaetes, and that the higher aquatic vegetation had increased over the past nine years but comprised only 1% of the total lake surface area.

SUPPORTED BY Iowa State Government - Des Moines

2.1273, CRITERIA FOR WASTE-DISPOSAL SITES IN THE KANSAS RIVER VALLEY

P.L. HILPMAN, Univ. of Kansas, State Geological Survey, *Lawrence, Kansas* 66044

Will honor any reasonable request for further information. To determine geologic criteria essential to establishment of standards for the evaluation of applications for waste-disposal sites in the Kansas River Valley.

To prepare a series of factor maps of water-table depth, water- table fluctuation, locations of deep Pleistocene channels in alluvium, areas of high scour potential, and quality of water. Sets of observation wells will be established locally to allow qualitative and quantitative analysis of ground water. Natural and man-made changes in the regimen of some parts of the Kansas River will be monitored to try to predict water-level fluctuations and erosion potentials. A sub- project will include a feasibility study of nearby upland sites as alternatives to waste disposal in valley alluvium.

SUPPORTED BY Kansas State Government - Topeka

2.1274, CATTLE FEEDLOT WASTE WATER TREATMENT

R.E. MCKINNEY, Univ. of Kansas, School of Engineering, *Lawrence, Kansas* 66044

This project is concerned with a combined anaerobic-aerobic treatment of cattle manure washed from a feedlot by rain. The liquid runoff is collected in an anaerobic lagoon where it is partially decomposed. The liquid displaced from the anaerobic unit is treated aerobically to remove the remaining BOD. The treated material must be discharged onto fields.

This project has supported two students a year.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1275, USE OF LIME-SODA ASH SLUDGE FOR THE TREATMENT OF MUNICIPAL WASTEWATER
W.J. OBRIEN, Univ. of Kansas, School of Engineering, *Lawrence, Kansas* 66044

The objectives of this research are to analyze the excess sludge produced by the lime-soda ash water softening process used in the municipal water treatment plant at Lawrence, Kansas, and to determine the effectiveness of this material as a precipitant for wastewater.

The water softening sludge will be added to the primary sedimentation basin in the municipal wastewater treatment plant to determine the level of phosphate and suspended solids removal that can be obtained at a pH of 9.5 in the sedimentation basin. Final disposal methods for the mixture of biodegradable organic matter and chemical sludge produced at the wastewater treatment plant will also be investigated.

Both laboratory and plant scale tests will be conducted. An economic evaluation of the process will also be prepared.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1276, EXPERIMENTAL OPTIMIZATION OF STEP AERATION WASTE TREATMENT SYSTEMS
L.E. ERICKSON, Kansas State University, School of Engineering, *Manhattan, Kansas* 66502

This proposal is for an experimental investigation of the optimum hydraulic regime for the step aeration biological waste treatment process. Experimental research will be conducted to verify experimentally the available theoretical results on the optimum hydraulic regime for biological waste treatment systems. The important parameters in the mathematical models will be experimentally measured and the correspondence of the models with experimental observations will be examined. Experimental search procedures will be used to experimentally determine the optimum hydraulic regime. The results will be compared with the optimum predicted by the mathematical models.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1277, OPTIMAL DESIGN OF WASTE TREATMENT SYSTEMS
L.T. FAN, Kansas State University, School of Engineering, *Manhattan, Kansas* 66502

The purpose of this investigation is to extend research related to an ongoing research program OPTIMAL DESIGN OF WASTE TREATMENT SYSTEMS which has been supported by FWPCA since June of 1967 (FWPCA Grant No. 01141-01 and Grant No. 1WP-01141-02). The primary objective of the ongoing research program has been and still is to develop optimal designs for a variety of waste treatment systems and to establish methods for designing optimal systems. More specifically, the program involves analysis, optimization, and process design studies of both conventional and modified activated sludge processes, anaerobic digestion processes and entire treatment systems.

The proposed investigation can be roughly classified into the following several areas, namely, Simulation and Optimization of Subsystems and Components of the Wastewater Treatment System, Experimental Verification of the Results of Optimal Design Studies, Experimental Optimization of the Activated Sludge Waste Treatment System, and Simulation and Optimization of the Entire Wastewater Treatment System. Efforts will be made to account for the effects of mixing and the dynamics caused by flow rate and concentration transients in the feed stream in this analysis. Sensitivity analysis will be used to focus attention upon the most important design variables. It is anticipated that the newly proposed work will be started in June 1970 and be completed in two years.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1278, BIOLOGICAL TREATMENT OF BEEF ANIMAL WASTES TO REDUCE WATER POLLUTION
R.I. LIPPER, Kansas State University, School of Engineering, *Manhattan, Kansas* 66502

Water pollution resulting from cattle feeding operations could be reduced greatly if cattle were reared in confinement on concrete so that wastes could be readily collected for biological treatment. Poultry and swine producers have already demonstrated that confinement rearing is practical on a large scale. Confinement systems for beef production are being investigated. This research proposes to evaluate two systems for the biological treatment of beef cattle wastes. A recirculating oxidation ditch will be operated under a slotted floor for pens holding twenty beef animals in an open front shed. Another shed with capacity for twenty animals will have a solid concrete floor. Manure from the second shed will be pushed into a waste collection hopper at weekly intervals. Waste from the hopper will be fed into a mixed, anaerobic treatment system. Total and volatile solids, BOD and COD will be determined for material fed to each system. The efficiencies and operating characteristics will be determined for each system. The adaptability of the system to cattle management schemes will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1279, PILOT PLANT DEMONSTRATION OF A LIME-BIOLOGICAL TREATMENT PHOSPHORUS REMOVAL SYSTEM
L.A. SCHMID, Kansas State University, School of Engineering, *Manhattan, Kansas* 66502

The economical removal of phosphates from domestic wastewaters is a problem facing many municipalities as water quality regulations in many areas of the country now specify 80 percent or better removal of phosphate.

Laboratory research has shown that a process of lime treatment followed by biological treatment may be quite economical. Raw wastewater is first coagulated with lime and settled. The supernatant, with reduced BOD and phosphate concentration, is then subjected to a high rate, complete mix activated sludge process. Microbial metabolism of the remaining organic load results in near complete conversion of the remaining phosphate into settleable cell mass.

A pilot plant of approximately 20,000 gallons per day is to be constructed to demonstrate the process and to develop design criteria, establish operational procedures, and to determine further the economics and limitations of the system.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1280, THE MECHANICS OF SEDIMENT REMOVAL FROM ALLUVIAL STREAMS
B.J. BARFIELD, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00119)

OBJECTIVE: Develop a mathematical model relating sediment concentration to stream flow parameters and use the model to design sediment removal structures.

APPROACH: Existing theories of turbulent diffusion will be utilized in developing a model of sediment movement as related to stream flow parameters. This model will be used in the design of sediment removal structures.

PROGRESS: Research during the year 1969 has been limited to completion of research apparatus for studying sediment movement in streams. This apparatus includes a 40 foot hydraulic research flume with an adjacent sump for storing water, a deionizer for providing high quality water, a calibrating tank for calibrating velocity probes. The facility is essentially complete and calibration is presently being accomplished.

SUPPORTED BY U.S. Dept. of Agriculture

2.1281, A FEASIBILITY STUDY OF ULTRAFILTRATION AND ELECTROPHORETIC DIALYSIS FOR RECOVERY OF VIRUSES IN WASTE AND OTHER WATERS
B.H. SWEET, Gulf South Research Institute, *Baton Rouge, Louisiana*

The objectives of this grant are to evaluate and determine the feasibility of utilizing the newer ultrafiltration techniques (reverse osmosis) with selective membranes alone or in combination with electrofiltration dialysis in concentrating and detecting viruses in waste and other waters.

Towards that end, a quantitative model system will be established using polio virus diluted in water or an appropriate diluent. This diluted virus will be subjected to concentration procedures utilizing various selective cellulosic asymmetric membranes, and employing hydrostatic or osmotic pressure gradients. Both static and continuous flow systems will be analyzed using modifications of the membrane pressure cells developed by Blatt.

The physical and biological parameters, effectiveness, and limitations of the system will be evaluated.

Studies will be initiated to evaluate the electrophoretic dialyzer- concentrator (Canalco) as a method of concentration and detection of polio virus which has been diluted in water. In addition, the procedure will be evaluated as a second step viral concentration procedure following the primary selective ultrafiltration step.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1282, PREVENTING LANDFILL LEACHATE CONTAMINATION OF WATER

E.J. WREN, Gulf South Research Institute, *Baton Rouge, Louisiana*

The objective of the proposed research is to develop materials or combinations of materials that will effectively serve as sealants for containment of leachates within sanitary landfills. This research will be conducted under conditions of high water tables, high temperatures, and some 60 inches of rainfall per year.

A survey of the availability of low cost industrial waste by-products will be made. Initial screening for permeability of promising materials will be done in our polymer chemistry laboratory in order to delete unsuitable products from further study. Materials which appear promising will then be tested in laboratory scale sanitary landfills. Sealant materials which pass this evaluation will then be tested in pilot field cells.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1283, NONAQUEOUS TREATMENTS TO IMPROVE FABRIC PROPERTIES AND REDUCE WATER POLLUTION

T.A. CALAMARI, U.S. Dept. of Agriculture, Southern Utilization Res. Div., *New Orleans, Louisiana* 70119 (S2-1-374)

OBJECTIVE: Reduce stream pollution from cotton textile finishing plant effluents by developing nonaqueous scouring and mercerizing processes that also enhance the physical and smooth-drying properties of resin-treated fabrics.

APPROACH: Develop nonaqueous textile processes which will reduce stream pollution and also maximize smooth-drying appearance of resin- treated cotton fabrics. Use nonaqueous solvents in fabric preparation to minimize finishing plant effluent and also to prevent hydrogen bonding in fabrics. Investigate warp compaction as a method of relieving stresses and strains in fabrics. Employ steaming techniques and mercerizing solvents to remove undesirable creases. Apply polymers from aqueous and nonaqueous solvents to control deposition sites. Study combination of the above.

PROGRESS: The statistical experimental design for the project has been developed, six bales of cotton obtained from commercial sources, and one lot of experimental yarn processed. The 12/1 yarn has been given 18 different polymer treatments, and knitted into fabrics. The knit fabrics will be tested for dimensional stability and the permanence of the polymer film on the yarns. A conference was held with officials of the Department of Interior, Water Pollution Control Division, on water pollution problems due to textile processing. Technical literature and test methods were also obtained which will aid in guiding this research on minimizing stream pollution from textile sizing materials.

SUPPORTED BY U.S. Dept. of Agriculture

2.1284, WARP SIZES THAT AVOID STREAM POLLUTION AND IMPROVE DURABLE-PRESS FABRICS

I.T. LOFTON, U.S. Dept. of Agriculture, Southern Utilization Res. Div., *New Orleans, Louisiana* 70119 (S2-1-376)

OBJECTIVE: Develop warp-size formulations and slashing echniques that eliminate stream pollution and produce improved oven and knit durable-press fabrics.

APPROACH: Develop specific warp size formulations and slashing techniques for cotton yarns for producing woven and knit fabrics with improved durable-press properties using polymeric materials having durable and/or nondurable properties to produce both temporary and permanent coatings on cotton yarns. Select formulas showing the best results. Slash sufficient yardages of warp yarns and evaluate weaving and knitting efficiency. Chemically finish and evaluate durable-press fabrics produced from these yarns for specific end uses.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

2.1285, EFFECT OF ANIMAL WASTES APPLIED TO SOILS ON SURFACE AND GROUND WATER SYSTEMS

F.E. HUTCHINSON, Univ. of Maine, School of Agriculture, *Orono, Maine* 04473

The vertical and lateral movement of nitrate and phosphate anions through soils will be studied in both the greenhouse and field following repeated applications of varying rates of poultry manure. The soils used will be selected to give a coarse-textured glacial outwash and a medium-textured glacial till.

In the greenhouse the soils will be placed in leaching columns where water samples can be removed at various depths to determine the vertical movement of the anions following manure application. The manure will be applied at varying rates and frequencies.

In the field, manure will be applied at varying rates to plots established on the two soils and the lateral as well as the vertical movement of nitrate and phosphate will be measured by sampling with tension lysimeters. At the glacial till site a small pond will be established down-slope from the plots to determine contamination of contiguous surface waters.

Data from controlled conditions (greenhouse) and field conditions will be correlated for practical application in the establishment of maximum loading rates for animals wastes applied to these types of soil. The proposed duration of this project is FY 1971 & 72.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1286, UNDERGROUND DISPOSAL OF LIQUID WASTES IN BRACKISH WATER FORMATIONS, MARYLAND

E.G. OTTON, U.S. Dept. of the Interior, Geological Survey, *Baltimore, Maryland* 21204

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Maryland.

Purpose: To appraise some factors to be considered by governmental regulatory agencies in evaluating proposals for subsurface disposal of wastes.

Methods: The factors bearing on the feasibility of underground disposal in terms of geologic units which might be used, the methods used in underground disposal and the hydrologic conditions which govern the feasibility of underground disposal will be reviewed and evaluated. A preliminary estimate will be made of the chemical character of water in the geologic units which appear to offer promise as disposal reservoirs.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1287, AGRICULTURAL PROCESSING PLANT WASTE WATER ACCOMMODATION BY FORAGES AND SOIL

J.H. AXLEY, Univ. of Maryland, School of Agriculture, *College Park, Maryland* 20742

Waste water from agricultural processing plants should be reactified before being dumped into the nearest stream. The processing of such water by classical procedure is a costly operation. In fact, such costs can at times be ruinous to the processor. One of the systems that operates with a minimum of cost and usually meets health requirements in the purification of water is the waste water sprinkler irrigation of soils. Here the soil and plant work as a team in the filtering off and removing from the waste water the undesirable material it carries. Fourteen forages will be studied under applications of effluent from a chicken processing plant.

The forages will be harvested usually 5 or more times a year and yields will be recorded. The plants will be analyzed for N, P, K and possibly other waste contaminants. The composition of the percolating water at 6, 12, and 36 inch depths in the soil will be determined under at least 3 legumes and 3 non-leguminous plants. Finally, as this is a study of a system of water purification the role of the plant and the soil as a means of removing and eliminating nitrogen from the soil solution found at the 3 foot depth will be studied with laboratory and field trials. Soil amelioration will also be investigated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1288, POLLUTION LOADS IN PERCOLATE WATER FROM SURFACE SPREAD SWINE WASTES

H.L. BRODIE, Univ. of Maryland, School of Agriculture, *College Park, Maryland* 20742

One method of swine waste disposal is the spreading of the waste on the soil surface. Ground water contamination may result from unstable organic matter, excess nitrates, phosphates and other chemicals found in the waste. Utilizing a trench lysimeter, percolate water samples will be removed from vegetated plots to which solid and/or liquid swine wastes are applied. Waste application will be taken during the summer months. Percolate samples will be taken throughout the year. Percolate water and applied effluent will be analyzed for COD, N, P, Cl, Ca, E. Coli and Salmonella. The expected duration of the project is two years.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1289, EFFECTS OF ECONOMIC DEVELOPMENT UPON WATER RESOURCES

J.H. CUMBERLAND, Univ. of Maryland, Graduate School, *College Park, Maryland* 20740

This is a proposal to undertake research intended to provide improved data for water resource quality analysis and management. Recently published data on industrial wastes would be added as coefficients to tested economic models in order to permit measuring the specific effects upon water quality generated by each different industry as a function of the level of economic activity of that industry. This extension of economic models to include environmental pollution coefficients is intended to identify present and projected future water pollution abatement priorities and to identify opportunities for constructive use of waste through improved technology and practice.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1290, TREATMENT OF LIQUID WASTE FROM FOOD PROCESSING PLANTS

A. KRAMER, Univ. of Maryland, School of Agriculture, *College Park, Maryland* 20742

Incoming water, waste effluent, and liquid in the waste disposal systems of six commercial food processing plants will be analyzed for total solids, organic matter, certain cations and anions, pH, gases, and pesticide residues. On the basis of analytical findings, recommendations will be made on the most efficient means of water reuse before discharge, and studies will be conducted on possibilities of neutralizing, salting-out and otherwise eliminating deleterious materials from water in the plant for possible reuse, or from effluent to be collected as solids before entering the waste disposal system or direct release onto land or streams. Minimizing off-odors from waste accumulations will also be considered.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1291, DISPOSAL OF WASTE FROM SWINE FEEDING FLOORS TO MINIMIZE OR ELIMINATE STREAM POLLUTION

W.F. SCHWIESOW, Univ. of Maryland, School of Agriculture, *College Park, Maryland* 20742

A septic tank system will be constructed for disposal of wastes from a swine feeding floor to prevent effluent from such floors polluting streams. The effectiveness of such a system will be evaluated for its ability to reduce the biochemical oxygen demand (BOD) of such wastes and to dispose of the wastes by distribution through an underground tile disposal field. Data to be collected will include sludge buildup in the tanks and the gradients of distribution through the soil and the gradients of BOD reduction. The effectiveness of the septic tank and underground disposal system will be compared to that of a lagoon for which three years' operation history is available and which will be continued in service.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1292, DEVELOPMENT AND DEMONSTRATION OF METHODS FOR TREATMENT OF DAIRY FARM WASTEWATERS

D.S. KAPPE, H.L. Mills Brookl. Dairy Farm, *Hagerstown, Maryland* 21740

The object of this project is to develop and demonstrate a wastewater treatment system for satisfactorily treating animal wastes and runoff from dairy cattle holding areas, beef cattle feedlots, and similar places that have a reasonable first cost, low operating expense, and minimal maintenance requirements. Under the project program, an experimental treatment facility will be designed for the study and demonstration of various treatment methods or schemes. This facility will be constructed on the grounds of an operational dairy and will receive for treatment animal wastes and storm water runoff from a cattle holding area as well as wastewaters from a milking parlor and a milk processing and bottling plant. Altogether, six methods of treatment will be evaluated and demonstrated with the facility, all based on biological processes. Complete records on relevant dairy operations will be kept and appropriate wastewater analyses will be performed to provide sufficient data to evaluate the effectiveness of each method of treatment investigated. In addition, facility construction, operation, and maintenance costs will be compiled and a cost analysis of the treatment system will be made. The project was initiated in December 1969 and will continue until September 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1293, BIODEGRADABILITY OF TNT

J.M. ROSEN, U.S. Navy, Ordnance Laboratory, *Silver Spring, Maryland* 20910

Technical Objective: Investigate the feasibility of microbiological means of counteracting water pollution from explosive facilities.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.1294, REVERSE OSMOSIS TREATMENT OF WASTEWATERS

R.T. SKRINDE, Univ. of Massachusetts, School of Engineering, *Amherst, Massachusetts* 01002

Removal of pollutants from water by reverse osmosis has great potential as a new, efficient, and economically feasible method of wastewater treatment. The process has been investigated primarily as a method of desalination of sea water, and only recently has any attempt been made to apply reverse osmosis to the treatment of municipal and industrial wastewaters.

The purpose of this research is to obtain data needed to evaluate and apply reverse osmosis as a process for the treatment of wastewaters. In particular, an improved understanding of the mechanism of separating organic materials from water is essential to development of more suitable membranes and better geometric design of reverse osmosis cells.

The objectives of this study are to: a. Obtain data essential to development of design parameters, including data on liquid diffusion rates, efficiency of separating organic pollutants, and cell operating characteristics for presently-available membranes utilizing waters containing selected organic and inorganic chemicals. b. Apply the above data in developing membrane separation techniques for advanced treatment of organic industrial wastes and municipal sewage. In addition to the development of membranes and cells specific to wastewater treatment, this phase of the investigation will consider systems in which reverse osmosis

may be utilized in conjunction with such chemical additives as activated carbon and polyelectrolyte coagulant aids. The systems developed will be tested on municipal sewages and industrial wastes.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1295, TRANSPORT AND FATE OF POLLUTANTS IN SOIL
H.A. THOMAS, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

Develop mathematical models describing the movement of liquids in unsaturated porous media to delineate the critical factors in design and utilization of soil systems for waste water treatment and disposal or waste water reclamation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1296, STUDIES IN FOAM SEPARATION AND RELATED TECHNIQUES
B.L. KARGER, Northeastern University, Graduate School, *Boston, Massachusetts* 02115

The distribution factors of several metal ions have been measured as a fuction of HCL concentration for a foam separation process. Measurements have been performed on a recycling batch foaming apparatus. Using a cationic surfactant, hexadecyltrimethylammonium bromide, maxima in distribution factors have been obtained at IN HCL for Hg and 8N HCL for Fe. Thus, by adding controlled amounts of HCL selective removals of metallic species can be achieved. It is also worth pointing out that distribution factors have been measured as low as 10 to the minus 12th power M metal ion concentration, and results indicate that foam separation techniques are effective at this level. These studies can be of value in deciding conditions necessary for use of foam separation techniques as in-plant clean-up procedures for industrial wastes. Studies are also underway in examining the extraction mechanism involved in solvent sublimation. The results of this study will be presented at a later date.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1297, AN ELECTROCHEMICAL METHOD FOR REMOVAL OF PHOSPHATES FROM WASTEWATERS
S. SADEK, Dynatech Corporation, *Cambridge, Massachusetts* 02139

The technical and economic feasibility of removing phosphate from wastewater by the application of an electrolytic process using expendable metal electrodes will be determined on a laboratory scale.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1298, MICROBIAL MEDIATION IN GENERATION OF ACID MINE WASTES
W. STUMM, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138

The objectives are: 1) The development of a field method, using radioactive carbon, which permits measurement of the synthetic activity of autotrophic iron bacteria in situ. 2) To perform field studies with the Carbon-14 Method: a) Measure in situ the activity of autotrophic bacteria directly or indirectly involved in oxidation of pyritic agglomerates. b) Compare microbial activity at various locations in the mine, i.e., vapor phase and liquid phase reaction sites, and interrelate these findings with results on chemical analysis for pH, Fe(II), Fe(III), acidity, SO4 minus 2. 3) Comparison of mine waters which differ in the rate of acidity production in an attempt to elucidate the chemical and biological factors responsible for these differences. 4) Evaluation of the results with regard to possible modes of control of microbial activity.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1299, MATHEMATICAL MODEL OF THE ELECTRODIALYSIS PROCESS FOR ADVANCED WASTE TREATMENT
J.D. SMITH, Process Research Incorporated, *Cambridge, Massachusetts* 02142

The objective of this contract is to develop a mathematical model of the electrodialysis process for use in preliminary design and simulation of wastewater treatment processes.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1300, SELECTIVE NITRATE AND PHOSPHATE REMOVAL
J.D. SMITH, Process Research Incorporated, *Cambridge, Massachusetts* 02142

The objectives of this proposed research program are: 1. To investigate an ion exchange membrane system for selective removal of nitrates and phosphates. 2. To determine the initial feasibility of this system. 3. To develop a preliminary design rationale for the proposed system, and 4. To estimate the potential effectiveness and economics of such a system in waste water nutrient removal applications.

A laboratory scale nitrate and phosphate removal system, using exchange membranes will be constructed. Nitrate and phosphate transport rates will be determined with this system, using commercially available anion exchange membranes. Parameters which will be examined will include: 1. Driving force, or chemical affinity. 2. Concentrations. 3. Flow velocity, and 4. Membrane type.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1301, COMMUNITY ADOPTION OF WATER RECYCLING SYSTEMS
R. KASPERSON, Clark University, Graduate School, *Worcester, Massachusetts* 01610

Within the last decade, research has demonstrated that recycling of reclaimed wastewater is a technological feasible and an economical viable alternative in the provision of domestic water supply. With the projected demand for water expected to exceed supply by the year 2000, especially for many of our large metropolitan areas, the alternative of recycling can contribute significantly toward alleviating the scarcity of water. To date, very few communities have chosen to develop a recycling system. And, in most places planning for improved urban water supplies, recycling is virtually absent from the discussion of alternatives. However, discussions of future water supply problems assume a widespread adoption of recycling.

Identification of the potential problems and prospects of community adoption of recycling systems constitutes the focus of this research project. The role of information and perception, and the type of political structure will be analyzed as they relate to the adoption process. An intensive study of eight cities, each concerned with the immediate provision of water supply, will be completed focusing upon: 1) the type of political framework in which water supply planning is formulated; 2) the perception of the range of choice and attitudes toward recycling by consumers, public officials, consulting engineers, and public health officials, and the bases for the identified perceptions; and, 3) the formulation of opportunities directed toward the encouragement of the consideration of water recycling systems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1302, PILOT-SCALE STUDY OF IMPROVED PHOSPHATE REMOVAL BY MODIFIED ACTIVATED SLUDGE PROCESS
G. REMUS, Detroit City Government, *Detroit, Michigan*

The primary objective of this project is to determine the most suitable and economically feasible treatment process for the continuous removal of at least 80 per cent of soluble phosphates from the wastewater of a large municipality. The process must also be compatible with treatment for removing a high percentage of suspended solids, phenols, oils, and bacteria, and reducing BOD.

By resticting the supply of phosphates to Lake Erie, the growth of algae in the Lake may be slowed and the life of the Lake lengthened.

The most promising tests will be subjected to large-scale pilot plant studies to determine their suitability for use in large treatment plants. Of importance will be the follow-through on sludge disposal to determine the adequacy of sludge thickening, dewatering, and incinerating devices for delivering the phosphates taken up by the sludge, and to keep them from the plant effluent.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1303, THE CHARACTERIZATION OF SOLUBLE PHOSPHORUS COMPOUNDS IN BIOLOGICAL WASTE TREATMENT PROCESSES

F.M. DITRI, Michigan State University, School of Engineering, *East Lansing, Michigan* 48823

The soluble phosphorus compounds existing in waste flows through the treatment plant are usually considered to be in the form of organic phosphates and simple or condensed forms of the oxyanion, while these complex compounds such as the hydroxyphosphates, hydroxyapatites and apatities, which may be present, are generally considered. Furthermore, data on the hydroysis transformation of these complex phosphorus compounds in an activated sludge environment are not known with any certainty. Since the trend in waste water renovation today is clearly toward tertiary treatment the influence of these complex phosphorus compounds needs to be established since the solubilities of several of these compounds are normally exceeded several-fold in the process stream.

This proposed research will be directed toward the in situ qualitative and quantitative identification of the soluble phosphorus compounds existing in the process streams of prototype units of the activated sludge processes. The various forms of phosphorus in a filtered sample of the waste water will be separated on thin-layer chromatographic plates and the respective concentrations determined by optical scanning of the thin-layer plates with a densitometer.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1304, THE RATE OF NITROGEN AND PHOSPHORUS STRIPPING FROM SEWAGE LAGOONS BY AQUATIC ANGIOSPERMS

C.D. MCNABB, Michigan State University, Graduate School, *East Lansing, Michigan* 48823

Stripping of nitrogen and phosphorus from organic effluents or from sections of stream overburdened with these plant nutrients continues to be a major problem in relation to degradation of the aquatic environment. While practical physio-chemical processes for use in treatment facilities have recently been improved to a degree, significant quantities of these elements are consistently discharged through installations of the most modern design to lakes and streams. It has been obvious to ecologists for decades that the harvest of primary producers would remove nutrients and a nuisance from eutrophic habitats, and possibly result in an economic gain from the harvest. Some impressive efforts have been expended to identify the most efficient system for the harvest of planktonic species of algae. Little effort has been applied to the aquatic angiosperms for the same end.

The objective of this research is to determine the rate at which nitrogen and phosphorus are removed by selected species of aquatic angiosperms from water in sewage oxidation ponds during different seasons of the year. Species of Cabomba, Ceratophyllum, Myriophyllum, and Ranunculus will be used. Groups of each type of plant will be acclimated to a pre-absorption physiological state in laboratory troughs. Light and temperature regimes close to those of the season in a nearby sewage oxidation pond will be maintained in the troughs. Concentrations of nitrogen and phosphorus in the tissues of experimental lots of plants will be fixed by controlled bleeding of medium into the troughs. Lots will be submerged for varying periods of time in the sewage pond. Tissue analyses will be made upon removal, and time- related changes in the levels of the nutrients determined. Environmental parameters will be monitored in the laboratory and field. Project begun in fiscal year 1969; to be completed in fiscal year 1970.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1305, AN EXPERIMENTAL PROGRAM ON WATER QUALITY MANAGEMENT

UNKNOWN, Michigan State University, Graduate School, *East Lansing, Michigan* 48823

Michigan State is planning to develop a series of lakes and ponds stocked with aquatic plants and fish to serve as 'living filters' for sewage effluent. Some of the water in various stages of purification, will feed areas planted with trees, grass, crops, and garden plants. Most of it will be retained in the system and allowed to replenish the water table, which has dropped 200 feet since 1945.

Part of the 300-acre area will be used as a public park, with boating, fishing, and other recreational facilities. Research and training will be carried out in hydrology, biology, argonomy, fish culture, and other sciences, and social and economic studies undertaken to evaluate the effectiveness of the system for community water quality management.

SUPPORTED BY Rockefeller Foundation - New York, N.Y.

2.1306, HYDROLOGY OF RIVER-BASED RECREATION

G.E. HENDRICKSON, U.S. Dept. of the Interior, Geological Survey, *Lansing, Michigan* 48933

Purpose:- This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of Michigan. To analyze the hydrologic factors related to use of cold-water rivers in a glacial terrain, to provide guidelines for assessing the potential recreational value of such rivers, and to determine how development by man in the watersheds affects the recreational value of the streams.

Methods: On the basis of streamflow and water quality records, geology, topography, and amount of development, select representative rivers in northern Michigan, assemble information regarding streamflow characteristics, stream morphology, water temperature, ground-water levels, and areas of ground-water discharge. Obtain information on recreational potential of rivers, including fish populations and present and future use for fishing, boating, and camping. Interpret relationships of recreational uses to hydrology of the watershed. In developed watersheds obtain information on surface and ground water withdrawals, disposal of sewage and other wastes, regulation by dams, and indirect controls by timber-cutting and other changes in land use in the watersheds. Report on relationships of characteristics of streamflow, water quality, and stream morphology to river-based recreation.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1307, DEMONSTRATION OF THE RECONDITION AND RE-USE OF ORGANICALLY CONTAMINATED BRINES FROM CHEMICAL PROCESS INDUSTRIES

C.J. PINAMONT, Dow Chemical Company, *Midland, Michigan* 48640

Project objectives and description of work: 1) Develop and demonstrate a charcoal adsorption process for the treatment of process wastewater from a phenol manufacturing plant. 2) Demonstrate the requirements for by-product recovery from the subject wastewater, which will include the net recovery of both organic and inorganic. Phenol and acetic acid will be removed from a sodium chloride brine. 3) Demonstrate wastewater re-use on an engineering scale. Process will recondition 100 gpm of wastewater. 4) Research and develop methods for a) the regeneration of adsorption materials to be used in the proposed process, and b) establishing requirements and limitations on the use of the renovated brine wastewater for chlorine-caustic production.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1308, PHOSPHATE REMOVAL BY BIOLOGICAL PROCESS

T.L. HENNESSEY, Trenton City Government, *Trenton, Michigan* 48183

2. WATER QUALITY

The purpose of this project is to develop a modified form of the activated sludge processes in which soluable phosphates are removed by natural biological processes from waste water and contained in the sludge withdrawn from the treating units. Phosphates will be removed from the liquid discharged from sludge dewatering either chemically or physically. Pilot plant operation shall establish the design criteria for the new secondary plant to be put into operation by November 1, 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1309, PILOT PLANT INSTALLATION FOR USE OF FUNGI IMPERFECTI ON VEGETABLE WASTES

W.R. BROSZ, Green Giant Company, *Le Sueur, Minnesota* 56058

The use of fungi imperfecti for the treatment of liquid waste streams from the vegetable processing industry has been investigated by North Star Research and Development Institute in the laboratory. They have been successful in reducing starch waste with a B.O.D. of 3,200 down to 40 ppm. in a twenty hour residence time by continuous fermentation with successful removal of mycelium.

The presently proposed program is aimed at determining whether the effectiveness of fungi imperfecti can be realized in a pilot scale installation at a plant site. It is proposed that two 7,500 gallon aerated systems be tried. One would be an aerated lagoon and the other an aerated ditch. These would be installed at Green Giant's corn and pea processing plant at Glencoe, Minnesota. Data and observations will be gathered to assure that a stable fermentation cycle is achieved, to establish suitable start-up procedures, to compare fungi imperfecti with uninoculated aerated lagoons (to be installed and operated by Green Giant), to determine the usefulness of lagooned wastes as feed to the fermentation, and to aid in subsequent scale up. Other objectives are to further study aeration requirements, to determine the effects of flow patterns on the success of the fermentation, and to study filtration and drying problems.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1310, DEMONSTRATION OF THE CHANNEL AERATION PROCESS IN TREATMENT OF SEWAGE

H. BAUER, State Dept. of Health, *Minneapolis, Minnesota* 55414

The purpose of the project is to demonstrate the efficiency of the channel aeration process of sewage treatment on the removal of plant nutrients such as phosphate and bound nitrogen, and the removal of Salmonella and enterovirus from the incoming sewage. The effect of the treated effluent on algae and other aquatic plant growth in the receiving lake will be studied.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1311, FLOCCULATION AND CLARIFICATION OF MINERAL SUSPENSIONS

I. IWASAKI, Univ. of Minnesota, School of Mineral Engin., *Minneapolis, Minnesota* 55455

The clarification of the plant effluents from mineral processing operations is becoming a major concern of the iron ore industry of Minnesota. In a recent test program on flocculation and clarification of iron ore slimes and taconite tailings using lime and starch as flocculants, a complex relationship among pH, calcium ion and starch concentrations, size distributions, and flocculation, clarification and filtration behavior has been noted. Not only for efficient utilization of the flocculating agents on the settling and clarification of the mineral suspensions, but also for minimizing the pollution of the effluent by these reagents, it is desirable to formulate the nature and extent of their adsorption and to correlate with the flocculation and clarification behavior of some pure minerals and their mixtures of interest to the iron ore industry. Quartz and goethite of several different size distributions have been chosen for the investigation. The surface properties in the presence of these flocculants are being studied using the streaming potential technique to provide further insight into the flocculation behavior of these minerals. Different types of polymeric flocculants are also being included to study the effect of their chemical constitution.

The project commenced on January 1, 1969 and will be completed on September 30, 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1312, NITRIFICATION AND DENITRIFICATION OF WASTE WATER

W.K. JOHNSON, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414

The objective of this project is to conduct small-scale continuous flow pilot plant investigations to investigate nitrification in the activated sludge process and denitrification for the purpose of removing nitrogen from wastewaters. Several flow patterns will be investigated including a staged operation with nitrification and denitrification used alternately. A synthetic milk waste will be used as the raw waste feed to the pilot plants. No results of the investigations are available at this time. It is planned that larger scale demonstration plant tests using domestic sewage will also be conducted during the coming year.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1313, REMOVAL OF COLLOIDAL MATTER FROM WASTE WATER

W.J. MAIER, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414

This research program is designed to provide a more basic understanding of the removal and metabolism of organic colloids from waste waters as a result of biological activity. The experimental work is set up to obtain information on both the mechanism and the rates of removal of various organic colloids. The program covers a broad range of operating variables. Experiments are being carried out in two types of reactors; the film flow reactor simulates conditions where mass transfer is a rate limiting factor whereas the well mixed reactor approaches conditions where mass transfer is rapid and metabolism is the rate limiting factor. A variety of colloidal substrates is being tested over a broad range of operating conditions, namely, protein, starch and lipid.

The final objective is to develop theoretically sound rate equations to describe the effects of process variables on the rates of removal of various organic colloids. This information is to be used in correlating and interpreting plant test data and day to day variations in conventional biological treatment processes.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1314, TREATMENT OF WASTES USING PEAT, AND PEAT IN COMBINATION WITH SOIL

R.S. FARNHAM, Univ. of Minnesota, School of Agriculture, *Saint Paul, Minnesota* 55101

To study the adsorption phenomenon of peat and peat-sod mixtures, both in the field and laboratory. The object is to reduce phosphates and organic loading of waste water.

The mechanics of the filtering process are being studied as well as addition of chemicals to increase efficiency of the phosphate and B.O.D. reduction by using peat.

Work is being done both at the laboratories of the University of Minnesota and in the field in St. Louis County, Minnesota, at Wilderness Valley Farms, Zim; Sewage Disposal Plant, Virginia, Minnesota. The first year of this project started April 1, 1969. Work to be completed by March, 1971.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.1315, EFFICIENCY AND ECONOMY OF POLYMERIC SEWAGE CLARIFICATION

K.D. LARSON, South St. Paul Sew. Disp. Com., *South Saint Paul, Minnesota* 55075

The project objectives are to determine the increased purification attainable by treating industrial wastes (packing house), sanitary sewage, combined sanitary sewage and storm waters or combinations of such wastes with polyelectrolytes and floc 'weighting agents.' Design parameters for the degree of treatment to be expected will be established on the combined city sewage

and industrial wastes, on the city wastes for both 'dry weather' and 'wet weather' flows, and on the industrial wastes separately. Physical and chemical characteristics of the sludge obtained as a result of this treatment procedure will be established.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1316, FORAGE CROP IRRIGATION WITH OXIDATION POND EFFLUENT
J.B. ALLEN, Mississippi St. University, School of Agriculture, *State College, Mississippi* 39762

This study will investigate the feasibility of using oxidation pond effluent for the irrigation of high yielding forage crops in Mississippi. The objectives are: 1. To determine the practicality of disposing of oxidation pond effluent through irrigation of forage crops. 2. To investigate the effect of oxidation pond effluent on forage crop yields. 3. To determine the effect of oxidation pond effluent on soil nutrients and on runoff water from the plots.

The field study will be carried out using effluent from a one acre oxidation pond which serves a residential area. A series of test plots will be prepared for furrow irrigation and planted in a high yielding sudan grass-sorghum hybrid. Various amounts of oxidation pond effluent and ordinary lake water will be applied to the plots. The weight and quality of the forage from each plot will be determined. At various times during the growing season the effluent from the oxidation pond and the storm runoff from the test plots will be analyzed for BOD, coliform bacteria, nitrogen, and phosphorous. The ground water level at the test plot area will be monitored.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1317, POLLUTION EFFECTS DETERMINATION
L.R. BROWN, Mississippi St. University, Inst. for Space Env. Sci. Eng., *State College, Mississippi* 39762

The purpose of this effort will be to evaluate the effect of RP-1 and trichloroethylene on the stabilization of sewage, and to relate these findings to the operation of sewage lagoons in terms of their effect on the efficiency of operation.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.1318, EVALUATION OF CURRENT TECHNIQUES OF NUTRIENT REMOVAL FROM WASTE WATERS
A. SHINDALA, Mississippi St. University, School of Engineering, *State College, Mississippi* 39762

As a result of an extensive research program, techniques for removing a high fraction of nutrients, mainly nitrogen and phosphorus, from waste effluents have already been developed. However, such information is so widely scattered through the literature that it is not readily available to those concerned with the problem.

The main objective of the proposed study is to compile and evaluate the available information on current techniques for removing nutrients from waste waters with emphasis on type of treatment (physical, chemical, biological or any combinations); economics (capital and operating costs); efficiencies; and applications.

The goals of the proposed study will be achieved through a comprehensive search of the literature, questionnaires and personal interviews with scientists, engineers and other investigators.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1319, ORGANIC WASTES AS A MEANS OF ACCELERATING RECOVERY OF ACID STRIP-MINE LAKES
D.L. KING, Univ. of Missouri, School of Engineering, *Columbia, Missouri* 65202

This proposed research is aimed at evaluating the potential for accelerating recovery of acid strip-mine lakes by the addition of waste organics such as domestic sewage sludges and animal manures. Specifically, this study plan calls for determination of the rate of formation of bicarbonate--carbonate alkalinity in acid strip-mine lakes by carbon dioxide release associated with bacterial utilization of organic wastes. The establishment of such a carbonate buffer system is required to provide the available carbon source necessary to support significant amounts of algal production as well as to neutralize the mineral acidity common to such lakes.

This study will be conducted in laboratory microcosms of acid mine water to which varying amounts of raw sewage sludge will be added. Measurement paramaters to evaluate the rate of recovery are inorganic and organic carbon content, titrametric buffer determinations, pH, and chlorophyll content.

Results of this study will allow calculation of the amount of organic waste which should be added to acid strip-mine lakes to yield a significant degree of recovery.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1320, RESEARCH INITIATION - LAKE POLLUTION BY INTERNALLY PRODUCED ORGANICS
J.T. NOVAK, Univ. of Missouri, School of Engineering, *Columbia, Missouri* 65202

The failure of man to control his natural environment is due to a lack of understanding of the complex systems which govern this environment. It is the purpose of this research to seek further insight into some of the relationships which govern plant productivity in lakes. Such information must be used as the basis for waste treatment plant design if the environment is to be most beneficially managed. In this study the production rate and identification of complex acidic organic materials produced as intermediates during anaerobic degradation of algae materials is to be determined. These degradation intermediates can effect productivity by two methods, increasing the concentration of nutrients in solution and increasing the availability of these nutrients for plant use. Identification of soluble organic constituents produced during anerobic metabolism will comprise a major portion of this study. The molecular weights, acidity and chemical composition of these organics will be determined.

SUPPORTED BY U.S. National Science Foundation

2.1321, AN INVESTIGATION OF LIGHT-CATALYZED CHLORINE FOR TREATMENT OF WASTE WATER
A.F. MEINERS, Midwest Research Institute, *Kansas City, Missouri* 64110

The purpose of the study is to investigate the effect of light on rate and extent of chlorine oxidation of a variety of organic materials typical of those found in waste water and representative samples of effluent from biological treatment plants; to determine the capabilities of light-catalyzed chlorine oxidation and to make an economic analysis of the feasibility of such treatment.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1322, WATER GEOCHEMISTRY OF MINING AND MILLING RETENTION PONDS IN THE 'NEW LEAD BELT' OF SE MISSOURI
E.A. BOLTER, Univ. of Missouri, School of Science, *Rolla, Missouri* 65401

The proposed research plan involves laboratory and field investigations directed at the determination of the removal processes of heavy metals from the waters of mining and milling retention ponds. The main approach in the investigation is to determine if the heavy metals are removed from the water as (a) precipitates, such as sulfides or carbonates, (b) by adsorption on clay minerals or (c) by uptake through organic matter, such as algae. In addition, the influence of organic flotation agents used in the milling processes on the transport of particulate matter will be investigated.

Field investigations: Water samples, samples of particulate matter and of organic material will be collected at several points in the ponds and at the outflow. The amount of particulate matter leaving the ponds will be determined. The retention time of the ponds will be investigated.

Laboratory investigations: The heavy metal content of pond water, suspended particulate matter and organic material will be determined by atomic absorption spectrophotometry. The mineralogy of particulate matter in the ponds will be determined

by X-ray analysis. The influence of organic flotation agents on the suspension time of particulate matter will be investigated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1323, THE USE OF ANAEROBIC FILTERS FOR THE RENOVATION OF ACIDIC WASTEWATERS
R.H. CLARK, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

The research proposed would investigate the use of anaerobic filters as a means of treating acidic wastewaters which are organically polluted. Laboratory completely mixed biological reactors are to be used to determine the steady state pH tolerance of anaerobic digestion using various typical acidified wastes and waste constitutents. Predictive and design equations for anaerobic filters treating these acidic wastes will be developed and then tested using laboratory anaerobic filters. Design and operational procedures and recommendations will be formulated during the final phase.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1324, A NEW APPROACH FOR WATER RECLAMATION - COMPLETE TREATMENT OF WASTE WATER BY PHYSICO-CHEMICAL PROCESSES
J.C. HUANG, Univ. of Missouri, Environmental Health Res Ctr, *Rolla, Missouri* 65401

The purpose of this research project is to investigate the applicability of using advanced physico-chemical processes for the complete treatment of primary effluents for reuse applications of several selected waste waters, ranging from regular domestic sewage to high strength, nonbiodegradable industrial waste. Particular emphasis will be placed on the evaluation of the treatment efficiency and performance characteristics in the operation of each process for various types of waste.

The proposed waste treatment scheme will include chemical coagulation and clarification, filtration, and carbon adsorption. Laboratory-scale units will be constructed for the operation of each treatment stage. Treatment efficiency will be determined on the basis of removals of organic materials, suspended solids, turbidity, phosphorus, nitrogen, and bacteria from waste waters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1325, USE OF DOMESTIC WASTE GLASS FOR URBAN PAVING
W.R. MALISCH, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

Laboratory and field studies have been used to investigate the possible utilization of waste glass as aggregate in asphaltic paving mixtures. Mixtures satisfying standard paving design criteria have been designed using penetration grade asphalts and aggregates. Bonding of asphalt and glass in the presence of water can be greatly improved by the addition of hydrated lime to the mixture.

Glass asphalt mixtures can be placed and compacted using conventional construction equipment. Initial skid resistance for the field installation has been adequate but tests are continuing to assess long term changes in skid resistance.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1326, REMOVAL OF PHOSPHATES BY SORPTION ON ACTIVATED ALUMINA
K. PURUSHOTHAMAN, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

The proposed research is a laboratory investigation of the sorption method of removing phosphates from water using activated alumina, and its specific objectives are to evaluate the capacity of the activated alumina to sorb phosphates in the presence of other ions and to determine the effect of ionic concentration on the efficiency of the process. Studies will be conducted using three types of phosphate containing test water, deionized water, tap water, and secondary sewage treatment plant effluent. Jar tests and column studies will be made to determine the sorptive capacity of activated alumina under equilibrium conditions to evaluate phosphate removal under varying phosphate concentration, ionic strength, feed flow rate, and alumina bed depth, and to investigate the feasibility of regeneration of the used alumina.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1327, EFFECT OF SURFACTANT MICELLES ON METAL ION REMOVAL BY FLOTATION FROM METALLURGICAL WASTEWATER
R.L. VENABLE, Univ. of Missouri, Water Resources Research Ctr., *Rolla, Missouri* 65401

Pollution of our water resources is now recognized as a pressing national problem. Among the serious contaminants are heavy metal ions such as copper, nickel, zinc, and lead. The proposed work will be a fundamental study of a possible way of removing such metal ions from dilute aqueous solutions by flotation with surfactants. The behavior of heavy metal ions in the presence of surfactants is complex and little work has been done to elucidate this complex behavior.

It is proposed to determine the state of solution of metal ions at various surfactant concentrations by a combination of turbidity and surface tension measurements. This is necessary to an understanding of the flotation process because the flotation characteristics of free heavy metal-surfactant molecules would be expected to be different from that of such molecules when they are incorporated into the interior of aggregates of surfactant molecules called micelles, which would be still different from the flotation characteristics of precipitated heavy metal-surfactant particles.

As a further aid to understanding the flotation process, efforts will be made to disintegrate surfactant micelles to fragments with bursts of ultrasonic energy and observe the effects of this disintegration on the efficiency of flotation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1328, REMOVAL OF METAL IONS BY FLOTATION WITH SURFACTANTS
R.L. VENABLE, Univ. of Missouri, Graduate School, *Rolla, Missouri* 65401

The nation's water resources are rapidly becoming seriously polluted and some of the very toxic contaminants are metal ions. If a way of removing these metal ions from solution could be developed which is more economical than present treatment methods, the technique would have potential as a means of reducing this pollution. The proposed study would be a fundamental investigation of the method called ion flotation which utilizes solutions of surface active agents or surfactants and which has potential as an economical treatment procedure.

The objectives of the proposed work are to make ion flotation studies on ions not previously investigated. The studies will attempt to determine what type of surfactant is most effective and what conditions of pH, surfactant concentration, and temperature are necessary for the method to be effective. An additional objective will be to study the effects of addition of surfactant on the state of solution and availability for flotation of the metal ions. These studies are to be correlated with the flotation studies as an aid to understanding the results obtained there.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1329, LIME-LIMESTONE NEUTRALIZATION OF ACID MINE DRAINAGE
L.G. KOEHRSEN, Peabody Coal Company, *Saint Louis, Missouri* 63102

This research project consists of the development of a full-scale plant for the neutralization of acid-mine drainage utilizing lime and limestone in series and in parallel. Interpretation of the operating data obtained in a manner that it may be utilized as a design basis at other locations where a neutralization facility is warranted.

The plan of operation includes research, design, construction and operation of a full-scale acid-mine drainage neutralization

plant for treating acidic discharges from the Will Scarlet Mine of Peabody Coal Company located near Carrier Mills, Illinois.

The immediate and long-range objectives of the proposed project include the following: 1. To add to current technology regarding techniques of neutralization of acid-mine drainage utilizing limestone alone and in combination with lime. 2. To design, construct and operate a full-scale neutralization plant to treat acidic discharges from the Will Scarlet Mine of Peabody Coal Compnay. 3. To develop through operation of the plant a workable and practical design of treatment units and techniques to optimize neutralization efficiency and minimize chemical and operating costs. 4. To extract design parameters from the operational data for application to efficient design of similar facilities at such locations where neutralization of acid-mine drainage is warranted. 5. To publish the background studies, operational information and final results in a form usable to all parties confronted with an acid-mine drainage problem.

This project was started during fiscal year 1969 and will be completed during fiscal year 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1330, COLOR AND MINERAL REMOVAL FROM KRAFT BLEACH WASTES

R.L. SANKS, Montana State University, School of Engineering, *Bozeman, Montana* 59715

The purpose of project is to determine the economic potential of synthetic resins for the control of pollution from kraft bleach wastes particularly in reuse and recycle systems.

The optimum treatment system is expected to consist of lime precipitation followed by decolorization and partial demineralization with resins. Processes to be evaluated include sorption only and partial demineralization by the Duocat and Desal processes and possibly by the Sul-biSul process as well.

Date of completion is June 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1331, MICROBIOLOGY OF ESTUARINE AND SHELLFISH POLLUTION

L.W. SLANETZ, Univ. of New Hampshire, School of Liberal Arts, *Durham, New Hampshire* 03824

Studies will be continued on the comparative efficiency of coliforms, fecal coliforms, fecal streptococci, and bacteriophages as indicators for the presence of salmonellae, enteric viruses, and other microbial pathogens in estuarine waters and shellfish. Sampling stations will be selected which meet sanitary standards for approved and conditionally approved shellfish growing areas. Attention will be given to procedures for the detection and use of bacteriophages as indicators of enteric virus contamination, and to methods for the enumeration or detection of salmonellae, pseudomonas, Vibrio parahemolyticus and other bacteria in estuarine water and shellfish. Emphasis will be given to factors which affect or procedures that may be effective for the decontamination or depuration of oysters and clams under controlled laboratory conditions using facilities in a new estuarine laboratory located next to the estuarine area under study. Naturally contaminated oysters and clams harvested from polluted areas and shellfish artificially contaminated with indicator bacteria, phages, salmonellae, and enteric viruses will be used for these studies. The efficiency of waste treatment plants for the elimination of indicator organisms and microbial pathogens in effluents discharged into estuarine waters and the impact of two new municipal treatment plants on the sanitary quality of these waters will be determined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1332, HYDROGRAPHY OF NEW YORK BIGHT IN RELATION TO OFFSHORE WASTE DISPOSAL

R.I. WICKLUND, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Highlands, New Jersey* 07732

Study the hydrography of the New York Bight with particular emphasis on conditions having a direct effect on the movements of waste disposal.

Measure and analyze temperature and salinity throughout the water column at 26 stations every two weeks, and release 300 sea bed drifters and drift bottles once a month.

Establish sta ons, utilizing sub-surface buoys, at six locations equipped with thermographs located at the bottom and in midwater. Supplemental buoy stations may be added to verify hypothesis developed from interpretation of regular station data.

Temperature, salinity, and density determinations to be plotted on horizontal and vertical profiles and drifter, current meter, and thermograph data processed and analyzed by computer techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1333, RECLAMATION OF METAL VALUES FROM METAL-FINISHING WASTE TREATMENT SLUDGES

W.V. TURNER, Metal Finishers Foundation, *Montclair, New Jersey* 07043

The nature of the waterborne wastes produced in metal-finishing operations is such that complex and costly methods have been needed to prevent the pollution of water by toxic compounds used by this industry. The specific steps involved in the treatment of these wastes vary considerably from installation to installation. However, the general treatment consists of: (1) separation of grease and oil; (2) reduction of chromates; (3) oxidative destruction of cyanides; (4) neutralization and liquid-solid separation; and (5) disposal of the sludge. The metals initially present in the wastewaters are precipitated as hydroxides during the treatment operations. The metal- bearing sludes are difficult to handle and their final disposal often is the most troublesome and costly aspect of the treatment of metal- finishing wastes. These sludges are a potential source for pollution of surface and ground waters because of the highly reactive nature of the metal hydroxides which they contain.

Preliminary surveys indicate (1) that the removal of metals from these sludges may simplify disposal and diminish potential hazards, and (2) that the reclamation of these materials (nickel, copper, cadmium, etc.) may significantly reduce the net cost of sludge disposal. The current program is concerned with supplementing the existing information by specific and numerous in-plant studies, determining whether metal reclamation is as worthwhile as is now suspected, and evaluating processes that would be applicable to the recovery of these metals and/or to the improvement of disposal methods.

The program is being conducted at the Columbus Laboratories of Battelle Memorial Institute. It is anticipated that the work at Battelle will begin in November, 1970, and will be completed in January, 1972.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1334, AN INVESTIGATION OF TECHNIQUES FOR THE REMOVAL OF CHROMIUM AND CYANIDES FROM ELECTROPLATING WASTES

W.V. TURNER, Metal Finishers Foundation, *Monclair, New Jersey* 07043

The Metal Finishers' Foundation will conduct a two-phase research and demonstration project on methods for economically treating cyanide and chromium wastes from small plating shops. Phase I will include (a) a 'State of the Art' review of recovery techniques, (b) accumulation of data on waste stream compositions, (c) selection of techniques for bench scale study and selection of extractants and complexing agents, (d) bench scale experimental investigation of selected techniques, and (e) evaluation of the test results and preparation of recommendations. This phase will require one year.

Phase II will consist of (a) the design of the process and the processing equipment, (b) acquisition and installation of the equipment in an electroplating plant, (c) operation of the demonstration plant to accumulate data, and (d) the evaluation of the data and preparation reports.

The work will be performed by subcontract to the Battelle Memorial Institute at Columbus, Ohio. Various treatment methods, including liquid-liquid extraction, ion flotation, and precipitate flotation, will be investigated and compared.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1335, PROCESS CONTROL MODEL FOR OXYGEN REGENERATION OF POLLUTED RIVERS
B. DAVIDSON, Rutgers the State University, School of Engineering, *New Brunswick, New Jersey* 08903

The proposed research plan involves the application of lumped and distributed parameter optimal control theory as a tool in the systems analysis of a new class of in situ treatment alternatives for polluted rivers and streams. The control variables are instream aeration, biochemical oxygen demand distribution, nuclear power plant cooling water distribution, and dilution water distribution from a reservoir. All controls are distributed continuously in space and time coordinates and optimized with respect to an objective function of the cost functional type with weighted energy constraints. For the lumped parameter cases, Pontryagin's Extremum Principle will be invoked, whereas for the distributed systems, a spatially discretized schema will be used in conjunction with Pontryagin's method in order to obtain optimal solutions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1336, REMOVAL OF PHOSPHATE FROM WASTE WATER BY ALUMINUM AND IRON
P.H. HSU, Rutgers the State University, School of Agriculture, *New Brunswick, New Jersey* 08903

Results from previous studies indicate that the effectiveness of aluminum and iron to precipitate phosphate from solution drastically varied with experimental conditions. Three subjects will be covered in this proposed project to continue the investigation on the factors that govern the optimum conditions of phosphate precipitation: 1. Effect of order of mixing reactants on the precipitation of phosphate by aluminum; 2. Effect of Casuper2plus and Mgsuper2plus on the precipitation of phosphate by aluminum; and, 3. Aging of iron solution and its effect on the precipitation of pnosphate.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1337, THE ORGANIC CONCENTRATION GRADIENT IN AN AERATION COLUMN
B.T. KOWN, Rutgers the State University, School of Engineering, *New Brunswick, New Jersey* 08903

The proposed research is to investigate those chemical and physical factors, in addition to operational variables and equipment geometries, which influence the organic concentration gradient in the bulk solution of an air bubble column containing waste water. The objectives of the proposed research are to determine the factors influencing the gradient and to evaluate its possible application to the removal of the pollutants from waste water.

The initial phase of the proposed study will be concerned with the determination of the relationship between the nature of foams generated by rising air bubbles in a bubble column and the nature of the pollutants in the waste. The studies are to be made by batch equilibrium-type experiments.

The second phase of the study will involve laboratory studies of the organic concentration gradient which resulted from stripping action of the rising air bubbles and deposit of concentrated pollutants at the liquid level by ruptured air bubbles. Equipment geometries and operational variables which influence the equilibrium concentration gradient will be investigated.

The final phase of the study will be devoted to the evaluation of the possible application of the concentration gradient in the separation of organic pollutants from waste water. The application will be considered in two areas; one in which the pollutants are directly separated by removing the organic-rich-surface liquid, and the other in which the gradient is applied to improve the foam fractionation process.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1338, REMOVAL OF BOD AND NUTRIENTS BY BIOLOGICAL SLIMES
W.N. TORPEY, Rutgers the State University, Graduate School, *New Brunswick, New Jersey* 08903

To establish as completely as possible the maximum efficiency, basis for design, and economy of the biological rotating disc process. The system basically exploits the activity of the attached biological growths on closely specialized rotating discs alternately submerged in wastewater and exposed to air for high degree removal of organic matter and oxidation of ammonia nitrogen. When a series of such units are employed, sequential specialized populations become prevalent. The general approach is as follows: (a) to evaluate the effect of treatment efficiency of stressing the hydraulic and organic loads, (b) to define the relationship between the detention period, surface area concentration, and disc rotational velocity on the ability of the pilot plant to take loads without sacrificing treatment efficiency.

Pilot work performed at Jamaica Long Island Waste Treatment Plant.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1339, A CONCEPTUAL STUDY OF THE DISTRICT OF COLUMBIA BIOLOGICAL TREATMENT PILOT PLANT
J. ROSE, Burns & Roe Incorporated, *Oradell, New Jersey* 07649

To perform a study to develop the concept of the District of Columbia Biological Treatment Pilot Plant in accordance with the requirements set forth herein: I. Study Criteria A. Evaluate the process layout and hydraulic requirements of the two train (100,000 gpd per train) biological treatment pilot plant as described in the attached specification for installation at the District of Columbia Water Pollution Control Plant. B. Develop a sludge disposal system for the above pilot plant which includes: 1. Sludge dewatering systems a. vacuum filtration b. centrifugation c. experimental dewatering 2. Sludge incineration C. Prepare functional process layout for two larger pilot plants based on the design criteria and flexibility in above D. C. pilot plant and including disposal facilities for plant sized with: 1. Two nominal 250,000 gal per day treatment trains 2. Two nominal 500,000 gal per day treatment trains D. Furnish a cost estimate for the (100,000 gpd/train) pilot plant in A above.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1340, DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY
P.J. WEBBER, Delaware River Basin Comm., *Trenton, New Jersey*

Studies have indicated the potential economic, technical, and other advantages which can be realized from the construction of a single regional treatment facility at Deepwater, Salem County, New Jersey to solve the liquid wastewater treatment problems of 10 major industries, and the adjacent municipalities in Salem and Gloucester Counties along the Delaware River Estuary. Industrial wastes include pesticides, dyes, heavy metals, plastics, solvents phenols and other refractory chemicals.

A pilot plant is operative at the site of the regional facility to determine treatability characteristics, develop cost and design criteria for a full scale facility, test methods of secondary and advanced waste treatment and provide data to base on equitable cost apportionment system.

Wastes are being hauled by tank truck to the 50 gpm pilot plant. Currently, BOD removals are in excess of 90% and there are similar removals for heavy metals (as a result of a neutralization unit) and phenol.

SUPPORTED BY Delaware River Basin Comm. - Washington

2.1341, BRINE DISPOSAL DESIGN METHODOLOGY FOR ADVANCED WASTE TREATMENT
N.N. GUNAJI, New Mexico State University, School of Engineering, *Las Cruces, New Mexico* 88001

This investigation proposes to estimate reasonable limits of accuracy required for brine evaporation rates. It is also proposed to determine what effect the composition and concentrations of advanced waste treatment brines have on evaporation rates and pond design. Further, this research will be conducted to optimize the size and number of ponds necessary for effective disposal. The investigation will also clarify and evaluate methods for brine evaporation rate prediction, estimate accuracies, and recommend further refinements for predictve methods.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1342, PERFORMANCE OF INTERMITTENT SAND FILTERS
L.J. HETLING, State Dept. of Env. Conserv., *Albany, New York* 12205

To determine by controlled condition the extent to which grain size and uniformity coefficients affect the performance of intermittent sand filters.

Observation on the quality of influent to and effluent from the filters for a period of three months will yield valuable information which, coupled with a research of the literature, will afford sound conclusions in the following areas: 1) Affect of grain size and uniform coefficient upon the performance of the filters. 2) For any one filter media the affect of retention time upon performance. 3) The affect of filter use upon removal. 4) Removal of phosphorous and nitrogen by filter.

An extensive review of the literature has been made and a detailed experimental program set up. Construction of the experimental setup is expected to be completed by late spring of 1970 with the actual filter run being carried out during the summer.

SUPPORTED BY New York State Government - Albany

2.1343, TREATMENT NEEDED BY SEWAGE BEFORE INJECTION-WELL RECHARGE
L.J. HETLING, State Dept. of Health, *Albany, New York* 12208

A study to investigate the mechanism of clogging and its reduction to increase the recharge capacity of the injection well. Various methods of tertiary treatment were used (rapid sand filtration, diatomite filtration, carbon filtration), including degasification, chlorination and the application of bivalent ions, to produce an optimum effluent for injection.

The distance that various constitutents of sewage travel through saturated soil was also investigated by continual observations of the water quality in the observation wells. The project began in 1964 and was completed in mid 1969. The final project report has been received by the New York State Department of Health.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1344, DESIGN OF WASTEWATER TREATMENT SYSTEMS TO SATISFY EFFLUENT QUALITY REQUIREMENTS BASED ON INTENDED USE
A.W. LAWRENCE, Cornell University, School of Engineering, *Ithaca, New York* 14850

It is the objective of this study to have a 'fresh' look at wastewater treatment processes and systems in light of the growing interest in the reclamation of wastewaters as a 'new' source of water. This fresh look or reevaluation of wastewater treatment technology will be directed towards: 1) a review of the intended uses for reclaimed waste waters and determination of the quality requirements associated with each use.

2) a reevaluation of existing wastewater treatment processes and systems in the context of expected future performance criteria, i.e., effluent quality requirements.

3) examination of new processes or new combinations of existing processes in an effort to develop treatment methodology capable of satisfying effluent quality requirements which are not presently attainable.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1345, ADAPTATION BY MICROBIAL POPULATIONS
N.C. DONDERO, State University of New York, School of Agriculture, *Ithaca, New York* 14850

Selected experiments on enzyme adaptation and repression have been made with pure cultures and mixed populations of microorganims derived from activated sludge for the purpose of determining the physiological and nutritional homogeneity or heterogeneity of the populations transforming aromatic materials and other carbonaceous substrates.

The analysis of the populations have been made previously by enumeration and replica-plating on a series of substrates planned to show the capabilities of the population to utilize the substrates present and to reveal shifts in the microbial population when they occur.

Similar analyses will be made of the microbial populations in the processes of sewage treatment and a potable water impoundment.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1346, TERTIARY TREATMENT OF ANIMAL WASTE WATERS
R.C. LOEHR, State University of New York, School of Agriculture, *Ithaca, New York* 14850

The objectives of the project are to evaluate feasible processes applicable to the removal of nitrogen, phosphorus, and color from animal wastewaters, especially intermittent, concentrated wastewaters. The study shall investigate biological-chemical treatment alternatives in attempting to discover the most effective treatment processes for dairy cattle and poultry waste waters. The study is not restricted solely to 'tertiary' treatment processes.

The processes are to be evaluated on a laboratory scale and will include aerobic biological treatment, precipitation, ammonia removal, and nitrification-denitrification. The project will cover a two year period starting from May 1969.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1347, ADVANCED WASTE TREATMENT FOR WATER RECLAMATION AND REUSE BY INJECTION
H.J. SIMINS, Nassau Co. Dept. of Pub. Works, *Mineola, New York* 11501

Nassau County is committed to a long-range program to demonstrate the feasibility of using water reclaimed from sewage-plant effluent to increase the available ground-water resources.

The objective of the project is to conduct studies of advanced waste treatment processes and to demonstrate that the reclaimed secondary effluent is suitable for reuse and injection into underground aquifers. The project will provide operating data on advanced waste treatment processes and allow optimizing the economics of the process. It will also demonstrate the effectiveness and reliability of advanced waste treatment as a method of providing water for reuse from secondary treatment plant effluent.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1348, WINERY WASTEWATER - CHARACTERIZATION AND TREATMENT
E. HAYNES, Widmers Wine Cellars Inc., *Naples, New York* 14512

This project includes the design, construction, and operation of a wastewater treatment system at Widmer's Wine Cellers, Inc., in Naples, New York. The operation phase of this project will include sampling and testing of the pressing season and processing season wastewaters to characterize the winery wastewaters. In addition, the project will include a study of the effectiveness of an aerobic biological treatment process on this type of wastewater.

The long-term activated sludge treatment process will be utilized to treat the winery wastewater. The study of this system will include a determination of the effectiveness in the reduction of the organic content of the wastewater. In addition, the use of

identical parallel systems will allow study of the effect of varying the nutrient levels in the wastewater on the effectiveness of the biological system. Other design parameters, including pH, will be varied to determine their effect on the plant operation.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1349, COORDINATED MANAGEMENT AND DESIGN OF METROPOLITAN AREA WATER SUPPLY AND WASTE WATER DISPOSAL NETWORKS - A LINKED SYSTEMS ANALYSIS

L. ZOBLER, Columbia University, Undergraduate School, *New York, New York* 10027 (C-1629)

A linked systems analysis is to be made of the water supply system and the waste water disposal system of metropolitan areas. The nature of the connectivity entities will be specified. System parameters will be identified and manipulated. A computer simulation model will be constructed and the water resource of the total will be maximized by an optimizing method. The model will be tested with data for the New York Metropolitan Region.

SUPPORTED BY U.S. Dept. of Interior O. Wtr. Res. Rch.

2.1350, THE PRODUCTION AND USE OF ACTIVATED CARBON FOR WATER RENOVATION IN KRAFT PULP AND PAPER MILLS

W.G. TIMPE, Saint Regis Paper Company, *New York, New York* 10017

This program is aimed at water renovation and recycle in Kraft pulp and paper mills based on effluent treatment using activated carbon. The program is designed to establish a firm technical basis for designing Kraft pulp and paper mill systems with drastically reduced water pollution and fresh water consumption at reasonable cost.

The program is organized in two parts: Part I: Develop technical and economic data on the treatment of various Kraft mill effluents with activated carbon and demonstrate on a pilot scale treatment systems incorporating activated carbon in a Kraft mill environment. Part II: Demonstrate production and activation of a carbon char produced from black liquor as a by-product of a process for the recovery of pulping chemicals concurrently under development. Other mill-site raw materials for activated carbon production will be investigated. Determine the economics of mill site preparation of activated carbon.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1351, PHOSPHORUS REMOVAL IN THE ACTIVATED SLUDGE PLANT

T.E. BRENNER, Soap & Detergent Association, *New York, New York* 10022

The overall objective of this project is to determine the feasibility of removing phosphorus in an activated sludge plant treating domestic waste water through chemical precipitation with aluminum ion and utilizing only the existing aeration and settling units of the plant.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1352, METAL REMOVAL/RECOVERY FROM POLLUTED WATER BY COMPLEXATION WITH LINEAR POLYELECTROLYTES

H.H. JELLINEK, Clarkson College of Technology, School of Science, *Potsdam, New York* 13676

This project is based on the observation that a polyacid and a suitable polybase in the presence of a metal ion form a complex-sandwich insoluble in water. The metal ion can be removed from this complex by small amounts of mineral acid; thus it can be recovered as a fairly concentrated solution. It has been shown by the applicant and co- workers that the synthetic polymer system polymethacrylic acid- polyethylen-imine complexes over 90% by weight of the following metal ions from aqueous solution (10 to minus the 2nd power to 10 to minus the 4th power : Cu, Zn, Cd, Cr207, Ni, Co, Fe and 70% w/w of Mg and Pb. This method can thus be applied in principle, to removal and recovery of metals from polluted waters especially of rinse waters of the electroplating industry. However, such a synthetic system is not economical enough from a financial point of view. Hence research has been initiated for a natural polymer system of sufficient efficiency. This research has led to a fairly efficient system i.e. alginic acid and gelatine. The amounts of metals recovered by this system are not as good as those by the synthetic polymer system. % w/w Cu 72, Zn 38, Cd 34, Cr 50, Ni 20.

A very efficient polymer has been found suitable for practical application in polygalacturonic acid (fully hydrolysed pectinic acid). It has the advantage that the insoluble metal complexes are formed by using this polymer on its own. Once the metal has been leached from the complex, it can be used again and again. The following weight percentages of metals were precipitated with polygalacturonic acid: Cu 98%, Zn 77%, Cd 80%, Ni 69%. It can also complex with these metals in presence of plating solutions (CrO3 and H2SO4). Thus, eventually, many polymer systems will be available which are suitable for various situations. In principle, the method is also applicable for producing potable water and for desalination.

It is anticipated, that in the second year, many more suitable systems will be found which will be studied in detail and that a beginning will be made to test these systems on actual solutions obtained from the metal industries. Thus, a number of processes will be worked out in detail, which will be suitable in practice for various metal industries.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1353, MARINE DISPOSAL OF FINE-GRAINED WASTE SOLIDS

M.G. GROSS, State University of New York, Marine Sciences Res. Center, *Stony Brook, New York* 11790

The project seeks to evaluate the sources, composition, and environmental impact of major sources of fine-grained waste solids (nonfloatable) commonly dumped in the coastal waters of North America. The New York Metropolitan Region is the primary area of concern owing to the large volume of diverse wastes commonly dumped in nearby estuarine and coastal waters. Particular attention is given to sewage solids, dredged wastes, and certain industrial wastes. Samples collected at the sources are analyzed to determine the physical and chemical composition. Selected waste disposal sites have been selected for study to determine the amount and composition of the deposits accumulating in them. These include portions of New York harbor, one area in Western Long Island Sound, and two sites in the New York Bight. Water quality parameters and characteristics of the benthic organisms in the area of active waste disposal operations have been under investigation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1354, BIOLOGICAL TREATMENT OF ACID MINE WATER

P.A. RICE, Syracuse University, Research Institute, *Syracuse, New York* 13210

A three-year study is proposed to test the feasibility and to gather basic process data on the treatment of acid mine water in an anaerobic biological reactor containing the species Desulfovibrio desulfoxidans. If initial experiments demonstrate the feasibility of biological treatment, a set of parametric experiments will be carried out to determine the relationships between the amounts of hydrogen, sulfate, ferrous, and ferric ions removed and the process conditions. Appropriate mathematical models will be developed to describe the relationships between variables and to indicate the mechanisms controlling the removal rate of ions under various operating conditions. These models will be useful in reactor scale up and in understanding the basic mechanisms of sulfate reduction.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1355, CARBON COLUMN OPERATION IN WATER TREATMENT

C. TIEN, Syracuse University, Research Institute, *Syracuse, New York* 13210

The main objectives of this work are: 1. To carry out a detailed study of the operation of the granular activated carbon process in waste water treatment. In particular, the study will center on investigation of the three major functions of the carbon column in this type of application, namely, (A) the removal of total organic carbon, (B) the filtering of colloidal and suspended matter, and (C) the growth of micro-organisms within the column and the resulting biological action. 2. To investigate the interrelationship among these three main functions, the possibility of promoting or suppressing any given function, and the resultant effect on overall column operation and effectiveness. 3. To obtain a mathematical model describing the overall column operation. The desired mathematical description must be reasonably adequate, but must have a simplicity commensurate with the accuracy of the experimental data and also with the requirement that it must be readily utilizable by the design and operating engineer.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1356, IMPROVE POLLUTION CONTROL BY REUSE OF PAPER MACHINE PROCESS WATERS
G. WACHTER, Champion Papers Incorporated, *Canton, North Carolina* 28716

This project is directed toward demonstrating the complete reuse of paper-machine process waters by removing these materials as stream pollutants. It is part of a long-term program to develop a method for essentially closed water use systems. The project will include: 1. Recovery of all usable materials from paper-making process waters. This work involves modifications to existing and new systems to increase recovery of paper making materials. Process-water effluent from this system will go to the treatment system. 2. Treatment of excess process water to allow its reuse in place of fresh water, thus greatly reducing the quantity of fresh water required for paper making. Coagulating chemicals and precipitating processes will be used. 3. Disposal of sludge, generated in the treatment process, in a non-pollutional manner. 4. Any excess water flow returning to the stream will be of a quality that it will not contribute to stream pollution.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1357, TEXTILE WASTE REDUCTION THROUGH RECOVERY AND REUSE OF SYNTHETIC WARP SIZES
C.E. BRYAN, Univ. of North Carolina, Graduate School, *Raleigh, North Carolina* 27607

Analysis of the effluents from a number of textile finishing plants have shown that 45-70% of the pollution potential, as measured by 5-day B.O.D., can be attributed to the desizing wastes. The basis of most warp sizes is starch which is readily biodegradable.

In recent years certain water-soluble, synthetic polymers, such as sodium carboxymethyl cellulose (CMC) and polyvinyl alcohol (PVA), have been proposed as warp sizes with low B.O.D. but, because they are considerably more expensive than starch, their use has been limited.

The objective of the work proposed here it to investigate the recovery and reuse of the synthetic warp sizes with the aim of developing an economically attractive process for pollution control. (Starch cannot be recovered and reused because it is degraded in the desizing operation). A batch type of recovery will be examined first and then, if it is successful, attempts will be made to develop a continuous process. Conventional wet-processing apparatus, available in the pilot-plant of these laboratories, will be used with only limited modification.

If insurmountable difficulties arise in reusing the recovered materials, a more restricted goal will be disposal by another procedure, e.g., burning or burying.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1358, WATER POLLUTION REDUCTION THROUGH RECOVERY OF DESIZING WASTES
C.E. BRYAN, Univ. of North Carolina, Graduate School, *Raleigh, North Carolina* 27607

Surveys have shown that desizing wastes contribute 45-70% of the BOD5 of the effluents from the scouring, dyeing and finishing operations in cotton textile mills. The annual use of such sizes amounts to more than 300-million pounds. Starch is the predominant warp size by far. Certain synthetic warp sizes, particularly carboxymethyl cellulose (CMC) and polyvinyl alcohol (PVA), with low BOD5 have been introduced in recent years, however, and their use may be expected to increase. The long-term effect of these synthetic materials on stream pollution is unknown as yet. The proposed research includes, but is not limited, to the following: 1. To investigate processes for the recovery of desizing wastes in solid or concentrated form suitable for final disposal. The wastes studied will be those from fabrics sized with carboxymethyl cellulose (CMC), polyvinyl alcohol (PVA), and starch. 2. To investigate processes for the recovery of desizing wastes in reusable form. Reuse, as a size, of the desizing wastes from starch is not possible, of course, since starch is degraded during desizing. 3. To obtain more complete data on the biodegradation of the synthetic warp sizes, CMC and PVA. This study is expected to give information on the fate of these materials in biological treatment systems and in receiving streams.

The methods of recovery will involve evaporation, precipitation and other suitable processes.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1359, AN ECONOMIC STUDY OF MUNICIPAL SURCHARGES ON INDUSTRIAL WASTES
J.A. SEAGRAVES, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

We will develop an operational theory of industrial response to sewage surcharges given the alternatives of in-plant waste reduction, discharge to city and flow augmentation. Using this theory and samples of firms within industries across time periods we will use regression to estimate elasticities of industrial response to surcharges and changes in water rates. These results will be compared with those implied by budgeting studies of the costs of in-plant waste reduction. The gains to society associated with use of surcharges will be estimated and publications will be prepared explaining the likely response of selected industries to surcharges and the social benefits. The costs of different monitoring systems will also be estimated and compared with the benefits to society in the light of different alternatives.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1360, WATER BALANCE IN SEWAGE STABILIZATION LAGOONS
G.O. FOSSUM, North Dakota State University, State Water Resources Inst, *Fargo, North Dakota* 58102

This project proposes to conduct field investigations and laboratory analysis aimed at determining the water balance for a sewage stabilization pond containing an appreciable loading of organic industrial wastes. It is also intended to trace lateral movement of seepage from lagoons, and its effect on the adjacent water table.

The water balance is to be determined by measuring influent and precipitation by meters and rain gages and comparing with effluent, evaporation, and seepage. Quantity of effluent discharged will be measured and evaporation losses determined from evaporating pans. Infiltrometers will be used to determine seepage from the lagoon bottom.

Observation wells surrounding the lagoon at varying distances are to be used for sampling ground water for laboratory analysis. Correlation with natural ground water in the vicinity will give indications of pollution and ground water travel. These wells will also be used for water table observations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1361, OPERATIONAL DEMONSTRATION OF OXIDATION DITCH METHOD OF WASTE TREATMENT
H.M. KANESHIGE, Ohio University, School of Engineering, *Athens, Ohio* 45701

2. WATER QUALITY

The project objectives are (1) to determine design criteria for the oxidation ditches based upon experimental and analytical evaluation of a currently available dual plant; (2) to determine most desirable operational procedures for obtaining maximum performance; and (3) to obtain an effectiveness comparison between the oxidation ditch and the lagoon methods of wastewater treatment.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1362, REUSE OF WATER, DALLAS PROJECT
J.D. WEEKS, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Cincinnati, Ohio* 45213

This project is designed to help set new drinking water standards when domestic sewage is the source of water. In addition, this project seeks to develop automatic monitors that will assure the continued safety of the effluent.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1363, PROCESS DEVELOPMENT FOR REMOVAL OF NUTRIENT MATERIALS FROM WASTEWATERS
E.F. BARTH, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Develop processes that more efficiently remove nutrient materials such as nitrogen, phosphorus, and sulfur from wastewater effluents; before discharge to receiving water.

Biological populations are controlled by process modifications which enhance desirable reactions. Chemical additives which can simultaneously be used with the biological flora are also investigated.

Nitrogen: Currently nitrification is being controlled by a two-stage biological treatment. Carbon is removed in a high-rate activated sludge system with high sludge wasting; the effluent enters a nitrification stage which contains an enriched culture of nitrifiers. The enriched culture is a result of the nature of the feed, and separate sludge recycle systems in the two-stage process.

Biological dentrification of the nitrified effluent is possible by passing the effluent through an anaerobic system and the addition of methyl alcohol to force use of the nitrate oxygen. Again the enriched culture approach with separate sludge recycle is used in this unit process.

Sulfur: The sulfur cycle is to be also be investigated in this integrated process.

Phosphorous: The efficiency of phosphorus removal by biological systems can be increased by adding chemicals that form slightly soluble phosphorus compounds directly to the biological reactor. Several compounds have been investigated and aluminum appears to be the most satisfactory for several reasons. The combination of biological activity with chemical supplements offers more consistent control than the biological system alone.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1364, CONTROL OF MINERAL CONSTITUENTS IN WASTE WATER BY ELECTRODIALYSIS
C.A. BRUNNER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Electrodialysis has been shown to be a technically feasible method for removing a sufficient amount of the inorganic dissolved solids from municipal waste water to restore it to a quality suitable for direct re- use. Although the process will work on biological-treated municipal waste water which still contains refractory organics, membrane fouling is a problem. Membrane fouling results in a decrease in the degree of mineralization during operation. This problem has been found to be due to the growth of microorganisms on the membranes. Disinfection methods are being studied to find one that is practical. Residual organics will be removed by carbon adsorption prior to electrodialysis. It is necessary to determine the economic feasibility of the process by operating a pilot-scale unit at a municipal waste treatment plant for a sufficient time to determine membrane life and operating costs. An electrodialysis stack has been constructed and is being operated for treating 50 gallons per minute of waste water. About 40 percent of the gross inorganic material (total dissolved solids) in the water is being removed. The fraction of the feed being used for concentrating and electrode streams is 0.086 or less. Appropriate pretreatment studies are being conducted . During the operation, the fractional removal of gross inorganics and selectivity of the removal process for various ions is being measured. Pilot work is being performed at Lebanon, Ohio.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1365, REMOVAL OF SUSPENDED SOLIDS AND PHOSPHATE FROM A SECONDARY EFFLUENT BY ALUM COAGULATION AND DUAL MEDIA FILTRATION
J.J. CONVERY, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Clarification of secondary effluents has application in pollution control, direct reuse and as a pretreatment for other tertiary processes such as electrodialysis, reverse osmosis and ion exchange. Alum coagulation, sedimentation and dual media filtration remove essentially all of the suspended solids, phosphorus and BOD associated with the solids from a secondary effluent. The following operating conditions have been found to be optimum: 1. Overflow rate - 700 GPD/FT2. 2. Alum Dose - 300 mg/l. 3. Filter Media a) Anthracite - 18 in. of 1.4 mm b) Sand - 6 in. of 0.45 mm. 4. Filtration Rate - 4 GPM/FT2.

A flocculant aid such as activated silica is necessary to increase the strength of the alum floc and prevent the premature breakthrough of turbidity through the filters. A silica concentration of 3 mg/l as SiO2 is optimum. Filter runs averaged 17 hours for the above operating conditions. Operating costs based on a 10 MGD plant are estimated to be $0.08/1,000 gal.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1366, DISSOLVED INORGANIC REMOVAL--SELECTIVE ION AND ORGANIC REMOVAL BY ION EXCHANGE RESINS
R.A. DOBBS, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

The problems associated with the discharge of nutrients to receiving waters and the incremental build-up of dissolved inorganic salts with each use cycle make it imperative that technology to remove these pollutants be developed and demonstrated. In this area, ion exchange has operational, technical and possibly economic advantages over other processes for demineralization.

In recent years several new types of synthetic resins have been developed, and are commercially available, which are particularly suitable for the removal of selected ions and have the additional capability of absorbing organic matter. Resins, in contrast to activated carbon, can be regenerated in situ by suitable regenerants.

The objective of this study is to develop the use of synthetic ion exchange resins for the selective removal of inorganic ions as well as organic materials. Phase I of the study will include, 1) optimization of flow rates for the exhaustion and regeneration cycles, 2) evaluation of regenerants for imparting selectivity, 3) determination of optimum volume and concentrations of regenerants for imparting 4) performance of the resin after repeated cycles of operation and 5) cost estimates for the process. Phase II will attempt to screen a variety of resins for the above process.

Experimental apparatus consists of multiple 2' glass columns with associated pumps and pressure equipment.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1367, REMOVAL OF NITROGEN COMPOUNDS FROM MUNICIPAL WASTEWATER
A.N. MASSE, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

A novel biological treatment process for reducing BOD and nitrogen content of a municipal wastewater is being investigated in a 100 gallons per day pilot plant at the Mill Creek Sewage Works, Cincinnati, Ohio. Primary effluent is treated by the contact stabilization process using abbreviated residence times for

both contact and sludge reaeration. The product from this process is then nitrified aerobically in a separate aeration tank settler combination. The nitrifying sludge is kept in this system. The nitrified effluent flows to an anaerobic, mechanically-agitated denitrifying unit followed by a final settler. The source of organic material to the denitrifying bacteria is sludge from the contact stabilization operation. This sludge has a high BOD/NH3-N ratio, thus decreasing the amount of NH3-N put in the denitrifying section. The sludge from the denitrifying settler is returned to the sludge reaeration tank of the contact stabilization process. Parameters being investigated include residence times and sludge recirculation rates.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1368, USE OF GRANULAR ACTIVATED CARBON IN TREATMENT OF WASTE WATERS
A.N. MASSE, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Granular activated carbon is being investigated as an adsorbent for the non-biodegradable materials in a well-treated municipal secondary effluent. A 300,000 gallons per day plant has been on-stream since May, 1965, at Pomona, California. Four down-flow carbon contractors, connected in series, act as both a filter and an adsorbent bed. When the final product quality exceeds specifications, the first column in the series is regenerated in a 6-hearth furnace and returned to the process as the last column in the series. Parameters being investigated include: a) relationship between contact time and removal of contaminants, b) carbon usage rate, c) effect of regeneration conditions on recovery of carbon capacity and d) attrition losses as a result of carbon handling and regeneration. Side studies on a smaller scale include studies of: a) effect of contact time and mass velocity on adsorption rates and effectiveness, b) nitrogen removal capabilities of carbon columns and c) effect of hot water and steam treatment on regeneration frequency.

Ultraviolet absorption at 2537 Angstrom units of carbon-treated water is being investigated as a rapid control method for the evaluation of carbon column performance. A high correlation exists between UV absorption and organic matter in clarified water. The hydrogen flame detector is being adapted to determine organic matter at levels below 1 mg/l.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1369, POWDERED CARBON TREATMENT OF WASTE-WATER
A.N. MASSE, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Evaluate a two-stage, counter current pilot plant contacting system for powdered carbon treatment of primary and secondary wastewater effluents. Required amounts of powdered carbon and polymer must be determined as well as the standard design and economic criteria.

With a flow rate of 10 gpm (total residence time in the system of 2.7 hours) secondary effluent to which is added 200 ppm powdered carbon and 1.5 mg/l of organic polyelectrolyte, the total organic carbon removed has averaged 90%. When the influent turbidty can be maintained below 20 J.U., the product turbidity is less than 1 J.U.

When feeding primary effluent at 5 gpm to the system and adding 200 ppm carbon and 3 ppm polyelectrolyte, the total organic carbon reduction has averaged between 85 and 91%. The product turbidity is between 1 and 3 Jackson Units. In all runs on primary effluent, the product quality, as measured by total organic carbon and turbidity, has been better than that produced by the activated sludge process.

Evaluate several powdered carbon regeneration methods in conjunction with the powdered carbon process. Regeneration methods to be tested include: (1) microwave heating, (2) reaction furnace, and (3) fluidized-bed techniques.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1370, LIME SLUDGE RECOVERY AND REUSE
M.C. MULBARGER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Lime in doses of 200 to 500 mg/l as Ca(OH)2 removes phosphates and suspended matter from secondary effluents. The resultant sludge consists of calcium carbonates and phosphates together with silicate minerals, magnesium hydroxide and organic matter. The lime values may be recovered by recalcining the dried sludge. Although the recovered lime may cost nearly as much as fresh lime, the problem of disposing of large volumes of sludge is solved. Waters differing in hardness and phosphate content have been treated through four cycles and the quantity and quality of the recovered lime has been measured. In soft waters calcium phosphate builds up until it represents over half of the weight of calcined lime without exerting any deleterious effect provided that fresh lime is added to make up the losses. In hard waters calcium carbonate is removed from the water and must be continuously wasted along with low concentrations of calcium phosphate.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1371, DISSOLVED REFRACTORY ORGANIC REMOVAL -- CARBON AS AN ADSORBENT AND FILTER MEDIUM
W.A. SCHWARTZ, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Removal of non-biodegradable organic compounds from wastewater represents an important unit process in the treatment train to obtain a product water useful for a variety of purposes. The single most promising process is adsorption on activated carbon. The objective of this study is to develop a process for removal of organic materials from wastewater by using activated carbon. In addition to adsorption the carbon also lends itself to use as a filter medium in conjunction with other media such as sand.

Primary and secondary treated waste effluents will be subjected to a treatment sequence consisting of coagulation, filtration and activated carbon adsorption. These pretreatments to adsorption will be varied or omitted to provide a variety of influents for the adsorption step. Hydraulic loadings and carbon bed characteristics will constitute additional variables in the study.

Experimental apparatus will consist of 4 inch plastic columns. Performance will be judged on the basis of removal of organic matter and turbidity as well as head-loss measurements. The experimental equipment will be located at the Lebanon experimental facility.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1372, A STUDY OF THE KINETICS OF THE ACTIVATED SLUDGE PROCESS
R. SMITH, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Study the kinetic or time dependent performance of the activated sludge process for the purpose of finding practicable methods for automatic control of the process to minimize the variation of water quality in the effluent stream and to improve the average performance of the process. A mathematical model for the activated sludge process has been developed which computes the process performance as a function of time when the influent stream or the operating decisions or both vary with time. One digital computer program has been completed which simulates the time dependent behavior of the activated sludge process. This computation which is a numerical integration utilizing the Runge- Kutta fourth-order method integrates the Monod differential equations which express the growth of three classes of bacteria: Heterotrophic carbon users, Nitrosomonas which converts ammonia to nitrite, and Nitrobacter which converts nitrite to nitrate.

The aerator is sub-divided into ten sub-volumes, any number of which can be used to simulate mixing, and a sludge storage tank is provided in the sludge return line. A surge tank, in which

no biological activity is assumed, is also provided upstream of the aerator. Sinusoidally varying flow and BOD concentration are applied to this system and the concentration of three classes of microorganisms and three substrates as well as flow are computed as a function of time at each of seventeen stations. Various control schemes involving pumping of sludge from the sludge storage tank to minimize the effect of the varying load on the plant or the use of the surge tank to smooth out the flow have been studied.

The ultimate goal of the time dependent model is to study methods for control of the activated sludge process to give optimum performance when the flow and BOD concentration entering the plant varies throughout the day.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1373, PIPELINE TRANSPORT OF SLUDGE
B.C. RAYNES, Rand Development Corporation, *Cleveland, Ohio* 44110

This program is designed to determine the factors required in pumping a digested sludge slurry from a sewage treatment plant through a six mile pipeline to a strip mine area for reclamation. The program entails research in the hydraulics of sludge transport, and the method of ultimate disposal of the sludge in a manner which has beneficial results in land reclamation. The program is being carried out at a strip mine site in Morgantown, W. Va.

The program was started in FY67 and is anticipated to go through FY69 or FY70. The present state of the project is in the design and construction stage of the pipeline and associated pilot plant equipment to handle the sludge.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1374, REMOVAL OF TRACE METALS FROM WATER BY ION FLOTATION
A.J. RUBIN, Ohio State University, Water Resources Center, *Columbus, Ohio* 43210

Contamination of domestic and industrial water supplied by trace metals is of increasing concern. The possible economic damage and potential health hazards of certain trace metals coupled with the difficulty in their removal requires a new approach in treatment process selection and design. Ion flotation, a new low gas flow -rate foam separation technique, offers promise as an effective unit process for the selective removal of such trace metals.

The general objectives of this research are to (1) investigate the variables affecting metal ion removal by ion flotation, and (2) establish design criteria for an ion flotation process. For the first year of the proposed research, the specific objectives are to study the kinetics and variables affecting the removal of lead (II) in batch ion flotation systems. Other cations will be investigated during the second year, and as time permits during the first year after completion of the lead (II) studies. These variables, which affect the rate and/or degree of removal, include the metal ion and collector surfactant concentrations, gas flow-rate , pH, and ionic strength. Interactions between variables will also be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1375, COAGULATION OF CLAYS WITH HYDROLYZING METALS
A.J. RUBIN, Ohio State University, School of Engineering, *Columbus, Ohio* 43212

One of the most widely used chemical processes in both water and wastewater treatment is that of coagulation. Clarification of turbid waters by this process is usually accomplished by addition of iron or aluminum sulfate and pH control. Provisions for rapid mixing of the chemicals, slow mixing for particle growth, and settling (or flotation) of the flocs are required. Although there is a vast literature on coagulation, very little impact has been made on practice. Only recently has coagulation research been sufficiently systematic and quantitative to elucidate some of the mechanisms underlying the process. There is a need both for further sound research on the factors controlling the coagulation process and an evaluation of research findings toward engineering practice. It is the purpose of the proposed research to investigate, in a systematic program, the basic mechanisms controlling the coagulation of clays and other hydrophobic sols. The significance of several chemical parameters of importance in wastes and natural waters will be examined. Evidence for the precipitation model of coagulation will be evaluated and the findings will be interpreted and related to practice whenever possible.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1376, RELATIONSHIP OF ACTIVATED SLUDGE BULKING TO ORGANIC LOADING, OXYGEN AVAILABILITY, AND HYDRAULIC CHARACTERISTICS OF THE AERATION TANK
K.S. SHUMATE, Ohio State University, Water Resources Center, *Columbus, Ohio* 43210

The specific objectives of this research are to investigate the interrelationships between oxygen availability, organic loading, agitation intensity, and mixed liquor age distribution as factors contributing to sludge bulking in the activated sludge process. A physical simulation of the complete mix reactor-in-series model will be used to provide controlled variation of mixed liquor age distribution. Agitation in the aeration tanks will be controlled by the combined use of diffused air and mechanical stirring. Diffusor air flow rate will be varied as required, and the mechanical stirrers will be adjusted to control the total power input per unit volume, which will be used as the parameter of agitation intensity.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1377, PRECIPITATION OF PHOSPHATES FROM WATER WITH FERROUS SALTS
K. SVANKS, Ohio State University, School of Engineering, *Columbus, Ohio* 43212

The objectives of this study are to determine: 1) The mechanism of the reaction and optimal conditions under which ferrous hydroxide (applied directly or indirectly in form of ferrous sulfate) may be used to remove phosphates from water. 2) Methods of removing the insoluble phosphates and polyphosphates formed in the reaction, with particular emphasis on flotation processes. 3) The effectiveness of insoluble ferrous salts with or without flocculants to reduce the BOD and total nitrogen and the possible interference of these and other substances to the removal of phosphates.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1378, AUTOMATED SYSTEM FOR WATER POLLUTION CONTROL FROM AN ANIMAL PRODUCTION UNIT
E.P. TAIGANIDES, Ohio State University, School of Agriculture, *Columbus, Ohio* 43210

To make the total animal production unit prove effective in meeting our ever-increasing demands for more and better quality animal products, there exists a need to develop a manure management technology which will meet both the public demand for control of environmental pollution (water pollution and aesthetic nuisance) and the producer's demand for the mechanization of the manure handling operations.

The specific objectives of the project are: a. to demonstrate to animal producers the type of waste treatment unit operations which could be used to process wastes from animal production units, b. to demonstrate a system of automated handling of animal wastes, c. to demonstrate an animal waste treatment system which would not create a public nuisance and whose effluent could be of such quality that it could not contribute to water pollution.

The wastes from a 500-pig confinement unit will be flushed into a settling tank. The supernatant of the tank will be processed by aeration in an oxidation ditch, clarified, deodorized and recirculated through the animal building as flushing water. The solids settled out of the settling tank will be composted with a liquid composter and afterwards disposed by field spreading.

The field work will be carried out at the Botkins Grain and Feed Company Research Farm in Botkins, Ohio, some 90 miles away from Columbus, Ohio.

The project would be initiated January 1, 1970 and terminated June 30, 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1379, STUDY OF UTILIZATION AND DISPOSAL OF LIME SLUDGES CONTAINING PHOSPHATES
R.E. OPFERKUCH, Monsanto Research Corporation, *Dayton, Ohio* 45407

The technical and economic feasibiliry of utilizing the sludges obtained from the lime treatment of wastewater to remove phosphates will be determined. Economic, market, and engineering studies will be made on each potential large volume (sulfate fertilizers, wet process phosphoric acid, and phosphated fertilizers) outlet for phosphate sludge. Samples of recovered lime from a number of installations where classification of waste waters is carried out will be evaluated.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.1380, ELECTRODIALYSIS TREATMENT OF SECONDARY EFFLUENT
C.A. BRUNNER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Lebanon, Ohio*

Electrodialysis is being pilot tested to determine the feasibility of the method for partially demineralizing municipal wastewater. The partial demineralization is necessary for removal of the increment of inorganic material added during use and becomes especially important when multiple reuse of the water is considered.

The pilot system consists of a 50-gpm electrodialysis stack. Feed to the stack is clarified and granular-activated-carbon treated municipal secondary effluent. The design value of the fraction of mineral removal is 40 percent. Concentrated waste rate is maintained at less than 10 percent of the product rate. During operation the degree of demineralization is monitored frequently by conductivity measurements of feed and product. Analyses of principal ions are obtained occasionally.

An operating problem that has been encountered is anion membrane fouling. The result of fouling is a decline in demineralization. Since the problem first arose, much of the experimental work has been aimed at overcoming it. Although fouling has been reduced by improved clarification, it has not been completely eliminated. The fouling materials can be removed by allowing the equipment to remain idle for several days.

In spite of the fouling problem, electrodialysis is considered to be technically feasible. Longer study is required to determine accurately the economic feasibility, but present estimates indicate the process is practical.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1381, SINGLE STAGE LIME TREATMENT OF WASTEWATER
C.A. BRUNNER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Lebanon, Ohio*

In certain envisioned reuses of wastewater, it is essential to remove suspended material. Chemical clarification with lime is one possible method of removal. In this study, lime clarification is being used to treat municipal secondary effluent prior to granular activated carbon treatment and demineralizatio by electrodialysis.

Secondary effluent is supplied to a circular up-flow clarifier at a rate of 75 gal. per min. Lime slurry and secondary effluent are mixed in a rapid mix zone where precipitation occurs. The mixture passes through a sludge blanket and finally into the sedimentation zone. The effluent from the clarifier is further polished with two dual media filters (anthrafilt and sand). The total organic carbon, suspended solids or turbidity, alkalinity, hardness, and phosphate concentration of feed and product water are monitored. The most important operating variable is the clarifier pH. Studies are being made over the pH range 9 to 10.5. Limited study has been made of flocculant aids.

Results indicate that good clarification can be obtained at pH values from 9 to 10.5 without a flocculant aid. Phosphate removal is also good over that pH range. Significant calcium and alkalinity removals occur at pH of 9.5.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1382, THE CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF IRRIGATION RETURN FLOWS
J.P. LAW, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

Preparation of a comprehensive report that will reflect the status of present knowledge regarding the pollutional problems associated with irrigation waste waters and their effects upon water quality of surface streams and groundwater resources in the United States.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1383, DEMONSTRATING THE EFFECT OF NUTRIENTS IN OXIDATION POND RECEIVING STREAMS
G.W. REID, Univ. of Oklahoma, Research Institute, *Norman, Oklahoma* 73069

Studies of receiving streams or drainages of operating waste stabilization ponds will be conducted to evaluate critically the fate of nitrogen and phosphorous, bacteria, algae and BOD of effluents subsequent to treatment by lagooning.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1384, MICROBIOLOGICAL REMOVAL OF IRON FROM MINE DRAINAGE WATERS
R.C. ALLRED, Continental Oil Company, *Ponca City, Oklahoma* 74602

The removal of iron from mine drainage waters using a two-step microbiological process will be investigated both in the laboratory and in the field. It is proposed to change iron from ferrous to ferric state using iron-oxidizing bacteria, followed by precipitation of a ferric sulfide using sulfate-reducing bacteria.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1385, OPERATIONAL STABILITY OF THE EXTENDED AERATION PROCESS
A.F. GAUDY, Okla. St. Univ., School of Engineering, *Stillwater, Oklahoma* 74074

Preliminary investigations on the stability of operations of the extended aeration process (no sludge wasting) over a period of nearly one year indicated that while the unit activity of the sludge dropped off during the operational period, the total waste purification capacity of the process remained extremely high. The proposed laboratory investigations are directed toward determination of the useful life of an extended aeration process and determination of the biochemical causation for breakdown, if such systems do eventually break down. It is also intended to determine the degree of stability of the process under changing environmental conditions and whether there is any useful parameter (s) which can be used to predict either impending upsets or continued efficient operation.

Laboratory pilot plants will be operated and all sludge except a small measured amount (plus or minus 2%) for analyses and batch experimentation will be returned to the aerator. Substrate removal efficiency, biological solids production, and sludge composition will be determined, and small sludge samples will be taken for measurement of unit activity with respect to oxygen uptake and substrate removal. Analysis of the data should permit useful conclusions concerning the utility of the process and possible ways to extend its use to a greater variety of waste water applications.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1386, KINETICS AND MECHANISMS IN ACTIVATED SLUDGE PROCESSES
A.F. GAUDY, Okla. St. Univ., School of Civil Engineering, *Stillwater, Oklahoma* 74074

The broad objective of the proposed research is the attainment of a more sound understanding of the basic chemical, physical, and biological factors underlying the kinetics and mechanisms involved in growth and substrate utilization in

heterogenous populations with particular reference to waste water purifcation in continuous and discontinuous activated sludge processes.

Since its initiation in 1962, the research has progressed toward accomplishment of this goal through the conduct of massive, long-term experiments under closely controlled conditions using a variety of steady, well-defined chemical and physical environments. A large number of analytical parameters have been determined and subjected to statistical analysis. Through continuation of this approach, the completion of the work should allow determination of the mechanistic and kinetic parameters which are of significance in formulations of predictive value for design and operation of activated sludge processes. During this renewal period all results obtained on this project will be integrated and consolidated with results of related studies conducted on the biological response to a changing environment (WP-00075) and with studies conducted on genetic and enzymic mechanisms of metabolic control applicable to heterogenous populations (WP-00786).

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1387, ADSORPTION OF VIRUS-SIZED PARTICLES IN POROUS MEDIA
R.W. FILMER, Oregon State University, School of Engineering, *Corvallis, Oregon* 97331

The fate of water-borne viral pathogens is a question of vital concern when untreated or partially treated waste water is used to replenish underground sources of supply. Little information is available concerning the mechanism by which ultra-small particles such as viruses are removed from suspension by soil materials. There is no data available from which accurate predictions can be made as to how far such contaminants will traval in a given water-bearing strata. Under this research program the removal process will be studied in detail and an attempt made to develop predictive relationships.

SUPPORTED BY U.S. National Science Foundation

2.1388, CHARACTERIZATION OF FOOD PROCESSING WASTEWATERS
M.R. SODERQUIST, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

It is proposed that a portable laboratory be sequentially located at various food processing centers during each of the next three summers for the purpose of conducting comprehensive (24 hour/day) sampling and on-site wastewater quality analyses of the effluents. Data will be obtained for the processing of each of the many commodities produced in the Pacific Northwest, including fruits, vegetables, seafoods, meats, poultry and dairy products. Parameters to be measured would vary with the nature of the waste, but would normally include flow, total, dissolved- and volatile-solids, five-day biochemical oxygen demand, ultimate biochemical oxygen demand, chemical oxygen demand, nitrate, ammonia, organic nitrogen, orthophosphate, total phosphate, treatability, microbiological analyses. Where warranted, chloride, sulfide, and other unconventional analyses necessary for the complete characterization of the waste under study. Results would be related to production (i.e., BOD sub 5 would be expressed not only as a concentration, mg/l, but also as lbs. BOD sub 5 /ton of product processed) and the influence of plant size (production volume) on efficiency of water use would be investigated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1389, THERMAL WATER DEMONSTRATION PROJECT
B. PRICE, Eugene Water & Electric Board, *Eugene, Oregon* 97401

The grant will be used to support a pilot demonstration program to show the possibilities for the multiple use of water warmed by industrial plants. The demonstration will be based on the state of the art as it existed when the project began in March, 1969. Results of new or recent research will be correlated into the program. Results of the project could be immediately applied into the National Water Resources program and the treatment of thermal-polluted water by the Federal Water Pollution Control Administration as well as other Government agencies and industry.

The assesment and evaluation of the proposed demonstration program will show economic benefits not only to agriculture but to fisheries, recreation, and related water- and land-use projects as they respond to the total utilization concept and its demonstration harmonization.

Of primary importance will be the demonstration that thermal water from nuclear-powered electrical generating plants, if properly managed, will not become a thermal pollutant.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1390, WASTE WATER PURIFICATION
F.J. MICALE, Lehigh University, Graduate School, *Bethlehem, Pennsylvania* 18015

A fundamental approach to the problem of waste water treatment is a determination of the mechanism whereby soluble and solid impurities are more efficiently removed from their aqueous environment. Although the problem is complicated by the complex nature of waste sludges, especially activated sludges, the ultimate driving force for any of the accepted water treatment operations occurs at the interface between various phases involved in a particular operation. The objective of this research program, simply stated, is to relate the interfacial properties to the dewatering characteristics of a sludge system.

Experimental evidence has shown that three incinerator ashes, and a Beckjord fly ash, exhibit varying degrees of effect on the sedimentation rate of activated sludges. In general, the addition of these ashes drastically increases the sedimentation rate. The objective of this program is to investigate the mechanism which leads to an increase in sedimentation rate. The surface properties of a number of ash samples will be studied with respect to particle size, specific surface area, composition, solution adsorption to various surfactants, and the concentration and effect of water soluble ions present on the ash surface. A number of model surfaces, e.g., silica, and carbon black, will also be investigated in order to determine their effect on the sedimentation rate of activated sludges as a function of ionic concentration.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1391, NEUTRALIZATION AND PRECOAT FILTRATION OF CONCENTRATION SLUDGES FROM MINE WATER
D.R. MANEVAL, State Dept. of Mines & Min., *Harrisburg, Pennsylvania* 17120

The project is directed at providing a cost-effectiveness evaluation of various neutralization processes in the treatment of acid mine drainage. Sludge disposal problems will be studied with emphasis on precoat filtration. Field tests will be accomplished on four abandoned mines in the Western Pennsylvania area.

Johns-Manville Company will perform the work. It is hoped that this method will provide significant information on economic feasibility of reducing acid mine drainage by neutralization.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1392, ABATEMENT OF MINE DRAINAGE POLLUTION BY REVERSE OSMOSIS
D.R. MANEVAL, State Dept. of Mines & Min., *Harrisburg, Pennsylvania* 17120

Previous work has shown that high ferrous AMD causes fouling of membranes. The proposed work is intended to minimize this, as well as other problems by conducting the following: 1. Laboratory studies, using synthetic AMD, designed to determine exact causes of and cures for iron fouling. 2. Optimization of alternate flow schemes. 3. Detailed cost analysis. 4. Sampling of mines to determine feasibility of obtaining AMD with no dissolved oxygen. 5. Field testing to verify lab results.

The laboratory work will be conducted at Rex Chainbelt, Inc., West Milwaukee, Wisconsin. The field work at possible sites in Pennsylvania.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1393, RECOVERY OF IRON IN A MORE DENSE FORM FROM COAL MINE DRAINAGE
D.R. MANEVAL, Bituminous Coal Research Inc., *Monroeville, Pennsylvania* 51146

The overall research program will be conducted in three phases. This project covers the first phase, including development of a conceptual process for the removal of iron sludge by means of a magnetic precipitate. Operation will be on a bench-scale, with test work to lead to the development of a continuous flow process for the treatment of specific types of mine drainage.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1394, DEVELOPMENT AND OPTIMIZATION OF THE LIMESTONE TREATMENT OF MINE DRAINAGE
R.K. YOUNG, Bituminous Coal Research Inc., *Monroeville, Pennsylvania* 51146

Initial achievement of this project, along with further laboratory studies, lead logically to the development of the process by designing, constructing and operating of research units in the field to obtain process design and engineering data for a detailed evaluation and cost estimate of the process projected to full industrial scale operation.

The laboratory studies will include: The evaluation of limestones by describing their physical and chemical properties and development of neutralization curves; and proof of such evaluation by conducting batch tests, continuous flow tests with determinations of sludge properties.

The design of the Field Research Unit will include; selection of variables, including site, the number of discharges and limestones, flow rates and the type of field unit; treatment conditions and effluent standards; engineering design; procurement; erection and installation requirements; and a summary report.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1395, TREATMENT OF WATERCRAFT WASTES
J.C. WHITE, General Electric Company, *Philadelphia, Pennsylvania* 19123

The design and development of a watercraft waste treatment system to be demonstrated functionally on a vessel with a crew of 40 to 50 men. The treatment utlizes an electrocoagulation cell to form a settleable floc from the sanitary and culinary sewage. Separation of this floc permits discharge of a chlorinated non-contaminated supernatant. The accumulated sludge will be collected and stored for disposal as determined by the initial project scope.

The design and functional shipboard demonstration of the system form two discrete phases of the project. In the initial phase of the system consisting of a pump-storage-grinder, electrocoagulation cell, settling tank, and chlorinator will be demonstrated functionally in the laboratory. Performance in static and simulated sea state conditions will be assessed.

Concurrently with the laboratory testing, a vessel will be selected for the second phase of the contract - the demonstration under actual conditions. Preparation for installation on a vessel entails a waste characterization of the selected vessel, and a suitable seaworthy design of the waste treatment system.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.1396, CHEMICAL TREATMENT OF ACID MINE DRAINAGE
UNKNOWN, Bituminous Coal Research Inc., *Pittsburgh, Pennsylvania* 15213

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Appalachian Regional Commission

2.1397, TREATMENT OF ACID MINE DRAINAGE-SULFUR AND IRON RECOVERY
J.A. KARNAVAS, Black Sivalls & Bryson Inc., *Pittsburgh, Pennsylvania* 15238

Obtain bench-scale laboratory data to determine the technical and economic feasibility of the BS&B process for acid mine water (AMW) treatment.

In this process, AMW is distilled with energy generated from inexpensive high-sulfur coal. The coal is combusted in a liquid iron bath to recover its sulfur content in a slag, from which elemental sulfur is recovered via a modified Claus process.

Laboratory studies are being conducted by Chemical Service Engineers, Inc., Pittsburgh, Pennsylvania, to provide data on the fluidity of slags, the partition of sulfur between iron and slag, the kinetics of sulfur recovery from slag, and the neutralization of AMW with slag.

The evaluation of the process will be based on the laboratory results, other available data, and a computer simulation of the process.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1398, ACID MINE DRAINAGE PILOT PLANT EVALUATION
UNKNOWN, Carnegie Mellon University, Mellon Institute, *Pittsburgh, Pennsylvania* 15213

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Appalachian Regional Commission

2.1399, STUDY OF THE USE OF INERT GASES TO ELIMINATE ACID POLLUTION FROM ABANDONED DEEP MINES
H.C. BRAMER, N U S Corporation, *Pittsburgh, Pennsylvania* 15205

This is the continuation of a project initiated during the 67 fiscal year. The initial phase studied the air flow required to seal two abandoned deep mines in Stewart Township, Fayette County, Pennsylvania. These mines had several major air leaks both through the overburden and barrier of the adjacent strip mine. These leaks prevented any significant build-up of pressure within the mine.

This continuation of the project will consist of an evaluation of the state-of-the-art of existing technology to locate points of air leakage from the mine; installation of seals in mine openings presently covered by backfilling operations of the strip mine; installation of larger air blowing equipment; and continuation of the original study work to pressurize the mine.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1400, A CONCEPTUAL STUDY OF THE DISTRICT OF COLUMBIA BIOLOGICAL TREATMENT PILOT PLANT
C. WOOD, Swindell Dressler Company, *Pittsburgh, Pennsylvania*

To perform a study to develop the concept of the District of Columbia Biological Treatment Pilot Plant in accordance with the requirements set forth herein: I. Study Criteria: A. Evaluate the process layout and hydraulic requirements of the two train (100,000 gpd per train) biological treatment pilot plant as described in the attached specification for installation at the District of Columbia Water Pollution Control Plant. B. Develop a sludge disposal system for the above pilot plant which includes: 1. Sludge dewatering systems. a. vacuum filtration. b. centrifugation. c. experimental dewatering. 2. Sludge incineration. C. Prepare functional process layout for two larger pilot plants based on the design criteria and flexibility in above D.C. pilot plant and including disposal facilities for plant sized with: 1. Two nominal 250,000 gal per day treatment trains. 2. Two nominal 500,000 gal per day treatment trains. D. Furnish a cost estimate for the (100,000 gpd/train) pilot plant in A above.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1401, ENVIRONMENTAL CONTROL RESEARCH CONTROL TECHNIQUES, FIELD TESTING, AND EVALUATION
N.N. MOEBS, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

The immediate objective of the Water Control program is to continue collecting and analyzing water effluents and air samples; obtain geologic, hydrologic, and mine data; and develop plans cooperatively with engineers of involved coal operations to reduce the quantity and improve adequately the quality of the water discharged from active mines.

Cooperative agreements with four coal companies are in effect, with encouraging prospects to seal and inundate 30 to 70 percent of the area of one mine to eliminate present treatment within 1 or 2 years after the mine is worked out; and to pipe a low acidity quantity of water generated in the active area of another mine (approximately one-half of the total discharged daily from the below drainage mine) to the main pump sump rather than permit it to flow first into the highly acid water in the main pool located within an old mined out area and, thereby, reduce the cost of treatment.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

2.1402, IMPROVED EXTRACTION SYSTEM - WATER CONTROL - CONTROL TECHNIQUES, FIELD TESTING AND EVALUATION
N.N. MOEBS, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

The immediate objective of the water control program is to continue collecting and analyzing water effluents and air samples; obtain geologic, hydrologic, and mine data; and develop plans cooperatively with engineers of involved coal operations to reduce the quantity and improve adequately the quality of the water discharged from active mines. Monitoring the flow and quality of effluents from, and of air in abondoned sealed underground mines.

Cooperative agreements with three coal companies are in effect, with encouraging propects to seal and inundate 30 to 70 percent of the area of one mine to eliminate the need for treatment within 1 or 2 years after the mine had been worked out: and to pipe a low acidity quantity of water generated in the active area of another mine after exhaustion and sealing (approximately one-third of the total discharged daily from the below drainage mine) to the main pump sump rather than permit it to flow first into the highly acid water in the main pool located within an old mined out area and, thereby, reduce the cost of treatment.

Also, installation of a continuously recording oxygen meter at a borehole in the first mine mentioned above has shown strikingly the degree of 'breathing' occurring at that mine after sealing.

At the third active mine, water samples and rock and coal cores are being analyzed to evaluate the potential for water pollution.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

2.1403, DEVELOPMENT OF CRITERIA FOR REGIONALIZATION OF WATER WASTES MANAGEMENT SYSTEMS
O.H. SAUERLENDER, Penn. State University, Inst. for Res. on Land & Water, *University Park, Pennsylvania* 16802

The proposed research project will study a part of the Middle Susquehanna river basin to analyze the existing structure of water management and sewage disposal systems. The purpose is to discover the relationship of social factors and institutional constraints leading to success and/or failure of communities securing the economies of scale that would result from the consolidation of smaller plants into single larger units.

Field investigation will gather information on the adequacy of existing systems to meet existing and projected demands for water and waste disposal. Costs of maintaining existing systems or for improving systems to satisfy standards of water quality established by the state will be computed and compared with costs of alternative water management systems including varying degrees of regional control.

The socio-economic structure of the entire region will be analyzed for developing criteria to determine the optimum regionalization regarding the management of water resources and waste disposal.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1404, EFFECTS OF IRRIGATION OF MUNICIPAL SEWAGE EFFLUENT ON SPOILS BANKS
W.E. SOPPER, Penn. State University, Inst. for Res. on Land & Water, *University Park, Pennsylvania* 16802

The purpose of the project is to investigate the feasibility of ameliorating adverse strip mine spoil bank sites through irrigation with municipal sewage effluent. Benefits derived from such a method, if feasible, would be twofold (1) alleviation of stream pollution as a result of diversion of the effluent load from streams to land areas and (2) restoration of these disturbed land areas to useful productivity. The specific objectives are: (1) to determine the degree of chemical renovation of municipal sewage effluent and sludge by spoils bank material, (2) to determine the extent of site amelioration as a result of irrigation of sewage effluent and mixtures of effluent and digested sludge on spoils banks material and (3) to determine the effectiveness of various proportions of sewage effluent and sludge and various amounts of the mixture on the revegetation of the spoils material.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1405, MICROBIOLOGICAL CHARACTERIZATION OF ACTIVATED SLUDGE IN A WASTEWATER TREATMENT PLANT CHEMICALLY MODIFIED FOR PHOSPHORUS REMOVAL
R.F. UNZ, Penn. State University, Inst. for Res. on Land & Water, *University Park, Pennsylvania* 16802

Full scale combined chemical-biological wastewater treatment for simultaneous removal of organic matters and phosphorous is in the pioneer stage. There is little evidence to show that the biological solids are not qualitatively and/or quantitatively altered in microbial composition as a result of chemical treatment. There is no information on the bacteriological quality of the effluent from the combined treatment systems.

The objectives of this study are: 1. To obtain basic information on the microbial composition of activated sludges before and following chemical treatment of wastewaters for phosphorous removal. 2. Assuming variations in wastewater treatment efficiency result during chemical treatment, it is the intent to determine if the changes in treatment efficiency parallel changes in microbial composition of the activated sludge. 3. To consider reasons for microbial diversity in activated sludges if such seems to be related to chemical treatment of the wastewaters. 4. To supplement the data to be collected by personnel connected with the engineering aspects of phosphorous removal project being conducted at this university's wastewater treatment plant and to contribute toward the final evaluation of that project as well as general design and operation of combined chemical-biological wastewater treatment schemes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1406, BIOLOGICAL TREATMENT PILOT PLANT AND SLUDGE DISPOSAL FACILITY
W.E. HOOVER, Roy F. Weston Incorporated, *West Chester, Pennsylvania* 19380

The scope of work of this contract requires the designer to: A. Complete a detailed design of a dual stream 100,000 gpd per train biological treatment pilot plant as described in the attached specifications. B. Design a sludge disposal facility for the above pilot plant which includes: 1. Sludge dewatering systems which include: a. vacuum filtration b. centrifugation c. one other dewatering method to be determined. 2. Sludge incineration. C. Provide cost estimates for construction of scaled up plants of the above

basic design with the following capacities: 1. One dual stream plant of 250,000 gal per day capacity per train 2. One dual stream plant of 500,000 gal per day capacity per train.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1407, A CONCEPTUAL STUDY OF THE DISTRICT OF COLUMBIA BIOLOGICAL TREATMENT PILOT PLANT
V.T. STACK, Roy F. Weston Incorporated, *West Chester, Pennsylvania* 19380

To perform a study to develop the concept of the District of Columbia Biological Treatment Plant in accordance with the requirements set forth herein: I. Study Criteria A. Evaluate the process layout and hydraulic requirements of the two train (100,000 gpd per train) biological treatment pilot plant as described in the attached specification for installation at the District of Columbia Water Pollution Control Plant. B. Develop a sludge disposal system for the above pilot plant which includes: 1. Sludge dewatering systems a. vacuum filtration b. centrifugation c. experimental dewatering 2. Sludge incineration C. Prepare functional process layout for two larger pilot plants based on the design criteria and flexibility in above D. C. pilot plant and including sludge disposal facilities for plant sized with: 1. Two nominal 250,000 gal per day treatment trains 2. Two nominal 500,000 gal per day treatment trains D. Furnish a cost estimate for the (100,000 gpd/train) pilot plant in A above.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1408, TOCKS ISLAND REGION ENVIRONMENTAL STUDY (TIRES)
R.F. WESTON, Roy F. Weston Incorporated, *West Chester, Pennsylvania* 19380

The Tocks Island Region Environmental Study deals with regional consideration of waste disposal and water supply needs for the next 50 years, and maintenance of the existing high quality environment in the 1000 square mile interstate area surrounding the Tocks Island Reservoir and the Delaware Water Gap National Recreation Area. The objective of the study is to develop a master plan for water supply and waste disposal in the three state, six county area expected to undergo rapid development pressures as a result of the reservoir and park developments. Major emphasis has been devoted to the study and feasibility of alternative regional and subregional sewerage schemes for the region. The study is being carried out in cooperation with all concerned local, state, and federal agencies in the region.

SUPPORTED BY Delaware River Basin Comm. - Washington

2.1409, DETERMINATION OF BIODEGRADATION RATES IN SOME POLLUTED TROPICAL WATERS AND IN SOME TYPES OF LIQUID WASTES COMMON IN PUERTO RICO
L.A. DELVALLE, Univ. of Puerto Rico, Water Resources Research Inst., *Mayaguez, Puerto Rico*

As such, there is no information available in regards to the effect of salt concentrations on the biodegradation rates of wastes and of the concentration of the wastes themselves in tropical zones.

This study is to determine the biodegradation rates on some types of wastes common in the tropical waters of Puerto Rico, with due regard to the effect of concentration and salinity, to evaluate different methods of analysis already available in pertinent literature.

To achieve this, an adequate number of samples of wastewater will be analyzed, both in their natural state and diluted in river and sea- water. Their biodegradation rates will be determined using the most adequate B.O.D., COD and/or T.O.C. techniques.

The result of the study will attempt to fulfil the general lack of information on the biodegradation rates of some common tropical waste- water not encountered in many parts of the nation, but in Puerto Rico. Moreover, it should be of valuable help to agencies dealing with water pollution control and the design of waste treatment works.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1410, CONTROL OF GEOTRICHUM CANDIDUM IN BIOLOGICAL WASTE TREATMENT
C.P. POON, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

The proposed research plan involves laboratory and field investigations directed at the determination of the control of filamentous Geotrichum candidum fungus in biological waste treatment.

The first four phases of this work will investigate factors giving rise to G. candidum overgrowth which causes bulking of sludge. Warburg respirometric technique and prototype laboratory aerators will be used in the work. The last phase of this work involves investigations of methods of control, using coagulation and fungicides, to eliminate the fungus after the treatment unit has been infested with this filamentous organism. Prototype laboratory study and field tests will be conducted for this phase of the work.

The five phases of this work include: 1. Metal toxicity --- silver, copper, zinc and chromium 2. Metal stimulation --- zinc, copper, cobalt, zinc and iron combined 3. Interactions of ions --- Antagonistic and synergistic actions of zinc, copper and cobalt with magnesium, calcium carbonate, selenite, tellurite and sulfhydryl compounds 4. Photosensitization --- photochemical reaction of bituminous material. All substances aforementioned may selectively favor the growth of G. candidum over the zoogleal bacteria in sludge to cause bulking. 5. Control -- coagulants, sludge ash and fungicides.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1411, CHEMICAL AND PHYSICAL FACTORS IN THE FLOCCULATION OF METAL PROCESSING WASTES WITH POLYELECTROLYTES
D.L. SUSSMAN, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

The proposed research plan involves the study of the factors involved in the flocculation of metal treatment wastes with polyelectrolytes. These factors are the effects of multivalent ions, pH, ionic strength, complex formation, the type of colloids present, organic matter and the rate of sedimentation.

The laboratory investigations will involve the measurement of the destabilization and flocculation of the colloidal particles by use of a light scattering photometer. Particle size measurements will be determined by the refiltration technique. The theoretical basis of this measurement is the Kozeny-Carmen equation for flow through a porous media.

These measurements will be made on laboratory prepared wastes and on samples of wastes taken from metal finishing operations in the Rhode Island and Southeastern New England area.

The objective of this project will be to determine the optimum conditions for improving the treatment of metal finishing wastes by polyelectrolyte addition.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1412, GROUNDWATER FLOW IN PARTIALLY SATURATED SOILS
M.C. WANG, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

The proposed research project involves laboratory and field investigations of non-steadystate unsaturated groundwater flow from disposal fields. The long-range objective of the study is to determine the minimum spacing required between a water supply and a sewage disposal field so that contamination of the water supply will be minimized.

Laboratory investigations would involve the following steps: 1. Development of a theoretical approach to the non-steadystate unsaturated seepage flow. 2. Determination of the hydraulic conductivity of unsaturated soils. 3. Verification of the theoretical solution with model study.

A tile drainage field near the college sewage treatment plant with field observation wells at varying distances away is planned to verify the results established in the laboratory.

Results of the study would be established in tabular or graphical form for various hydraulic conditions, soil types and fluid supplies.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1413, GEIGY CHEMICAL WASTE TREATMENT FACILITY

R.F. CURRAN, Geigy Chemical Corporation, *Providence, Rhode Island* 02905

The proposed project is for the full scale (1.4 MGD) treatment of chemical wastes from a multiple organic products plant. The system for treatment is to have as its major component a multi-stage plastic trickling filter system and is to be automated to produce controllable process resulting in a consistent quality effluent suitable for discharge to receiving waters.

Project Objectives Include: 1. Demonstration of the feasibility of a multi-stage plastic media trickling filter process for wastewaters from a multiple organic chemicals plant. 2) Develop and demonstrate technical feasibility of total process control by automated systems for the process. 3. Evaluate the performance of a specific design of plastic media. 4) Demonstrate the stage-wise acclimation of micro- organisms as a factor in attaining extra high loading per unit of trickling filter packing. 5) Obtain performance data on an additional treatment operation, such as activated carbon adsorption, for further effluent quality improvement.

Construction of the facility was commenced in April 1970. Operational start-up is anticipated in April 1971 and it is expected that this research project will be completed by September 1972.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.1414, ZEOLITE REMOVAL OF 137-CS FROM LIQUID WASTE

R.H. HAWKINS, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801

The objective of this study is to improve the operation and reduce the cost of removing 137 Cs from Savannah River Plant liquid waste. Pluggage has been a frequent problem with zeolite columns now in routine operation. Also, regeneration is not attempted. Causes of pluggage have been narrowed to suspended solids in feed and a precipitate due to reaction between feed and zeolite. A 6' long column of zeolite serving as a granular, backwashable prefilter has significantly improved performance of laboratory cesium removal zeolite columns.

SUPPORTED BY U.S. Atomic Energy Commission

2.1415, ION EXCHANGE MEMBRANE STUDIES

R.M. WALLACE, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801

The objective of this program is to investigate the application of ion exchange membranes (Donnan membrane equilibria) to the concentration of radionuclides from dilute aqueous waste streams.

Both flat and tubular membranes are being studied. Potential of the technique for scale-up to flow rates of tens of gallons per minute is being explored. Costing studies are planned to determine if membrane concentration is competitive with evaporation and conventional ion exchange.

Studies with dilute aqueous waste indicate super 137 Cs concentration of 1000 with 50-fold volume reduction may be feasible. Small scale units were designed for tests with flat membranes, a commerical source of tubular ion exchange membranes was located and a tubular dialyzer was purchased for evaluation.

SUPPORTED BY U.S. Atomic Energy Commission

2.1416, STUDY OF COSTS OF TREATING TEXTILE WASTES IN MUNICIPAL AND INDUSTRIAL SEWAGE PLANTS

J.M. STEPP, Clemson University, Water Resources Research Inst., *Clemson, South Carolina* 29631

The textile industry, which is concentrated and still growing in the Carolinas and Georgia, is a major user and polluter of water while at the same time requiring high-quality water for dyeing and finishing operations. The liquid wastes from such operations are strong, complicated, variable, and difficult to remove from wastewater. The public interest requires effective treatment of industrial wastes, hence it is in the interest of the general public, the textile industry and the people and communities supported by it to obtain information on methods, problems and costs of treating textile wastes, and the relation of such costs to other components of the cost and income structure of the plants.

The study will cover all of the 32 sewered South Carolina municipalities which accept and treat textile wastes in their municipal sewage plants, and a substantial number of the 89 South Carolina wet- process textile manufacturing plants which operate waste-treatment facilities. Data will be obtained from the managers of the sewage systems and plants by means of questionnaires, from published reports, from the records of public agencies, and from consulting engineering firms which specialize in the design and operation of waste-treatment systems. The municipal phase of the study will precede the industrial phase.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1417, REMOVAL OF NITROGENOUS COMPOUNDS FROM A FERTILIZER PLANT EFFLUENT USING A MODIFIED OPERATION OF CONVENTIONAL WASTE TREATMENT SYSTEMS

E.C. BINGHAM, Farmers Chemical Assn. Inc., *Harrison, Tennessee* 37341

The primary objective of the project is to evaluate the technical and economic feasibility of reducing high concentrations of nitrogen by use of conventional treatment techniques with specific modifications. The study will determine the effects of selected variables on nitrogen removal, collect operational data to develop design criteria for other projects of a similar nature and examine the feasibility of reuse of certain wastestreams. In operation, high concentrations of ammonia will be reduced by stripping in a countercurrent aeration tower and the remaining ammonia will be oxidized to nitrates in existing trickling filter sewage plant. Nitrates will be denitrified to nitrogen gas under anaerobic conditions in facultative stabilization ponds. The feasibility of ammonia removal by an ion exchange or chemical precipitation process will also be investigated. Initial laboratory studies to determine approximate loadings and detention times to employ in the various treatment processes are currently underway in the laboratories of Associated Water and Air Resources Engineers, Inc. at Nashville, Tennessee.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1418, THE EFFECTS ON RUNOFF, GROUNDWATER, AND LAND OF IRRIGATING WITH CATTLE MANURE SLURRIES

J.J. SEWELL, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916

Hydraulic cleaning of dairy barns saves labor and improves sanitation; however, large quantities of manure slurry are produced. This slurry can be spread on fields by irrigation. The objectives follow: (1) determine the effects of ground slope, ground cover, and season on the maximum allowable slurry application rates, (2) learn the effects of continued slurry irrigation on groundwater quality and surface runoff and (3) develop slurry irrigation management techniques which minimize groundwater, land, and stream pollution.

A manure slurry holding tank equipped with agitation and slurry irrigation equipment will be constructed on a research dairy farm. A series of field plots will be planted to pasture and a

silage crop. The crops will be irrigated, and slurry runoff data and crop-yield data will be recorded during the season. Water from groundwater wells in the vicinity of the plots will be analyzed to determine coliform count, total bacteria count, nitrate level, phosphate level, BOD, pH, alkalinity, and water hardness. Management practices minimizing water and land pollution while being workable from the producer's point of view will be developed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1419, DEWATERING AND DRYING OF SLUDGE ON POROUS MEDIA
K.B. SCHNELLE, Vanderbilt University, School of Engineering, *Nashville, Tennessee* 37203

The dewatering and drying of sewage sludge is most commonly carried out in porous supporting media such as sand over a soil in a drying bed. Dewatering takes place as the water in the sludge simultaneously filters down through the porous supporting media and evaporates from the surface of the bed into the atmosphere. As the dewatering takes place moisture gradients are established and in turn provide the driving force for the diffusion of the moisture to the surface of the bed and the subsequent further drying of the sludge. Sludge, being a porus colloidal substance, often biologically unstable even if digested, forms a highly compressible structural lattice of low tensile strength as it dries. This weak lattice structure results in a decrease in permeability as well as surface cracking as the material dries.

The proposed research evolves around the determination of moisture gradients and transport rates within the supporting media, the sludge, and the air-vapor boundary layer in the atmosphere. Gamma ray spectroscopy will be used to ascertain the changes in moisture without disturbing the flow system. These measurements will be used to establish the dewatering and drying rate of sludge under various climatic, operating and design conditions.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.1420, A STUDY OF SOME OF THE FACTORS WHICH INFLUENCE THE EFFICIENCY OF OXIDATION PONDS IN THE TERTIARY TREATMENT OF WASTE WATER
H.D. MCAFEE, Univ. of Texas, Undergraduate School, *Arlington, Texas* 76010

Efforts will be made to determine the effect of chemical characteristics of waste water on the production of chlorophyll by algae.

We will furthermore attempt to establish a more concise relationship between phosphates in water and algal growth.

Samples of water to be tested will be taken from oxidation ponds at the sewage disposal plant of the Trinity River Authority at Grand Prairie, Texas.

This work will fall in the category, Water Quality Management and Protection and will begin in September, 1970.

SUPPORTED BY University of Texas - Austin

2.1421, INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION
C. TUCK, State Water Development Board, *Austin, Texas* 78711

The quantity and quality of irrigation return flow water from rice culture is being investigated for future planning of the return flows available for reuse in the Texas Coastal Prairie Region. There are two sample study areas in the project. One area uses a ground water supply and is instrumented for continuous operation. The other area uses a surface water supply and is being studied on a reconnaissance level.

The quantity of return flows will be obtained on a percent basis and/or on an acre-feet/acre basis from the records of water diversions, rainfall and volume of drainage that are collected. The quality of these return flows are analyzed from samples taken to investigate the possible change in water quality due to fertilizers and pesticides used in the culture of rice farming.

SUPPORTED BY Texas State Government - Austin

2.1422, DOCUMENT PROCESSING IN THE AREA OF WASTEWATER TREATMENT
E.F. GLOYNA, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

The objective of this proposal is to provide the Water Resources Scientific Information Center with abstracts of articles, reports, books, etc. which deal with the general subject of wastewater treatment. Specifically, the scope of this proposal includes an abstracting service, transcription of abstracts on a prescribed format, and the development of a detailed bibliography of documents not abstracted on regular scheduled intervals. Procedures implemented to provide the abstracting service are as follows: a. Copies of selected periodicals and other pertinent publications will be obtained from Librarians as they become available. b. Selected publications will be reviewed by faculty and research staff members to establish a priority in listing articles to be processed. c. Draft abstracts for high priority articles will be prepared by a professional staff member assigned to the 'Center of Competence.' d. Draft abstracts will be reviewed periodically for technical accuracy by members of the Faculty Advisory Committee. Changes recommended by these specialists will be incorporated in the draft abstracts. e. Abstracts prepared in final form will be in accordance with WRSIC guidelines.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1423, PROCESS MODELING OF BIOLOGICAL WASTE TREATMENT
D.M. HIMMELBLAU, Univ. of Texas, School of Engineering, *Austin, Texas* 78712 (DADA17)

Technical Objective: To increase available knowledge on biological mechanisms of sewage treatment in order to improve quality of waste water treatment thereby reducing environmental pollution from military installations.

SUPPORTED BY U.S. Dept. of Defense - Army

2.1424, DEVELOPMENT OF WASTE TREATMENT SYSTEMS ABOARD MARINE AND FRESH WATER CRAFT
W.B. DAVIS, Texas A & M University System, School of Engineering, *College Station, Texas* 77843

This project will be responsible for the development of waste treatment systems which can be used aboard existing marine and fresh water craft. The waste treatment system will include some of the features of existing biological systems, but will be designed to be used under pressure using sound for mixing. The system will be tried on a number of different types of waste which will simulate the treatment efficiency aboard various size marine vessels. The systems will be designed for minimum contact and low detention times with high efficiency of treatment.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1425, MANAGEMENT OF INDUSTRIAL WASTE DISCHARGES IN COMPLEX ESTUARINE SYSTEMS
R.W. HANN, Texas A & M University System, School of Engineering, *College Station, Texas* 77843

This project is concerned with investigations of the quantity and quality parameters relevant to a consistent water quality management program for the Houston Ship Channel-Galveston Bay Estuary System. Included are data collection and evaluation on such parameters as salinity, diffusion patterns, water and industrial effluent quality, benthal deposits, and other pertinent variables.

Results of the data are to be translated into a management scheme which provides for achieving water quality standards in an orderly and efficient manner.

The final phases of the study are to be devoted to developing a three-dimensional dynamic model of the entire estuarine system for precise management of industrial waste discharge throughout the entire region.

2. WATER QUALITY

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1426, WATER RESOURCE SYSTEM OPTIMIZATION BY GEOMETRIC PROGRAMMING
W.L. MEIER, Texas A & M University System, School of Engineering, *College Station, Texas* 77843

Techniques useful in the optimization of water resource system design problems will be developed in this research. A new and powerful optimization method, geometric programming, will form the basis for this study. Using geometric programming, highly nonlinear problems may be solved with relative ease.

In this investigation, the geometric programming optimization technique will be applied to a variety of water resource design problems to tests its usefulness in design optimization. Two such problems are concerned with the optimal design of water treatment units and pipelines. A computer algorithm will be developed to make the geometric programming available for use by water resource analysts.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1427, TERTIARY TREATMENT BY COUNTER-CURRENT CARBON FILTRATION
T.D. REYNOLDS, Texas A & M University System, School of Engineering, *College Station, Texas* 77843

The purpose of the project is to develop a mathematical model for tertiary waste water treatment using counter-current moving-bed activated carbon filtration. The initial model was developed from the equation X/m equals Kt (n power) and constants are obtained from both tests. The initial model is C sub o minus C sub e equals Gamma sub c Q sub c (1-n power) KV (n power)/Q sub w, where X equals amount of organic absorbed, m equals amount of carbon present, t equals time of contact, n, K equals experimental constants, gamma sub c equals specific weight of grandular carbon, C sub o equals organic concentration in influent, C sub e equals organic concentration in effluent, Q sub c equals carbon volumetric flow rate, Q sub w equals water volumetric flow rate, V equals filter volume.

The primary parameter to be measured is total organic carbon, however, COD, BOD, phosphates and other parameters will be measured as deemed necessary to evaluate the model. Testing methods will involve batch testing, bench-scale counter-current apparatus and a 100 gallon per day pilot plant located at the University wastewater treatment plant.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1428, USE OF POLYMERS TO REDUCE OR ELIMINATE SEWER OVERFLOW IN THE BACHMAN CREEK SEWER
A.E. HOLCOMB, Dallas City Water Works, *Dallas, Texas* 75201

During periods of rainfall the Bachman Creek sewer receives excess quantities of ground or storm water due to infiltration. The flow exceeds the sewer line capacity resulting in untreated wastes overflowing into Bachman Creek causing pollution.

The project will identify the points of overflow. A portable injector system will be used to verify the best location for a permanent injector station for the polymers. A permanent automatic polymer injection station will be constructed and evaluated. Through the use of polymers, the flow in the sewer pipe will be increased thus, eliminating or greatly reducing the overflows. Design criteria, operating techniques, optimum polymer concentrations and other pertinent data critical to the intended use will be evaluated.

The project was started in the fiscal year of 1969 and will be completed in fiscal year of 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1429, PHOSPHORUS REMOVAL AND DISPOSAL FROM MUNICIPAL WASTEWATER
C.H. CONNELL, Univ. of Texas, School of Medicine, *Galveston, Texas*

The objective of this project is to demonstrate effectiveness, feasibility and costs of biological, chemical and physical processes for removal and disposal of phosphorus from municipal wastewater.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1430, DEVELOPMENT OF SYSTEMS FOR GROUND WATER RECHARGE INTO THE OGALLALA FORMATION
M.J. DVORACEK, Texas Technological University, School of Agriculture, *Lubbock, Texas* 79409

The work proposed in this project is to develop systems for recharging underground formations. Several approaches - well, pit, basin, shaft, & trench recharge plus water spreading - will be investigated. Particular consideration will be given toward development of a filter or clarification system for removal of the high sediment load carried by waters used for recharge. Waters available for recharge are generally excess water such as surface runoff collecting in natural depressions (playas).

Investigation will include both field and laboratory installations of filter systems suitable for clarification of waters for both pit and well recharge. Pit, shaft, & trench recharge and water spreading will be primarily field evaluations of constructed recharge facilities. The establishment of design criteria for pits, shafts & trenches and filters for clarification of water is the primary objective of the project.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1431, EFFECT OF UNLINED TREATED SEWAGE STORAGE PONDS ON WATER QUALITY IN THE OGALLALA FORMATION
D.M. WELLS, Texas Technological University, Water Resources Center, *Lubbock, Texas* 79409

Treated effluent from approximately eighty municipalities located in the high plains of Texas is presently being stored in unlined ponds and used for irrigation of crops. This project is designed to determine the effect of such surface stored on groundwater quality in the underlying Ogallala formation.

A pond has recently been constructed for storing municipal effluent on the Texas Tech campus. Two wells will be drilled, cased, and equipped with electric pumps in the vicinity of this pond. One well will be located adjacent to the pond, and the other several hundred feet downstream. Samples will be collected weekly from these wells and from several other existing wells located in various distances around the pond. Weekly samples will also be collected from three or four points within the pond.

All samples collected will be analyzed for total nitrogen, total phosphorus, chlorides, and total dissolved solids. Changes in groundwater quality will be observed and quantitative estimates of the rate in which sewage percolates into the groundwater will be made by determining the rate and the extent of propagation of quality change from the test well adjacent to the storage pond.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1432, METHODS TO REDUCE WATER POLLUTION CAUSED BY STORM WATER SEWER LOADING BY USING FLUID FLOW FRICTION REDUCERS
H.R. CRAWFORD, Western Company, *Richardson, Texas* 75080

The research plan involves laboratory and field investigations directed at the use of high molecular weight polymers added to sanitary sewage with infiltrated ground water to demonstrate feasibility of reducing pipe friction loss with resulting increase in sewer flow rates.

Laboratory investigations shall consist of the following: 1. Small scale experiments on a water-polymer system to characterize friction reducing capabilities, storage life, toxicity, and effect as a coagulant. 2. Experiments to classify domestic sewage from chemical and physical properties. Field investigations shall consist of the following: 1. Testing on small scale models of a partial sewer system the friction reducing capability of selected polymers at varying sewage pipe depth and including surcharge. 2. Development of an injection device and method of injection of the polymer into the sewer pipe. 3. Determine the best location for injecting polymer into sewer pipe.

Laboratory and field data would be correlated for application in a full scale test of polymers added in a sanitary sewer infiltrated with ground water and in a waste water treatment plant.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1433, DEVELOPMENT AND DEMONSTRATION OF MATERIALS TO REDUCE OR ELIMINATE WATER INFILTRATION INTO SEWERAGE
H.R. CRAWFORD, Western Company, *Richardson, Texas* 75080

The research plan involves laboratory and large-scale investigations directed at the development of a chemical sealant to prevent ground water infiltrations into sanitary sewers and its feasibility in application.

Laboratory investigations shall consist of the following: 1. Small scale experiments to determine the most promising sealant formulations according to the following properties: a. Bonding ability b. Strength c. Variable cure time d. Ease of handling e. Stability f. Cost 2. The following parameters will be utilized in evaluating the sealant formulations: a. Tensile strength through the bond between cured sealant and the conduit. b. Flexural strength of cured sealant material. c. Environmental tests of cured sealant material.

The large-scale investigation shall consist of further screening of sealant formulations in a sewer line mock-up with a controlled environment. This will include an investigation and evaluation of existing equipment to apply the new sealant.

At the conclusion of the program recommendations will be made for a chemical sealant to prevent ground water infiltration and needed improvement and/or development for application of the sealant.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1434, TREATMENT OF OIL WASTES
M. WHITEFIELD, Western Company, *Richardson, Texas* 75080

The objective of this project is to prevent pollution by gelling the oil contained in a damaged tanker. The solidified oil will prevent the pollution of the ocean and the beaches since it will be confined to the tanker.

The purpose of this project is to develop materials and equipment for the gelling of crude oil contained in an oil tanker. Included as a part of the purpose will be a literature survey, a gelling material survey, the improvement of gelling materials, a schematic design of a system for off-loading of the gelled oil, and a system designed for gelling the oil in a tanker. In addition to laboratory oil gelling tests, the better materials will be used to get crude oil in a 1,000 and a 25,000 gallon test tank.

The final report on this project will include the major accomplishments and results of the project including the identification of the best gelling materials, the economics of a gelling system, and an injector system design.

The project was initiated in fiscal 1969 and will be completed in fiscal 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1435, STUDIES TO DEVELOP PROCESS DESIGNS FOR EFFLUENT QUALITY CONTROL
L.L. HISER, Southwest Research Institute, *San Antonio, Texas* 78228

No summary has been provided to the Science Information Exchange.

SUPPORTED BY No Formal Support Reported

2.1436, THERMODYNAMICS OF WASTE STABILIZATION PONDS
D.W. HENDRICKS, Utah State University, Utah Water Research Laboratory, *Logan, Utah* 84321

The project objective is to model the flow of free energy through a waste stabilization pond system, with principal emphasis on the primary pond in the initial stages.

The thermodynamic model will provide a scientific basis for recommending rational design criteria for waste stabilization ponds. The thermodynamic model will allow identification of adjustments in design that will maximize the energy degradation in the reactor and minimize energy production (photosynthesis).

The procedure is to delineate important reactions in each thermodynamic zone and develop a theoretical model; this model will be qualitatively and quantitatively ascertained through field measurements on a prototype system.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1437, ENVIRONMENTAL GEOLOGY OF SELECTED PARTS OF NORTHWESTERN VERMONT
W.P. WAGNER, Univ. of Vermont, School of Arts, *Burlington, Vermont* 05401

The objectives of the proposed project are: (1) to evaluate the water supply potential of the Champlain Valley, by delineating aquifers, water table elevations, recharge areas, and aquifer capacities; (2) to locate and evaluate suitable sites for garbage dumps in the Champlain Valley; (3) to determine septic waste disposal potentials of selected upland areas by mapping the distributions and evaluating the characteristics of unconsolidated materials; (4) to evaluate the nature, occurrence, and extent (rates) of stream bank and beach erosion.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1438, A STUDY OF NATIONAL POLICY ALTERNATIVES FOR URBAN WATER MANAGEMENT
A.B. BIGLER, U.S. Natl. Water Commission, *Arlington, Virginia* 22203

The objective of the study is to provide a comprehensive analysis of the water problems of metropolitan regions, including waste disposal problems, to ascertain the scope and nature of the programs required to meet the needs of such regions, and to develop alternative policy proposals. The study tasks will include: (a) formulation of alternative goals and objectives for urban water management; (b) identification of the planning, decision-making and implementation phases for urban water management; (c) analysis of cost-sharing and benefit allocation practices in urban water management; (d) determination of operational procedures and techniques for managing urban water facilities and related land and water resources; and (e) development of alternative approaches to urban water management and identification of the corresponding national water policy impact requirements. The plan of investigation includes literature surveys, interviews, and analysis of selected metropolitan case study areas.

The study was initiated in fiscal year 1970 and will terminate in fiscal year 1972.

SUPPORTED BY U.S. National Wtr. Comm. - Arlington, Va.

2.1439, ADVANCED WASTE TREATMENT FOR WATER REUSE - STATE OF THE ART
J. GAVIS, U.S. Natl. Water Commission, *Arlington, Virginia* 22203

The objective of the investigation is to: 1. Review the present state of the art in the development of methods for intensive treatment of waste waters to facilitate reuse. 2. Assess the feasibility of increase of water supply by means of advanced waste treatment processes to allow reuse of sewage treatment plant effluents.

The plan of the investigation is to review the current literature and to interview engineers and scientists engaged in research and development of advanced treatment methods. The project was started in fiscal year 1969 and will terminate in fiscal year 1970.

SUPPORTED BY U.S. Executive Office - Natl. Water Comm.

2.1440, THE EFFECT OF DETERGENTS ON THE OXYGENATION OF WATER
J.A. CASKEY, Virginia Polytechnic Institute, Graduate School, *Blacksburg, Virginia* 24061

Although many studies have been made showing that surfactants can lower oxygenation rates the mechanism by which this occurs is not known. The purpose of this investigation is to study what part of the surfactant molecule is responsible for this interfacial resistance to oxygenation. To this end the effect of following parameters on the interfacial resistance will be studied: hydrophobic chain length, hydrophilic functional group, surface

orientation and counter ion effect. Pure surfactants will be used so that the resistance can be related to the surface concentration by means of Gibbs' adsorption isotherm.

A quiescent liquid manometric gas absorption contactor will be used for the study. From this investigation it is hoped that it will be possible to specify what type of detergent is needed to increase the capacity of existing activated sludge units in municipal waste treatment facilities.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1441, TREATMENT OF DYEING BATH WASTE STREAMS BY FOAMING AND FLOTATION TECHNIQUES
D.L. MICHELSEN, Virginia Polytechnic Institute, School of Engineering, *Blacksburg, Virginia* 24061

The treatment of waste streams from dyeing operations is a problem in industrial waste treatment centering in the southeastern states. The proposed research plan will be the study of waste treatment and color removal of dispersed dye bath waste streams using foaming techniques. The initial stream to be studied will be a synthetic black or blue-black dispersed dye formulation including carrier approximating waste stream conditions from the dyeing of polyesters (Dacron) and triacetate rayon. The object of the work will be to study the removal of color, carrier (solvent), and perhaps dispersant surfactant using foam fractionation, adsorptive bubble fractionation and homogeneous ion flotation (complexing). Various parameters will be studied.

Depending on the outcome, the treatment of waste streams from other types of dyeing procedures may be tested using foaming techniques.

Some exploratory work on the removal of dissolved phenol and phenol derivatives from water may also be explored. This problem is pertinent to waste treatment because of toxicity and fish taste.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1442, OPTIMAL CONDITIONING PROCEDURES FOR WASTE ACTIVATED SLUDGE DISPOSAL
C.W. RANDALL, Virginia Polytechnic Institute, School of Engineering, *Blacksburg, Virginia* 24061

The proposed research plan involves laboratory investigations of the relative merits of biological and chemical waste activated sludge conditioning procedures. The approach of the investigation is to evaluate the effect of processes such as anaerobic digestion, aerobic digestion, and chemical conditioning on the overall sludge volume reduction rate.

Specific research objectives are: 1. To determine the comparative extents and rates of waste activated sludge destruction that can be obtained with anaerobic and aerobic digestion. 2. To evaluate the effect of anaerobic digestion on the subsequent dewatering rates of activated sludge as compared to the effect of aerobic digestion. 3. To evaluate the feasibility of using polyelectrolytes to conditioning anaerobically and aerobically digested activated sludge prior to dewatering. To measure the relative quality and quantity of waste liquid produced by the various conditioning processes.

The data will be correlated to define an optimum dewatering process for both sand bed and mechanical processing.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1443, PROCESSING PLANT EFFLUENTS FOR IRRIGATION IN COASTAL PLAINS OF NORTHEAST
G.A. PEARSON, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Norfolk, Virginia* 23501 (SWC-019-ANOR-1)

OBJECTIVE: Investigate waters of inferior quality, such as processing plant effluents, in regard to problems related to land disposal, and potential use for supplemental irrigation of crops; evaluate effects of these waters on plant growth and soil physicochemical properties.

APPROACH: Coordinated laboratory-greenhouse-field research program designed to evaluate the effects of these effluents on soils, crops and ground water when used for supplemental irrigation and for land disposal. This program is in initial planning stages.

PROGRESS: In compliance with restrictions on the indiscriminate discharge of waste water into streams, many vegetable processing plants have installed sprinkler irrigation systems to spread their waste water onto woodland or grassland for disposal. Effort is being made to utilize this waste water for irrigation. Because of its composition care must be exercised. In one study sprinkler irrigation with effluent from a plant using lye-peeling of potatoes caused severe soil damage in one season. Structure of top soil was altered, hydraulic conductivity was virtually zero, soil was covered with half-inch thick mat of potato peels and skins. This covering effectively sealed the soil surface creating anaerobic conditions. No vegetation was growing on the soil.

SUPPORTED BY U.S. Dept. of Agriculture

2.1444, INVESTIGATION OF RECOVERY OF LARGE MARINE OIL SPILLS BY USE OF A VORTEX ASSISTED AIR LIFT
P.C. WALKUP, Battelle Memorial Institute, *Richland, Washington* 99352

Efforts to recover spilled oil from recent marine disasters have shown that airlift recovery systems are effective and relatively efficient in calm waters. The purpose of this study is twofold: 1) investigate the feasibility of assisting an airlift recovery system by drawing the spilled oil to a central location with the gravity depression created by the vortex and 2) investigate the wave suppression effects of an induced vortex. Test apparatus has been installed in a 432 foot by 209 foot by 16 foot deep water basin consisting of a vortex generator with capabilities up to 6000 gpm and intake piping up to 18 inches in diameter, a wave suppression device, a wave making device and an airlift oil recovery system. Data will be gathered on wave height and length of both the generated and suppressed waves and the vortex profile through a broad spectrum of wave action. Tests will be conducted with a variety of oils having high potential for marine spillage, high gravity crude, low gravity crude, Bunker 'C' etc. and analysis will be made of the cohesive drawing of the oil as influenced by the induced vortex. It is expected that these and other data will be used to optimize the design of an open sea oil recovery system. This project was started FY 1969 and is expected to be completed by FY 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1445, REDUCTION OF RADIOISOTOPES IN HANFORD REACTOR EFFLUENTS
R.G. GEIER, Douglas United Nuclear Inc., *Richland, Washington* 99352

The radionuclides in Hanford's reactor effluent are formed by neutron activation of salts not removed in the water pre-treatment process, salt additives, and corrosion products which adhere to the reactor coolant lines as a film long enough to become significantly activated.

This research includes both laboratory and in-reactor studies of the three methods of reducing effluent radioactivity: better methods of pre-treatment, reducing film adherence time, and effluent treatment.

SUPPORTED BY U.S. Atomic Energy Commission

2.1446, RECOVERY OF BY-PRODUCTS FROM SHELLFISH WASTE
Q.P. PENISTON, Food Chemical & Res. Labs., *Seattle, Washington* 98107

The purpose of this project is to develop a new process to use waste material from shellfish processing operations to manufacture useful products. The work is planned to result in information sufficient to design a commercial scale plant to apply this new process.

The wet waste material is collected and brought to a central processing site. It is than ground and extracted with dilute sodium hydroxide to remove the protein. Protein is precipitated and spray dried to result in a product that contains approximately 90% protein. The remaining shell is then treated with hydrochloric acid to remove the mineral matter. The product from this step is a calcium chloride brine useful as an industrial chemical. The

remaining shell consists principally of chitin which is further purified, bleached, and transformed into chitosan for use in special applications.

This work was initiated under contract in FY 1969 and will continue in FY 1970. The process is now being proposed for a research demonstration grant to the Federal Water Pollution Control Administration by the City of Kodiak.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1447, WASTE WATER ODOR REDUCTION MECHANISMS IN SOIL FILTERS
D.A. CARLSON, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

The purpose of this study will be to investigate the processs involved in the removal of odorous compounds in soil filters. Previous work at the University of Washington indicates that the process of hydrogen sulfide degradation in soil filters is biological in nature, but further research is needed to establish the organisms responsible, to attempt pure culture studies with isolated colonies to verify column activity, and to establish optimum conditions for their growth and ability to degrade test compounds.

Other phases of the research will consider changes in soil properties during test gas application, accumulation of deposited products in the soil, gas pressure requirements under various gas flow conditions and development of optimum conditions for long period use of soil filters.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1448, STREAM STRIPPING OF KRAFT PULP MILL EFFLUENT STREAMS
J.L. MCCARTHY, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

The broad objective of the presently proposed research is to improve the effectiveness and to extend knowledge concerning the possible industrial applications of the 'SEKOR' process which in, essence, comprises the counter-current steam stripping of kraft pulp volatile organic compounds from the fluid and thereby provide relatively clean effluent water which can be reused in pulp mill process or else discharged without danger. The volatilized organic substances are condensed to yield water-immiscible 'SEKOR oils' which may find uses in commerce. Use of the process may also result in a substantial decrease in the odorous substances emitted into the atmosphere from kraft pulp mills.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1449, POLLUTION PREVENTION BY AERATION OF FRUIT PROCESSING WASTES
L. ESVELT, Snokist Growers, *Yakima, Washington*

The project involves a study of three methods of aerobic biological treatment of wastes from a fruit processing plant. The methods to be studied include a completely mixed aerated lagoon, a completely mixed activated sludge system, and a modified contact stabilization process. Oxygen transfer rates and utilization rates will be determined, and sludge dewatering studies will be made. A study of possible installation of solids removal equipment in the plant will be made as a possible method of reducing waste volumes and of reducing sugar leading into the carriage waters.

SUPPORTED BY U.S. Dept. of Interior - F Wtr. Qua. Adm.

2.1450, A DEMONSTRATION OF A NEW MINING TECHNIQUE TO PREVENT THE FORMATION OF MINE ACID IN AN ACTIVE DEEP COAL MINE
S. BARKER, Island Creek Coal Company, *Holden, West Virginia* 25625

Summary of Proposed Work: The project is Phase I of a four part program, being conducted under a Research and Development Grant, to demonstrate that mining coal in an oxygen-free atmosphere will prevent the formation and subsequent discharge of acid mine water into streams and other water courses. Investigation and demonstration of the adaptability of life support systems, similar to those used by NASA in the space program, to conventional coal mining techniques will aid in determining the feasibility of mining coal in an oxygen-free atmosphere. Other benefits expected include the reduction of chances for explosions and fires in a mine and a decrease in the occurrence of lung disease in miners. This study will further research of the inert gas atmosphere technique which has been performed in laboratory bench scale studies of inert gas atmosphere effects on pyrites, and the experimental application of inert gas atmospheres to abandoned mines. The purpose of the Phase I study is to make engineering evaluations of life support systems, in-mine systems, outside systems, and facilities, personnel programs, mine sites exploration and evaluation, safety, and planning associated with continuation of the project into the additional phases initially delineated (component evaluations, construction and operation of a demonstration mine and project evaluation and final report).

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1451, PHOSPHATE UPTAKE, STORAGE, AND RELEASE BY MICROORGANISMS IN WASTEWATER TREATMENT
W.A. SACK, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

The objective of this investigation is to understand and develop the capability of heterotrophic microorganisms to remove phosphate from wastewater. The first phase of the work will seek to determine how the uptake and turnover of phosphorus depend on the presence and level of a metabolizable substrate. Batch and continuous culture techniques will be used to simulate in a controlled manner the actual conditions of sludge contact with waste. The substrate-to-microorganism ratio will be varied over a wide range to observe the phosphate uptake per cell in growth situations. To closely follow the flow of phosphate, rigorous phosphate balances will be made on the cell mass and substrate. The second phase of the study will be an investigation of cellular storage of phosphate. Complex polyphosphates accumulate in a wide variety of organisms under certain conditions which limit their usual synthetic activities toward growth and division. In waste treatment systems, carbon is the parameter limiting cellular growth. Observations therefore will be made for inorganic polyphosphate storage under carbon limiting conditions. The substrate limitation will be enforced on the culture under various patterns and cycles of loading.

Estimates of stored polyphosphates will be made by staining procedures and by chemical analyses. Chemically defined media will be used. Pure cultures and mixed cultures representative of those found in wastewater will be employed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1452, MINE SPOIL POTENTIALS FOR WATER QUALITY AND CONTROLLED EROSION
R.M. SMITH, West Va. University, School of Agriculture, *Morgantown, West Virginia* 26506

Test core and blast hole samples of strata overlying coal considered for strip mining will be evaluated chemically, physically, and mineralogically to determine desirability for soil formation and unpolluted seepage and runoff waters. Forms of sulphur, carbonates, mineral species, buffering capacities, soluble or exchangeable plant nutrients or toxic elements, and weathering changes over time in environments of spoil deposits will be studied to guide plans for coal stripping operations, placement of different spoils and practices necessary for prevention of water pollution, improvement of the environment for planned uses, and expansion of results to areas other than Northern West Virginia.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1453, THE THICKENING AND DEWATERING OF PRECIPITATES FROM THE LIME/LIMESTONE TREATMENT OF MINE DRAINAGE
E.B. WILSON, West Va. University, School of Mines, *Morgantown, West Virginia* 26506

2. WATER QUALITY

The proposed work will consist of a detailed study of the problem of densification of ferric hydroxide--calcium sulfate sludges which result from the lime or limestone treatment and aeration of acid waters from coal mines. The project will focus on the interrelationship of mine wate chemistry with the settleability of sludges and possible methods used to chemically or mechanically concentrate and dewater these sludges. Areas of study will include filtering, flocculation, decantation, centrifuging, thickening, and cycloning. A State of the Art review of potentially useful existing dewatering methods as they apply to mine water treatment sludges will be completed early in the study. The economics of alternative treatment schemes will be examined with the objective of reducing the overall costs of water treatment and sludge disposal. The project will begin in February, 1970, and is scheduled for completion in January, 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1454, COMBINED STEEL MILL AND MUNICIPAL WASTEWATERS TREATMENT
W.M. SMITH, Natl. Steel Corporation, *Weirton, West Virginia* 26062

The project is Phase I of a proposed three part program, being conducted under a Research and Development Grant, to demonstrate new and unique methods of treating selected steel mill and sanitary wastewaters in a municipal sewage treatment plant. The synergistic properties of the various wastewaters will be utilized to maximize the cost effectiveness of maintaining the stream quality objectives. Phase I consists of three tasks. Task I includes characterization of the steel mill wastes, evaluation of existing wastewater treatment facilities, determination of the quantity and quality of wastes to be treated, performance of a survey of the municipal treatment facility to evaluate processes to upgrade the plant to meet new standards, estimation of the overall effects of increased discharges in the Ohio River from larger volume mill effluents, determination of the hydraulic adequacy of the sewer system with regard to storm runoff, and evaluation of the effects of mill waste waters on sewer system materials of construction. Task 2 provides for the assessment of alternative treatment processes for combined steel mill and municipal wastewaters, utilizing laboratory and bench-scale studies. The most effective treatment processes for a demonstration project will be evaluated in Task 3, based on Task 2 data.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1455, COMBINED INDUSTRIAL AND MUNICIPAL WASTE TREATMENT
D. MARTIN, Green Bay Met. Sewage Dist., *Green Bay, Wisconsin*

The project will be a study, evaluation, and determination of the effectiveness, design, and operating parameters of four alternative biological treatment processes and modifications for treating combined municipal and industrial (primarily paper mill) waste waters. A pilot waste water treatment plant for each process will be determined. Each pilot plant will have a 1 to 10 gpm capacity for combined waste waters. After selecting the most promising process, an existing 60 gpm pilot will be modified to suit the selected process and will be operated for a year to demonstrate its performance and to generate performance data. The final objective is to evaluate the design, performace, and use of the systems and to generalize the results for applicability to other locations.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1456, DEMONSTRATION PROJECT OF BIOLOGICAL ADSORPTION OF POLLUTANTS FROM COMBINED STORM WATER RUNOFF AND SANITARY SEWAGE
F.I. VILEN, Kenosha City Water Utility, *Kenosha, Wisconsin* 53140

The project objective is to provide a means for high rate biological adsorptive treatment of combined sewage by the utilization of viable activated sludge, clarification, and disinfection. The method will be to store activated sludge in a biosolids reservoir and maintain a contact tank and a solids stabilization tank in an empty and ready condition at a location adjacent to the sewage treatment plant. When a rain event occurs, the excess combined sewage is directed to the contact tank and the activated sludge solids proportioned in. After a contact period (15 - 30 minutes) during which pollutants are adsorbed by the biosolids, the mixed liquor is discharged to a clarifier for solids/liquid separation. The effluent is disinfected and discharged to receiving waters. The sludge solids are discharged to the stabilization tank and reused or sent to digestion facilities as required.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1457, RESEARCH AND REFERENCE TO SEWAGE EFFLUENT PONDS
W.C. BOYLE, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

The objective of this investigation was to determine base design criteria for effluent stabilization ponds in Wisconsin by ascertaining the effects of detention time, organic loading and temperature on pond efficiencies. By the use of two partitions a 5 foot deep pond was converted into each of three ponds, approximately 35' by 35'. Secondary domestic sewage effluent was fed on a controlled basis to these three ponds to give the following detention times; 3, 10 and 30 days. The effects of these different detention times were determined at various temperatures and organic loadings by conducting tests throughout the year.

The performance of these ponds under different experimental conditions were determined by use of the following analytical tests: B.O.D., C.O.D., solids, nitrogen, bacteriological (mainly fecal coliform), and phosphorus. In addition, algae and plant studies were conducted, dissolved oxygen and temperature profiles were measured and actual detention times were measured by means of dye tracer techniques.

This study, conducted in connection with the Ixonia (Wisconsin) activated sludge treatment plant, was started in the fiscal year of 1966 and is expected to be completed by December, 1969.

SUPPORTED BY Wisconsin State Government - Madison

2.1458, APPLICATIONS OF AGGLOMERATE SIZE MEASUREMENT TO PROBLEMS IN WATER RESOURCES MANAGEMENT
R.K. HAM, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

Agglomeration is one of the most basic and common unit processes to be found in natural and man-made water systems; yet, there is need for improved utilization of the process, as might be attained once the process is better understood, to meet contemporary problems of water resources management and control.

This study is expected to provide for monitoring the dynamic process of agglomeration and should lead directly to improved process applications. It is based on the use of a concentric cylinder device which incorporates a specially designed particle size analyzer for monitoring certain properties of agglomerates as they are formed in the annulus.

This study is divided as follows: 1. An apparatus is devised to measure fundamental changes occurring during agglomeration processes. 2. The apparatus is applied to work on the agglomeration of organic and inorganic colloidal matter. In particular, the effects of shear rate and agglomerate concentration are examined. 3. The above results are applied to use of the unit on other agglomeration processes, including the precipitation of phosphates, hardness, and iron or manganese; and the flocculation of biological systems, such as bacteria in the activated sludge process, or algae in nutrient removal processes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1459, DEVELOP FIELD PROCEDURES FOR PREDICTING MOVEMENT OF LIQUID WASTES IN SOILS
F.D. HOLE, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

Hydraulic conductivity of a volume of soil approximately 4 in. (10 cm.) in diameter will be measured under saturated condi-

tions in major horizons of several representative soils of Wisconsin. Measurements in situ will be made with the Bouwer double tube apparatus (with a hydraulic head of nearly 2 meters) developed in the U.S.D.A., Research Service Laboratory at Phoenix, Arizona. This first application of this new rapid field method to Wisconsin soils will be related to standard soil percolation tests required by state law to determine suitability of soils for septic tank installations. Correlative analysis of soil fabric and laboratory tests of undisturbed soil cores will be made. On the basis of the data, evaluations will be made of (a) current concepts of hydraulic properties of soil horizons and entire profiles, (b) the standard percolation test, and (c) possible future approaches to research problems encountered during the course of this study. The project began on July 1, 1969 and will be completed on June 30, 1971.

SUPPORTED BY Wisconsin State Government - Madison

2.1460, DEFINITION OF THE MIXING ZONE FOR WASTE EFFLUENT DISCHARGED INTO SURFACE WATERS

J.A. HOOPES, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

The objectives of this project are: (1) Determine the mixing zones for three or four waste effluents in well defined field environments, using ground and aerial sampling methods; (2) Develop a detailed experimental program to test simple, idealized laboratory models of outfall discharges into river and lake environments; and (3) Analyze and interpret the summer field surveys in light of the mixing zone hypothesis, developed during the first year of this study, and the laboratory model observations.

During the summer of 1969, field surveys of the pollutant patterns from municipal, powerplant and other industrial waste discharges into three or four Wisconsin rivers will be made. These surveys will include the measurement of depth, velocity, temperature and pollutant concentration both along and across the river, downstream of the outfall. Simultaneous with the ground sampling, aerial photographs of the pollutant patterns will be taken. Field sites will be selected in order to include different river and effluent conditions.

In an effort to extend and generalize these field observations, simple, idealized laboratory and mathematical models of waste effluent discharges will be studied. These models will be used to study the effects of outfall location and type and river discharge and geometry on the rate of dilution or mixing of the effluent with the river.

Based upon upon these studies, it is hoped that: (1) more definitive criteria regarding the mixing zone can be developed; (2) the proper location of sampling or monitoring stations can be prescribed; and (3) criteria on the location and design of outfall structures to maximize the rate of effluent dilution in different river environments will result.

SUPPORTED BY Wisconsin State Government - Madison

2.1461, INVESTIGATIONS OF ZOOGLOEAL FLOCS

G.A. ROHLICH, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

The proposed work has been divided into the following general areas: Floc Formation - studies are being undertaken to determine the quantitative and qualitative factors affecting the flocculation of bacteria of the genus Zoogloea.

Metabolism and Growth of Zoogloeal Species - Further work is being undertaken to better understand the metabolism of the Zoogloeal Species. Identification and taxonomic studies are also being made.

Kinetic and Diffusional Studies - The diffusion of nutrients (including oxygen) through pure culture floc is being studied. Both kinetic and diffusional models will be investigated and tested.

Gravity Settling of Flocs - Preliminary studies are being made to better ascertain the factors affecting the density, specific surface and shape of pure culture flocs that might affect settling properties.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1462, PILOT STUDIES IN THE RESTORATION OF THE PHYSICAL ENVIRONMENT OF A STREAM TO MAINTAIN A CLEAN WATER FLORA AND FAUNA

R.V. HARMSWORTH, Limnetics Incorporated, *Milwaukee, Wisconsin* 53218

The proposed study is to evaluate a method of accelerating the natural 'purification' processes of streams receiving shock loads of sewage effluent. The method proposed is a horizontal gravel filter, similar to the trickling filter of sewage treatment plants. The method also has possibilities for diverting some nutrients from the algal cycle to an animal food chain and would therefore have potential for retardation of the algal eutrophication process. The program consists of two parts and will take place over a two year period.

The pilot study is to determine the feasibility of building a biological reactor in which the proper ecological environment for the development of periphytic and planktonic communities will be established. The pilot study will also evaluate the effect of the reactor in developing diverse communities of organisms and improving water quality.

If the first year's program is successful, a full scale reactor will be built in the stream in the second year and the impact of the reactor upon the stream fauna and water quality evaluated. The pilot study will be undertaken on Jackson Creek at Delavan, Wisconsin.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1463, LUXURY METABOLIC STORAGE OF PHOSPHORUS IN THE ACTIVATED SLUDGE FLOC

S.K. MALHOTRA, Marquette University, School of Engineering, *Milwaukee, Wisconsin* 53233

The relative ineffectiveness of the activated sludge waste water treatment process in removing phosphorus is a major cause of progressive fertilization of natural bodies of water receiving treated waste waters. Phosphorus enrichment often results in algal blooms, which frequently result in objectionable odors and many other deteriorating effects on the quality of water.

Recently it has been reported that the activated sludge process can be adapted to make the organisms store phosphorus during their endogeneous respiration phase, far in excess of their metabolic uptake in the logarithmic growth and declining growth phases. This excess phosphorus uptake, 'Luxury Storage,' has also been reported to be affected by the cations in the environment.

The objectives are to examine the storage of phosphorus in the activated sludge flocs as the microorganisms pass through different growth phases, and to determine the proportions of the total stored phosphorus in each of the growth phases; the effects of ionic and surface adsorption and storage of phosphorus by cationic colloidal formations.

Batch processes with a synthetic substrate under controlled parameters of pH, food/microorganisms ratio, cationic concentrations, dissolved oxygen concentrations and the degree of mixing will be employed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1464, PROCESSING RETORTING WASTE WATERS

A.B. HUBBARD, U.S. Dept. of the Interior, Bureau of Mines, *Laramie, Wyoming*

Detailed studies of waters produced during the retorting of oil shale will be made to: Determine what pollutants are present, demonstrate if any pollutants of value can be recovered to offset waste disposal costs, and develop methods for pollutant removal or disposal.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

2.1465, STUDY OF WASTE DISPOSAL PROBLEMS

J.R. RUARK, U.S. Dept. of the Interior, Bureau of Mines, *Laramie, Wyoming* 82070

2. WATER QUALITY

This project is directed toward the determination of organic and inorganic pollutants in process and product waters from an oil shale processing operation in order to devise methods for removing the contaminants or reducing their concentrations to harmless levels.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

2.1466, POLLUTANTS IN PRODUCT AND PROCESS WATERS FROM OIL-SHALE RETORTING OPERATIONS AND METHODS FOR THEIR REMOVAL
S.S. TIHEN, U.S. Dept. of the Interior, Bureau of Mines, *Laramie, Wyoming*

This project is directed toward the determination of organic and inorganic pollutants in process and product waters from an oil-shale processing operation in order to devise methods for removing the contaminants or reducing their concentrations to harmless levels.

Because Green River oil-shale deposits are located in arid or semiarid regions, process water will be scarce and provisions must be made for its reuse. It would also be desirable to augment existing water supplies by reclaiming the water product during retorting. In either case, the pollutants must be either removed or reduced to such low concentrations as to render them harmless. Detailed knowledge of the compositions and amounts of pollutants may be removed or reduced to harmless or unobjectionable levels. Organic contaminants might be present in sufficient quatities to make recovering them economically attractive.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

F. POLLUTION EFFECTS

Ecological, Physiological, and Physical Effects of Water Pollution.

2.1467, INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT
D.E. DAVIS, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

Five aquatic weed species, alligator weed (Alternanthera philoxeroides (Mart) Griseb), water hyacinth (Eichornia crassipes (Mart.) Solms), egeria (Egeria densa Planch), slender naiad (Najas flexilis (Willd) Rostk and Schmidt), and curly pondweed (Pontamogeton crispus L.) will be grown in 100% well water and in 75% well water and 25% sewage effluent. Experiments will be conducted in pools out-of-doors and in plastic pans in a growth chamber. The following determinations will be made: (1) effect of sewage effluent on the growth of the aquatic weeds and phytoplankton, (2) effect of the growth of aquatic weeds on the removal of nitrogen and phosphorus from the water and on the growth of phytoplankton, and (3) the amounts of protein, total nitrogen and phosphorous present in the different aquatic weed species grown in different sewage concentrations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1468, DYNAMICS OF CHEMICAL & PHYSICAL CHARACTER OF WATER, BOTTOM MUDS & AQUATIC LIFE IN A LARGE IMPOUNDMENT ON A RIVER
J.M. LAWRENCE, Auburn University, Water Resources Research Inst., *Auburn, Alabama* 36830

This study of impoundments on parts of the Chattahoochee and Flint Rivers will supplement work completed under OWRR Project B-00 -ALA (Phase I). This study will indicate: (1) input-output relationships of salts and organic matter brought into the impoundment by creeks, streams and rivers and their distribution in water, biota and bottom muds within the impoundment and its tailwaters; (2) the influence of treated domestic pollution on chemical and physical characteristics of water throughout a long, relatively deep, power impoundment; (3) the importance of paper mill waste introduced into the prevailing domestic sewage pollution upon aquatic plant development and upon fish population conditions in downstream areas of such polluted impoundments; (4) critical periods and conditions that may affect aquatic life in this and similar impoundments; (5) the dynamics of physiochemical characteristics of mainstream impoundments and aid in the establishment of water quality criteria for multi-purpose impoundments.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1469, EFFECT OF POLLUTANTS ON AQUATIC MICROORGANISMS
W.C. NEELY, Auburn University, School of Arts, *Auburn, Alabama* 36830

Laboratory work will be conducted to determine the following: (a) The effect of typical pollutant molecules on sunlight mortality of and sunlight induced mutations in typical aquatic microorganisms. (b) The mechanisms by which these effects occur will be elucidated for various pollutants of different molecular structures.

The above information will be used to obtain a working relationship which will enable prediction of biological activity of a pollutant from knowledge of its molecular structure.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1470, EFFECT OF INDUSTRIAL POLLUTANTS ON WATER QUALITY
B.E. HUNTLEY, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Dauphin Island, Alabama* 36528

Objectives of the project are to determine if wastes from selected industrial complexes which are discharged into waters adjacent to the plant operations create environmental conditions conducive to bacterial multiplication. Wastes from paper mills and related industrial operations, for example, may discharge bacterial nutrients, such as xylose (wood sugar) into ponds or rivers. This would provide excellent nutritional conditions for growth of some bacteria including pathogens and organisms included in the coliform group used as indicators of fecal pollution. Growth of fecal coliform organisms under these conditions would lessen their value as indicators of fecal pollution.

Samples for bacterial analyses will be collected at points near waste discharge ports and at downstream sites along the flow route. Chemical analyses of the samples containing large numbers of bacteria will be conducted to determine the nutrient composition.

The project started in August 1969 and is continuing.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1471, A BIOLOGICAL INVENTORY OF THE STREAMS AND IMPOUNDMENTS OF THOSE PORTIONS OF RIVER BASINS WITHIN 12 EAST CENTRAL ALABAMA COUNTIES
H.D. KELLY, State Game & Fish Division, *Eastaboga, Alabama* 36260

The purpose of this study is to collect biological data from the streams and impoundments as related to the fishery of these river basins as follows: I. Fish: a. Species, b. Species distribution, c. Food habits, d. Spawning data, e. Stream production (as indicated by population samples), f. Impoundment production (as indicated by population samples). II. Fish food organisms. III. Aquatic plants. IV. Sport fishery utilization. V. Commercial Fishery. VI. Effects of pollution.

Recent studies have indicated the pressures of an increased demand upon our waters by fishermen and others who use our waters in the years to come. It is felt that this information will better equip us to meet this challenge.

Period for this study: 10/65 - 9/73.

SUPPORTED BY Alabama State Government

2.1472, THERMAL AND CONVENTIONAL RIVER POLLUTION
L.P. MORIN, Univ. of Alabama, Research Institute, *Huntsville, Alabama*

Environmental studies on the ecological requirements of aquatic organisms associated with the Tennessee River and its watershed begun several years ago are being continued. The portion of the river from Guntersville Lake to below the proposed

Brown's Ferry Nuclear Plant is the area under intensive study for physical, chemical, and biological factors. Efforts are continuing to interest the Department of the Interior in sponsoring this study.

As a direct result of these studies, cooperation has been extended to the Facilities Office and the Environmental Health Service of the MSFC Medical Center. Assistance is in the form of analysis of fluid effluent from the center and facilities design to treat this effluent. Since this discharge is into Indian Creek, which flows through a wildlife refuge before reaching the river, the discharge can affect aquatic organisms and ecological conditions over an extended area. By determining the effluent contents, results should indicate the physical facilities necessary for the center to control its fluid discharge into natural waters.

Also as a result of these studies, assistance has been extended to the City of Huntsville in the formulation of a water pollution control ordinance.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

2.1473, FACTORS INFLUENCING THE PRODUCTION OF PLANKTONIC AND BENTHIC PLANTS

G.E. SMITH, U.S. Tennessee Valley Auth., Div. of Environ. Res. & Dev., *Muscle Shoals, Alabama* 35660

The role of factors that control rates of growth and total standing crop of both planktonic and benthic plants will be studied in streams and reservoirs. These studies will evaluate effects of the following factors in growth rates under field and, in some cases, laboratory conditions: (a) various nutrient levels; (b) interaction of communities due to excretion of extracellular metabolites or competition for nutrients; (c) the source of nutrients in streams and reservoirs whether from land areas having various forms of vegetal cover, or from waste discharges; (d) substrate types; (e) light penetration; (f) reservoir operation and hydraulic flow characteristics; and (g) other physical and chemical characteristics of the flowing or impounded waters. A prediction equation that will include and define the relative importance of the significant factors will be developed, based on a multivariate analysis of the data.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1474, EFFECTS OF LARGE SCALE FOREST FIRES ON WATER QUALITY IN THE INTERIOR OF ALASKA

F.B. LOTSPEICH, U.S. Dept. of the Interior, Federal Water Quality Admin., *College, Alaska* 99701

The purpose of this project is to evaluate the significance of large scale forest fires as polluting agents in Alaska's interior. Evidence from work in other states suggests that soil properties change as a result of burning. Little or no work is available on the effect of these changes in soil properties on water chemistry of streams draining burned watersheds. Moreover, the effects of burning on stream biota, resulting from aberrations in water chemistry, has received little attention. This project is designed to compare soil chemistry to water quality of streams draining these watersheds. Species composition of stream biota will be related to water chemistry to provide information on the significance of burning to biological changes caused by forest fires.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1475, BIOLOGICAL EFFECTS OF HEAVY METAL POLLUTION

D.K. BUTTON, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

Our thesis is that heavy metals combined with microorganisms effecting their affinity for substrates. This phenomenon is significant only when the buffer and chelating capacity of the medium is very low such as in natural water systems (rivers, lakes, and the ocean). This steady state level of biooxidizable organic material is a function of heavy metal levels. We find that phosphate limited cultures of a marine yeast and a marine bacterium in continuous culture are adversely effected by 10 to minus the 7th power M Cu ion. We have described the phosphate incorporation kinetics and are proceeding to describe the phosphate-heavy metal-organism relationship.

Work is being performed at the University of Alaska and the Department of Biophysics, University of Colorado Medical Center.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1476, ECOLOGY AND NITROGEN CYCLE IN A MARINE PLANT COMMUNITY

J.J. GOERING, Univ. of Alaska, Inst. of Marine Sciences, *College, Alaska* 99735

The physiological ecology of eelgrass (Zostera marina) communities will be examined in concurrence with the dynamics of the nitrogen cycle in a lagoon on the Bering Sea coast of Alaska. A comparison of natural conditions will be made with an area receiving untreated sewage. This will include an examination of the relationship between the primary producers and nitrogen cycle, with emphasis on the role played by nitrogen in the total productivity of the community. Also to be included is the control of the environment on the growth and morphology of the dominant primary producer, eelgrass. The contribution of organic matter, particulate and dissolved, from the eelgrass community to near-shore oceanic food webs will also be investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1477, POSSIBLE EFFECTS OF CRUDE OIL ON AQUATIC ORGANISMS

J.E. MORROW, Univ. of Alaska, School of Biological Sciences, *College, Alaska* 99701

Normal, unexposed fishes will be analyzed to determine normal ranges of variation. Gills, stomach, liver, intestine, pancreas, spleen and kidney will be examined histologically. Blood parameters, Na plus, Cl minus, K plus, CO2, O2, Hb, serum proteins and lipids and pH will be measured. During experiments, same parameters will be examined on controls and experimental animals.

Three series of experiments are planned, in salt water, since the major pollution effects can be expected in the marine environment, all replicated at 3 temperatures. Temperatures will approximate maximum, minimum and mean to be encountered in Central Alaskan fisheries areas. Experiments are as follows: Series I. Fish will be exposed to crude oil, various concentrations, for periods up to 30 days. Their reactions will be observed and measured. Series II. Fish will be passed through a film of crude oil to expose respiratory organs to oil. Respiratory organs and reactions of animals will be examined in detail. Series III. Fishes will be fed controlled amounts of oil to determine whether ingestion of oil has deleterious effects on animals, and if so, how effects are produced.

Most of the work will be done in the Alaska Water Laboratory, FWQA. Histology to be done in Department of Biological Sciences, University of Alaska, computer work at the University of Alaska computer center.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1478, RELATIONSHIPS BETWEEN LOGGING ACTIVITIES AND SALMON PRODUCTION

K. DURLEY, State Dept. of Fish & Game, *Juneau, Alaska* 99801

Objectives of this phase are to complement and extend the presently established joint monitoring effort of the U. S. Forest Service and the Alaska Department of Fish and Game in order to determine if stream changes due to logging and other causes occur and to what extent changes effect the potential of these streams to produce salmon fry.

The following characteristics are being monitored on three important salmon producing streams in Southeastern Alaska: (1) Composition of streambed spawning areas; (2) stream flow and water temperature; (3) stream channel configuration and amount and kind of debris in the stream; (4) classification of soil types in the watershed; (5) sources of sediment; (6) production of salmon fry and survival and (7) assessment of adult salmon escapement.

The studies to date have been a cooperative venture between the U.S. Forest Service and the Alaska Department of Fish and Game, with each agency responsible for part of the work. The

study is primarily concerned with establishing a base for management action to assure that no single resource is being utilized for the detriment of another resource.

Procedures for characteristics monitored by the Alaska Department of Fish and Game are described in the Fisheries Research Institute, University of Washington, Field Manual, dated 17 February 1964.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1479, MONITORING THE EFFECTS OF LAND USE ON SALMON PRODUCTION

T.C. HOFFMAN, State Div. of Comm. Fisheries, *Juneau, Alaska* 99801

Objectives: To complement and extend the presently established joint monitoring effort of the U.S. Forest Service and the Alaska Department of Fish and Game in order to determine if stream changes due to logging and other causes occurred and to what extent these changes affected the potential of these streams to produce salmon fry.

Characteristics Monitored: (1) Composition of streambed spawning areas. (2) Streamflow and water temperature. (3) Stream channel configuration and amount and kind of debris in the stream. (4) Classification of soil types in the watershed. (5) Sources of sediment. (6) Production of salmon fry and survival. (7) Assessment of adult salmon escapement.

Characteristics studied prior and subsequent to land use and observations taken yearly.

The studies to date have been a cooperative venture between the U.S. Forest Service and the Alaska Department of Fish and Game with each agency responsible for part of the work. The study is primarily to establish a base for management action and is presently being conducted in one important salmon producer in Southeastern Alaska and will be extended to three with special reference to logging and road building.

Procedures: For these characteristics monitored by the Alaska Department of Fish and Game as described in Fisheries Research Institute, University of Washington Field Manual dated 17 February 1964.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1480, LIMNOLOGICAL EFFECTS OF ORGANIC WATERSHED LITTER

W.J. MCCONNELL, Univ. of Arizona, Arizona Coop. Fishery Unit, *Tucson, Arizona* 85721

Previous work under this project has shown that phenolics derived from litter may occasionally reach concentrations in excess of 10 mg/liter in some natural waters. Considering the documented physiological effects on mammals of many phenolics, one may postulate that fish and aquatic invertebrates are affected by litter phenolics. Current project emphasis is on long term bioassays of fish and invertebrates to detect sub-acute effects on survival, growth, and larval development. Classes of compounds being tested are hydrolyzable tanning, flavonoid tannins, hydroxy-benzenes, hydroxy benzoic acids, flavonoids, vanillin-like compounds, and hydroxy-cinnamic acids.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1481, IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES

D.A. BECKER, Univ. of Arkansas, Water Resources Research Ctr., *Fayetteville, Arkansas* 72701

The proposed study is the first pre-impoundment through early impoundment investigation of this nature to be conducted in the United States.

Field investigations will employ electrical shocking gear for the live collections of the black basses Micropterus dolomieui Lacepede, M. punctulatus (Rafinesque), and M. salmonides (Lacepede).

Basses will be examined in the laboratory for helminth and copepod parasites in an effort to follow the quantitative and qualitative dispersions and fluctuations of these parasites as the water quality is effected by the water level fluctuations from a river to a reservoir environment. Standard and total length, weight, and scale samples will be obtained to ascertain the effect of parasitism on the aging and growth rates of basses which may help explain why sport fishing declines after several years in recently impounded reservoirs effecting the recreational economy of the municipalities surrounding reservoirs. Parasitism will be related to the whole food chain in an attempt to establish another parameter for water quality.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1482, EFFECTS OF WATER DIVERSION ON BIOTA AND WATER QUALITY IN THE STATE OF ARKANSAS

R.V. KILAMBI, Univ. of Arkansas, Water Resources Research Ctr., *Fayetteville, Arkansas* 72701

The proposed study is to evaluate biological characteristics of fish in Arkansas Reservoirs and the King's River, the latter serving as an unaltered environment. The emphasis is on the population structure in relation to the environment with special reference to meristic and morphometric characters, age and sex composition, rate of growth, fecundity, and interaction between populations or species and their environment. Laboratory experiments will be planned to study the effects of temperature on hatching and survival of eggs, critical period in the development of eggs, and the fixation of the meristic characters.

It is also planned to tabulate and correlate plankton data with physical and chemical variants collected from five small Arkansas impoundments over a period of 28 years. Emphasis will be placed on seasonal cycles of plankton species characteristics of these environments, their possible use as indices of trophic levels, and the succession of species along with physical chemical change in two small artificial lakes over 28 years. Laboratory experiments will be performed to determine effects of controlled physical and chemical factors on resident plankters and the results compared with field data.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1483, BUILD-UP OF MINERAL CONTENT IN LAKE DARDANELLE AND THE EFFECT ON ZOOPLANKTON

T.N. PALKO, Arkansas Polytechnic College, Water Resources Research Ctr., *Russellville, Arkansas* 72801

This project is concerned with pollution and build-up of mineral concentrations in Lake Dardanelle Reservoir, principally as a result of turkey farming ranges in the watershed area of Lake Dardanelle and their effects on zooplankton populations.

The study will cover a 3 year period; starting date is June 1, 1970, and completion is November 1, 1972. Testing is to be conducted during the months of June, July, August, and September of each year.

Lake Dardanelle is a large, artificial lake created by the damming of the Arkansas River as a part of the Arkansas River Navigation Project. It is located in North Central Arkansas near Russellville, Arkansas.

Objectives are to include: chemical analysis; quantitative and quantitative zooplankton counts on a weekly basis. These weekly tests are to be conducted 1. on several tributaries near locations of turkey ranges; 2. at the mouths of said tributaries as they enter the lake; and 3. out in the lake to determine dilution rates.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1484, ICHTHYOFAUNAL DIVERSIFICATION AND DISTRIBUTION IN THE BIG CREEK WATERSHED, CRAIGHEAD AND GREENE COUNTIES, ARKANSAS

G.L. HARP, Arkansas State University, Graduate School, *State University, Arkansas* 72467

Big Creek is a relatively small deltaic stream in northeastern Arkansas, in an area of intense cultivation. Recently it has been dredged in the interest of flood control. Lost Creek and Mud Creek are the major tributaries of Big Creek and collectively drain the Big Creek watershed. The streams had relatively low alkalinity, moderate CO2 and adequate O2 values, and relatively high turbidity. Channeling of Big Creek and Lost Creek had effec-

tively destroyed distinct pool-riffle biocies and reduced the number of acceptable spawning sites. Lost Creek also receives effluent from residential dwellings, a secondary treatment sewage plant, and a meat rendering plant. Mud Creek, in the absence of channeling and deleterious effects of effluents, provided a relatively greater diversity of habitat than did Big or Lost Creeks.

A total of 21 species were collected. Big Creek supported 17 species, Mud and Lost Creeks supported 14 and 11 species, respectively. Five of the 11 species in Lost Creek are characteristic of streams with much organic debris and were not collected in numbers at any other station in the watershed.

Of the 2,209 fishes collected, Notropis umbratilis, Fundulus olivaceous, and Lepomis cyanellus made up 63% of the total and were taken at all stations. Their relative abundance is supported by their ability to withstand high turbidity and limited competition due to depth effect.

Limited species including Ictalurus natalis, Aphredoderus sayanus, and Etheostoma gracile in Mud Creek; Dorosoma cepedianum in Lost Creek; and the headwater species Semotilus atromaculatus in Big and Mud Creeks.

SUPPORTED BY Arkansas State University

2.1485, ENVIRONMENTAL STUDY OF PORT PHILLIP BAY

UNKNOWN, Australian Dept. of Fish. Wlf., *Melbourne, Victoria, Australia*

To determine what adverse effects, if any, are likely to result from the disposal to the bay of effluent from the Board's South Eastern Purification Plant.

Background study completed, coarse grid mathematical 'hydraulic - water quality' model of bay developed.

SUPPORTED BY Australian National University

2.1486, TO STUDY THE ENVIRONMENTAL FACTORS AFFECTING REPRODUCTION IN OSPREYS OF FLATHEAD LAKE, MONTANA

J.R. KOPLIN, Humboldt State College, Graduate School, *Arcata, California* 95521

Special techniques. Continue obtaining measurements on reproductive performance of ospreys on Flathead Lake; critically assess the effect of food supply on reproductive performance of ospreys; collect and analyze addled eggs for pesticide residues and shellthickness; try to determine cause of losses of eggs or chicks.

SUPPORTED BY National Geographic Society

2.1487, TURBIDITY EFFECTS ON MARINE ANIMALS RESULTING FROM MARINE MINING

F.A. NUDI, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Belvedere, California* 94920

Objective: To study the effects of suspended inorganic sedimentary materials on selected marine animals. This is a cooperative study with the Bureau of Mines, Marine Minerals Technology Center, Tiburon, Caifornia. The study is an integral part of the Bureau of Mines effort to define the environmental problems that may be triggered as future offshore mining accelerates. This study is expected to take from 2 to 5 years to complete and will be conducted in temporary wet laboratory facilities located at the University of California Laboratory, Bodega Bay, California.

Procedure: 1) Development of laboratory facilities to provide a wide range of turbidity for flowing water aquaria tests. 2) Tests will be conducted with various types of inorganic clays of various grain sizes on selected marine organisms. 3) Physical parameters, such as dissolved oxygen, temperature, pH, salinity and turbidity, will be continuously monitored. 4) Parameters to be examined on the test animals as related to various turbidity levels will be weight changes, growth, time to mortality and possible respiration rate and some tissue analysis. 5) Analytical data and conlusions will be summarized in a final report for publication.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1488, FLOOD AND SEDIMENT REDUCTION IN THE CONIFEROUS TIMBER ZONE IN CALIFORNIA

R.R. ZIEMER, U.S. Dept. of Agriculture, Pac. Sw. For. & Rg. Expt. Sta., *Berkeley, California* (PSW1603)

OBJECTIVE: Develop management methods that will minimize local floods, erosion and sedimentation, maintain water quality, and improve timing of streamflow; and to develop methods for predicting the effects of forest and land management practices upon sedimentation and streamflow.

APPROACH: Studies of gravitational mass movement will continue; resurveys of inclinometer holes will determine rate and location of surface and subsurface creep; and aerial photo comparisons will point out causes of landslides. Continue to study the effects of logging on streamflow, sedimentation, and fish habitat, and current studies will relate soil moisture to logging effects and to moisture storage opportunities for flood abatement.

PROGRESS: In California's north coast, landslides are frequently the major cost hazard facing the construction, maintenance, and satisfactory performance of roads. The direct annual costs of road maintenance and postconstruction stabilization efforts, necessitated by landslides, alone often amount to a large percentage of the initial construction costs. The indirect costs of landslides are of greater magnitude and persist longer than the more obvious direct costs. Not included in the estimate is the long-term erosion and sedimentation damage caused by road-triggered landslides. Such disturbances to the normal erosion cycle are not limited to the boundaries, locality, mechanism, or time of the original slide. Landslides reaching stream channels often force streams against the opposing bank, resulting in their oversteepening and the triggering of new slides. Riprap placed in channels to protect the unstable toe of a slide may bring about the same result. The movement of C from the old needles to the roots, and later to the new needles, was measured in 2-year-old ponderosa pine seedlings. The seedlings were in one of three growth stages at the time of feeding CO_2: 9 days before spring bud break with no root activity; 7 days before spring bud break with high root activity; and 7 days after spring bud break with moderate root activity.

SUPPORTED BY U.S. Dept. of Agriculture

2.1489, NAVY ENVIRONMENT CONTROL OF ENVIRONMENTAL FACTORS AFFECTING NAVAL PERSONNEL AND MATERIALS

N.A. VEDROS, Univ. of California, School of Public Health, *Berkeley, California* 94720 (N00014-69-A-0200-1001)

Technical Objective: The effective use of the ocean as a working environment requires a thorough knowledge of its microbial activity. This is especially true when consideration is given to the biological fouling problems which confront the Navy. This effort will assist in developing methods to control fouling, corrosion, and deterioration.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.1490, BIOLOGICAL METHODS OF SLUDGE DEWATERING

F.R. BOWERMAN, Aerojet General Corporation, *El Monte, California* 91734

A twelve-month program is proposed to investigate the poly-beta hydroxybutyric acid depolymerase activity of various microorganisms and to prepare extracts displaying such activity. These enzyme preparations would be applied to typical microbial sludges obtained from activated sludge plants to determine the effect on water retention of the sludge. Satisfactory demonstration of a beneficial effect would lead to screening of microorganisms for an extracellular source of the enzyme. Factors that affect enzyme production and stability will also be investigated.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1491, RADIOECOLOGICAL STUDY OF THE HUMBOLDT BAY MARINE ENVIRONMENT - DEVELOPMENT OF A MODEL
R.E. HEFT, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

The underlying objective is to develop a capability for predicting, for any arbitrary site at which oceanographic parameters are known, the amounts of individual radionuclides that will be taken up by specific marine organisms, given the amount and frequency of radionuclide release. This objective is best considered as involving two separate problems: (1) transport objective, given an arbitrary site for which oceanographic data are known, to predict for any given location and time after release the amounts of individual radionuclides that would be present (a) in solution, (b) attached to suspended silt, (c) in plankton, and (d) attached to settled silt; (2) uptake objective: given a pool containing an ecologically balanced group of marine organisms and with known amounts of stable element and individual radionuclides in (a), (b),(c) and (d) as listed above, predict the amounts and the manner in which the individual radionuclides will be taken up by each species of marine organism.

SUPPORTED BY U.S. Atomic Energy Commission

2.1492, BACTERIOLOGY OF BIODEGRADABLE SURFACTANTS
D.A. ANDERSON, Calif. State College, Graduate School, *Los Angeles, California* 90032

This investigation is concerned with responses of typical Gram negative and Gram positive bacteria when grown in the presence of various molecular varieties of syndets. Representative anionic or nonionic biodegradable surfactants used include: dodecylbenzene sulfonates (linear), ethoxylated alcohols, ethoxylated alkyl phenols, alkyl ether sulfates, taurates, and ricinoleates. Gram negative bacteria used are primarily strains of Escherichia coli and Pseudomonas spp. Gram positive forms are mostly Staphylococcus spp. and Bacillus spp.

Gram negatives typically exhibited a temporary inhibition of growth in the presence of certain surfactants followed by rapid proliferation with profuse production of a pervasive slime. Roles of cell membrane leakage, extracellular synthesis of slime, or both, are being studied. Chemical nature of the slime is being investigated. An apparent blocking of phage receptor sites by slime has been observed and is under study. Attention is also being given to effects of the slime on pili and flagella.

With Gram positive bacteria, quite different growth responses have been noted. Non-sporing or vegetative cells of sporeformers appear to be uniformly rendered nonviable. Lethal damage to cell membranes or cell walls is under study. In addition to the usual chemical and physical procedures, extensive use is being made of electron microscopy.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1493, NAVY ENVIRONMENT - AVOIDANCE AND CONTROL OF THE EFFECTS ON MEN & MARINE LIFE OF TOXIC RED TIDES INITIATED BY LOCAL POLLUTION OF THE SEA
B.C. ABBOTT, Univ. of Southern California, School of Letters, *Los Angeles, California* 90007 (N00014-67-A-0269-0017)

Technical Objective: The phenomenon known as red tide, in which there is a sudden rapid multiplication of marine microorganisms leading to tinting of the water, the production of toxin which may be lethal to marine life and a health hazard to man, is the subject of this investigation. In the laboratory, the investigator has been able to reproduce the essential effects when certain growth stimulants are added to quiescent cultures of the organisms. The question arises as to what provides the stimulus in nature. There is a high probability that the materials appear in triggering concentrations in localized areas as pollutants, and the question then becomes what they are and what they do. The possibility that effluents from underwater habitats or from ships at anchor could trigger a red tide or related phenomenon must be investigated since such a localized production of incapacitating neurotoxin could kill or incapacitate Naval personnel and since, even in less extreme circumstances, the effects on local ecology, food supply or living environment could result in embarrassment to the Navy if the danger is not recognized and controlled.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.1494, RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY
K.V. SLACK, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

Biological processes are among the major controls on the quality of natural waters. Organic control on solute concentration occurs in two ways: substances enter or leave solution either as the results of changed physico-chemical conditions in the water, or as the results of physiological processes within living cells or at their boundaries.

The work is divisible into three related phases:

Phase 1. Stream Limnology. a. The effect of stream-bed algae on water quality will be studied in flowing-water cultures (laboratory streams) in which temperature, light intensity, flow rate, water composition and algae species can be controlled. The first problem being studied is the uptake and release of combined inorganic nitrogen by mixed populations of stream algae. b. Investigation of the physical, chemical and biological properties of different types of natural streams will continue. The emphasis will be on the interrelations of the biota and water quality.

Phase 2. Lake and reservoir limnology. a. Effects of reservoir destratification. The hydrologic effects of destratification will be studied experimentally by isolating portions of a stratified reservoir in polyethylene cylinders extending from the water surface to the bottom. b. Environmental controls on phytoplankton populations. This will combine the results of field investigation with controlled laboratory studies of static and flowing cultures of nuisance species of algae.

Phase 3. Ecological role of natural organic compounds in water. The particular emphasis will be on the identification of organic compounds which influence biological activity in natural waters.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1495, MARINE WASTE DISPOSAL AND SEA URCHIN ECOLOGY
W.J. NORTH, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

The primary objectives are to establish whether discharged sewage effluent aids survival of urchin populations and if so, would the effect be lessened by altering sewage treatment. Our hypothesis, developed during the first two years of this study, postulates that dissolved organic substances from sewage effluents make significant contributions to urchin nutrition. The dissolved substances might even sustain urchin populations completely after their natural food resources, the valuable kelp forests, have disappeared. Our measurements of dissolved free amino acids (DFAA) indicate concentrations near outfalls may be twice or more above background. At such concentrations, one common urchin (Strongylocentrotus purpuratus) can absorb DFAA across the body wall at a rate sufficient to supply 50% of the daily maintenance requirement. Physiological evaluations indicate that urchin populations at outfall stations are nutritionally in good condition, although gametogenesis may be altered.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1496, EFFECTS OF SELECTIVE LOGGING ON STREAMBED SEDIMENTATION AND WATER TEMPERATURES IN SOUTH FORK YAGER CREEK, HUMBOLDT CO., CALIF
J.W. BURNS, State Dept. of Fish & Game, *Sacramento, California* 95819

P.S. Objectives: To determine and evaluate the effects of selective logging on stream habitat and juvenile salmonid populations in California's small coastal streams.

Job Objectives: 1. To measure streambed riffle size composition, percentage pool length, and stream temperatures; 2. to compare these results with values obtained in prelogging surveys and with upstream, experimental control values; and 3. to determine the effects selective logging has had on streambed sedimentation, pool periodicity and water temperatures.

Procedures: Streambed samples are obtained with a stainless steel cylinder similar to the one described by McNeil and Ahnell (1964). Single samples are taken from the center of the stream near the head of a riffle. The lower tube of the sampler is worked into the streambed to a depth of 6 inches, the contents dug by hand and lifted into a bucket. After removing the large materials, water within the tube is agitated, settling the remaining small materials into suspension. A plunger is pushed into the tube and a cork inserted in the plunger. Turning the plunger handle expands the O ring rubber seal allowing no water or sediment to spill while removing the sampler from the streambed. Ten samples are taken at equidistant points within each of the two study units during the August survey. Standard Tyler screens with 26.67mm, 3.327-mm, and 0.833-mm openings are used to separate the samples into four size classes, three of which are retained by the respective sieves while the remaining class passes through the 0.833- mm screen. Volumes for those classes are measured by water displacement in 4,000-ml graduated cylinders. The fraction passing the 0.833-mm screen is allowed to settle for 10 minutes before measuring the amount of solids settling to the bottom of the cylinder. Results are expressed as the mean percentage.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1497, EFFECTS OF ALTERNATE BLOCK CUTTING ON STREAMBED SEDIMENTATION & WATER TEMPERATURES IN BUMMER LAKE CREEK, DEL NORTE COUNTY, CALIFORNIA

J.W. BURNS, State Dept. of Fish & Game, *Sacramento, California* 95819

P.S.Objectives: To determine and evaluate the effects of alternate block cut logging on stream habitat and salmonids in California's small coastal streams.

Job Objectives: 1. To measure streambed riffle size composition, percentage pool length and stream temperatures in Bummer Lake Creek; 2. To compare these results with values obtained in prelogging surveys and with Godwood Creek, Humboldt County (experimental control) values; and 3. To determine the effects of alternate block cut logging on streambed sedimentation, pool periodicity and water temperatures.

Procedures: Streambed samples are obtained with a stainless steel cylinder similar to the one described by McNeil and Ahnell (1964). Single samples are taken from the center of the stream near the head of a riffle.

Twenty-one samples are taken at equidistant points within each stream during each survey. Standard Tyler screens are used to separate the samples into four size classes, three of which are retained by the respective sieves, while the remaining class passes through the 0.833-mm screen. Volumes for those classes retained are measured by water displacement.

Results are expressed as the mean percentage of the total sample volume passing each sieve. Sample volumes are assumed equivalent so that individual samples can be transformed into sediment size class percentages and then averaged.

Stream width and average depth are measured on transects at permanent stations. Percentage pool length is determined by measuring pool length in a 100-ft section immediately downstream from each 250-ft station and 50 ft downstream from every 100-ft station. Stream discharge is measured at the mouth of each stream. Mean stream width is determined by averaging the width measurements, while average stream depth is determined by weighting each average station depth by the width at that station. Bummer Lake Creek data are compared with prelogging and Godwood Creek data to ascertain the effects of alternate block cutting on streambed composition and living space. (Text Abridged)

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1498, THERMAL POLLUTION AND SOCIAL BEHAVIOR OF FISHES

J.A. TODD, San Diego State University, School of Liberal Arts, *San Diego, California* 92115 (AT)

The sublethal effects of thermal pollution have been little studied but it appears that they may be more significant in reducing or eliminating fish populations than the occasional heat-induced mortality. A recent pilot study carried out by the junior investigator indicates that at sublethal high temperatures social behavior of fishes may be drastically altered. It is proposed to futher evaluate the effects on social behavior of high sublethal temperatures for a temperature- tolerant fresh water fish, the yellow bullhead, Ictalurus natalis, and a sensitive species, the mottled sculpin, Cottus bairdi. Similar observations will be made on a common marine species, the mussel blenny, Hyosoblennius jenkinsi. Our principal objectives are to determine whether at high sublethal temperatures the social behavior of the test species is quantitatively or qualitatively altered and to observe the effects of such changes on the population structure of these species.

All laboratory experiments will be carried out first at normal summer temperatures for the species being studied, then repeated at temperature increments of 1 degree C until the lethal point is reached. Three aspects of social behavior will be observed under this temperature regime: interaction between individuals, community structure and recognition of individuals by chemosensory means.

Interactions between individuals will be studied by confining pairs of fish together and making daily ethological recordings. The resulting data will be analyzed for thermally induced changes in level of aggression, relative dominance and territorial behavior.

Community structure will be studied by setting up communities of three or more fish in large aquaria and making daily ethological recordings at normal temperatures until it is judged that the fish have established a stable relationship with one another. Then the temperature will be gradually raised and further ethological recordings made as described above. Visual observation will be supplemented by still and cine photography in endeavoring to detect possible breakdowns in community structure and other changes in social behavior.

If significant changes in community structure are observed, the observations will be repeated at selected high temperatures with the addition of a strange fish to each test community. The reactions of the resident fish will be recorded and compared with the social interactions of similar communities.

SUPPORTED BY U.S. Atomic Energy Commission

2.1499, EFFECTS OF NUTRIENTS AND POLLUTANTS ON THE GROWTH OF MARINE PHYTOPLANKTON

W.A. THOMAS, Univ. of California, Inst. of Marine Resources, *San Diego, California* 92038

This grant continues support for studies on the effects of nutrients on the growth of marine phytoplankton, and initiates support for studies of the efects of pollutants on these organisms. The nutrient studies will concentrate on the effects of limiting concentrations of inorganic nitrogen on tropical Pacific algae, and the effect of light and temperature on the nutrient requirements of these forms. Major emphasis will also be placed on development of a fluorescence technique for measuring cell densities in test tube cultures. Such a technique would be far less time consuming than direct cell counts, and its use would permit efficient examination of phytoplankton growth rates under a great variety of natural and pollutant effected conditions. Initial experiments suggest that this technique is feasible. This grant will support studies to test it further.

SUPPORTED BY U.S. National Science Foundation

2.1500, THE EFFECT OF SCHOOL WATER FLUORIDATION ON DENTAL CARIES

S.B. HEIFETZ, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *San Francisco, California*

2. WATER QUALITY

Purpose: To determine the relative decay preventive benefits derived by children who, when at home, drink water that is essentially devoid of fluoride but, when at school, consume fluoridated water.

Subject: Children in grades 1-12 who have continuously attended the study school since the time they were eight years of age or younger. Approximately 800 children in Seagrove, North Carolina were examined on the baseline.

Methods: Fluorides were added to the school water supply in Seagrove, North Carolina at 6.3 ppm, seven times the level considered optimal for community fluoridation in the same geographic area. A higher than optimum concentration for community fluoridation in the geographic area is used in an attempt to duplicate the total fluoride intake of children who drink optimally fluoridated water on a full-time basis. Prior to the installation of fluoridation equipment, dental examinations using the DMF tooth and surface index were conducted to determine initial caries prevalence rates. Follow-up examinations, including an assessment of the extent of fluorosis, if any, will be conducted at four-year intervals.

Findings to date, if any: Interim reports will be prepared after 4 and 8 years of study. The study will continue for 13 years.

SUPPORTED BY: North Carolina State Government - Raleigh

2.1501. ABUNDANCE AND COMPOSITION OF DEEP AND SHALLOW WATER MACROPLANKTON AND LITTORAL FISH POPULATIONS IN AND ABOUT THE SANTA BARBARA CHANNEL

A.W. EBELING, Univ. of California, School of Letters, *Santa Barbara, California* 93106

From February through August, 1969 inshore fish communities were sampled with a 16-foot semi-balloon trawl in deep and shallow water habitats off Santa Barbara, California. Fifty-eight collections sampled three communities: mud bottom at 150-200 feet, sandy bottom on the seaward edge of a kelp bed at 30-45 feet, and sandy bottom inside the kelp bed at 12-18 feet. To assess possible changes in fish communities after a January oil spill, these collections were compared with others from 1967 and from an unpolluted area to the south. The deep community had changed little between years or localities; the same fishes predominated in similar abundances: flatfishes, young rock fishes, a sculpin, midshipman fish, and surf perch. Although the shallow communities fluctuated more than the deep, differences, such as the shallow occurrences of deep species, may be attributable to the vagaries of upwelling. Stations in the southern unpolluted area were less productive than those in Santa Barbara.

Offshore plankton collections trawled from the General Motors Research Vessel SWAN were similar in composition and abundance to others made during the same month, March, in three previous years. Breeding was apparently normal; collections contained the fish larvae characteristic of the area. We have noted, however, the disappearance after the oil spill and subsequent gradual reappearance of a common mysid shrimp that usually abounds on the surface of the kelp.

SUPPORTED BY: U.S. Environ. Protect. Agency - O.O.W.P.

2.1502. A STUDY OF THE INITIAL EFFECTS OF THE SANTA BARBARA OIL SPILL

M. NEUSHUL, Univ. of California, Graduate School, *Santa Barbara, California* 93106

The study deals with the effect of a flow of oil that began on January 28, 1969, and still flows from the ocean floor near an offshore oil platform. By February 8, 1969, 4,508 metric tons of pollutant oil was deposited on 87.7 kilometers of coastline. Heavy biological damage occurred in intertidal surf grass communities and among barnacle populations. The damage attributable directly to the oil was obscured by heavy storm damage that took place just prior and during the oil spill. The potential long-term biological effects of continuing oil pollution are discussed. (Work completed Sept. 1969).

SUPPORTED BY: U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1503. LIGHT EXTINCTION IN LAKE WATERS

J.O. BLANTON, Canadian Cen. for Inland Water, *Burlington, Ontario, Canada*

Studies of light extinction in lake waters, related to studies of biological eutrophication.

SUPPORTED BY: Canadian Government - Ottawa

2.1504. ECOLOGY OF COLORADO MOLLUSKS

R.W. PENNAK, Univ. of Colorado, Graduate School, *Boulder, Colorado* 80302

Changes in distribution and ecology of mollusks in Colorado, especially during the past 60 years, as influenced by pollution. Shell morphology as determined by water chemistry.

SUPPORTED BY: University of Colorado

2.1505. BOTANICAL RESEARCH - ENVIRONMENTAL GEOCHEMISTRY IN RELATION TO HEALTH AND DISEASE

H.L. CANNON, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: U.S.

A preliminary evaluation by an interdisciplinary group of the possible effects of the geochemistry of rocks, soil, plants, and water on patterns and incidence of human and animal disease has resulted in the establishment of an NRC Subcommittee under the chairmanship of H. Cannon to establish the state-of-the-art through symposia and workshops. Probably the greatest gaps in our knowledge involve the availability and interaction of metals at each step through the food chain, and the acquisition of data concerning background and optimum levels of metals in soil, water and plants. Only with such basic data can the effects of treatment and of pollution be properly evaluated. A symposium chaired by H. Cannon and H.C. Hopps, M.D., on 'Metals of the Geochemical Environment--Health and Disease' was presented at the AAAS meetings in Chicago. A New York Acad. conference is planned for 1971 and a workshop in 1972.

Cannon will collate survey material on Pb in plant-soil relationships for a professional paper by several authors on lead in the environment.

SUPPORTED BY: U.S. Dept. of Interior - Geological Survey

2.1506. RESEARCH AND BASIC DATA ON THERMAL POLLUTION

G.E. HARBECK, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

This work, initiated in FY'69, involves research into some of the theoretical aspects of heat transfer and dissipation when heated water is discharged to rivers. Of primary interest will be the relationships among the eddy-transfer coefficients, or diffusivities, of heat, momentum, and water vapor when the atmospheric lapse rate is non- adiabatic.

In addition to the research, certain basic data will be collected and published that will be immediately helpful to both plant designers and researchers. The data would include flow measurements of temperature profiles, and velocity distribution under controlled conditions on 10 to 12 streams representing a wide range of flow conditions and a variety of climatic and weather conditions. In addition, various pertinent meteorological parameters would be measured, air temperature, humidity, and wind speed.

SUPPORTED BY: U.S. Atomic Energy Commission

2.1507. LARGE IMPOUNDMENTS - PUEBLO RESERVOIR

D.A. HOFFMAN, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The Bureau of Reclamation has constructed numerous large impoundments which are characterized by being deep and long.

located in an arid climate, and relatively unknown from the standpoint of limnological data. The lack of information is perhaps the greatest void in water data on these reservoirs. Pueblo Reservoir, located in the foothills of the Central Rocky Mountains, typifies a large terminal reservoir of a project which delivers water for irrigation, industrial, and municipal purposes. As such, its climatic, operational, and functional factors make it an ideal choice for a general study. This program will investigate the effect of a large reservoir and its limnological characteristic upon downstream water quality. Climatic, limnological and hydrological data will be collected for use in predicting future conditions in Pueblo Reservoir as well as determining effects of construction operations on downstream aquatic life, downstream community water supply, and water quality in a downstream reservoir.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.1508, ECOLOGICAL IMPACTS OF RECLAMATION PROJECTS
D.A. HOFFMAN, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The construction and operation of water resource projects including impoundment, conveyance structures, transmission facilities, roads, building, etc. changes the ecology of the organisms in the affected area. The significance and magnitude of these changes are not known. The opportunities for enhancement or avoiding detrimental environmental effects were not known so that they could be accomplished. This study will document the ecological impact of water resource projects on a basinwide basis, and establish guidelines for construction of future projects and rehabilitation of existing ones. The results will be used to develop a similiar study for a large river basin such as the Colorado.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.1509, ECOLOGICAL AND LIMNOLOGICAL IMPACT OF THE CONSTRUCTION AND OPERATION OF PUMP-BACK STORAGE PROJECTS
D.A. HOFFMAN, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

In order to meet the growing demand for electrical energy, pump- back storage powerplants are being built in the western United States. These sites are usually in areas of high quality esthetic and environmental values. The effect of the construction and operation of these plants on the ecology and limnology of rivers and lakes is relatively unknown. One such plant will be the Mt. Elbert pump-back plant on Twin Lakes Reservoir. This reservoir contains one of the highest quality Lake Trout fisheries in the western United States. It is not known what the effect of the Mt. Elbert plant will be. The study will determine (1) the ecological requirements of the Lake Trout, (2) the effect of the pump-back operation on the heat budget of the reservoir, (3) the relationship between resuspension of heavy metals (from mine drainage) from the bottom muds back into the water ecosystem, (4) the circulation patterns in the reservoir due to the pump-back operation, (5) what enhancement opportunities are possible, (6) identify possible detrimental effects, and (7) chemical and physical limnology. Study will follow from preconstruction to full operation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.1510, STANDARDS AND CRITERIA - EFFECT OF TURBIDITY
P.R. TRAMUTT, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

In order to establish water quality standards and criteria, it is necessary to know the requirements of the biota, materials, and users of the water. Specific studies will be made to better define reasonable standards for water quality factors of particular interest to reclamation projects.

Effect of turbidity studies in the laboratory and field will be conducted to quantitatively and qualitatively measure various types of turbidity producing materials as to size, source, composition, etc., in relation to hydrologic conditions and their ultimate effect on aquatic life, irrigation structures, and transmission facilities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.1511, MICROBIOLOGICAL INVESTIGATIONS
P.M. TURNER, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Microorganisms occurring in water supply, storage and conveyance systems cause problems such as corrosion, deposition, plugging and fouling. Investigations are made to identify the organisms, determine their mode of action and response to their environment, and to find effective measures of control.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.1512, EFFECTS OF CHEMICAL VARIATIONS IN AQUATIC ENVIRONMENTS
W.H. EVERHART, Colorado State University, School of Forestry, *Fort Collins, Colorado* 80521

The Colorado River has already been severely altered by Man, the Little South Poudre is as close to an unaltered water as can be obtained naturally today, and Piceance Creek represents a water area naturally high in salinity. These three very different water areas provide an opportunity for obtaining basic chemical characteristics. Further, Piceance Creek would be altered by any exploitation of the oil shale in the area. Year round studies of these water supplies has provided chemical analyses with an opportunity to detect any gradients correlated with time of year or environmental conditions. Collection of background information will be phased out by April 30, 1970.

Efforts during the final year of the grant (May 1, 1970 through April 30, 1971) will be directed to acute and chronic toxicity studies of aluminum and lead. The test animals are rainbow trout. Effects of lead and aluminum will be observed on the growth, behavior, and on eggs.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1513, EFFECTS OF SODIUM NITRATE AND WATER CONTAMINANTS ON TURKEY PERFORMANCE
E.W. KIENHOLZ, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00053)

OBJECTIVE: Establish the cause of delayed growth response after broad turkeys receive drinking water containing sodium nitrate for the first four weeks of life.

APPROACH: The effect of the sodium nitrate treatment will be sought by concentrated examination of turkey carcasses. Since we have noticed a trend towards reduced testes size, gonadotrophin elaboration and metabolism will be studied in turkeys that have or have not received the sodium nitrate treatment. Efficiency of meat production will be determined, and meat characteristics will be examined. For the other phase of the experimentation, selected Colorado water samples will be compared to distilled water for growing turkey performance. The effects of biological contaminants in turkey drinking water and ways to reduce ill effects of such contamination will be studied.

PROGRESS: A study was conducted to further evaluate the effect of early administration of sodium nitrate on subsequent growth of turkeys. No significant increase was observed in this year's trial when sodium nitrate was administered orally through the water or the feed at 925 and 2050 ppm. Turkeys were grown both on range and in confinement to determine if environmental conditions played a role in the response observed in previous years. Two strains of turkeys were used to determine if a strain response could be observed. Neither environmental conditions nor strain made any difference in the response to the treatments. An additional trial is being conducted to evaluate the effect of sodium nitrate as a growth stimulant on broad breasted bronze male turkeys. Sodium nitrate was administered orally in the feed and water at levels of 925 and 2050 ppm. The birds are being grown in confinement only due to adverse weather conditions. Initial data are being evaluated at the present time.

SUPPORTED BY Colorado State Government

2.1514, WATER TEMPERATURE AS A QUALITY FACTOR IN THE USE OF STREAMS AND RESERVOIRS
J.C. WARD, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

2. WATER QUALITY

Objectives: (1) Relate quantitatively the three parameters of the surface water sine curve to the meteorologic and hydrologic factors influencing water temperature. (2) To work out methods for the quantitative application of the water temperature sine curve to all types of lakes and reservoirs. (3) To obtain methods for predicting quantitatively the effects of thermal pollution on stream and lake water temperatures. (4) To study quantitatively the diurnal variation in stream and lake water temperature at all depths.

The laminar phenomena of surface injected heat will be studied in detail to determine the degree of insulation in both horizontal and vertical axes in providing habitat for motile and non-motile aquatic organisms. New measurements of dispersal patterns of heated waters in relation to substrate types will be accumulated.

Pre-installation studies will be continued in an area of a small river system soon to be subjected to waste waters from a thermal power station.

Heat barrier effects in a lotic environment especially as related to fishes will be a part of a continuing study.

The effects of water temperatures and ice cover on the use of reservoirs and streams by waterfowl will be studied. The effectiveness of artificial ice-preventive measures will be determined on selected reservoirs.

SUPPORTED BY: U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1515. BEHAVIOR PATTERN OF SHAD IN THE VICINITY OF A HEATED EFFLUENT DURING A NO-HEAT PERIOD

W.C. LEGGETT, Essex Marine Laboratory Inc., *Essex, Connecticut* 06426

Objectives: To use sonic tags to ascertain the migration behavior, especially migration rate, through an area of the Connecticut River with a significant heated effluent during a no-heat period.

Location: Study site will be in the vicinity of the Connecticut Yankee Atomic Power Company (CYAP) outfall at Haddam Neck on the Connecticut River.

Procedures: Shad tagged during Job 1 of this segment will be expected to pass the CYAP outfall area within 5 - 10 days of entering the river. Shore based automatic monitors (described in AFC-1) will be installed at, above and below the outfall area to determine migration rates in this area. After the major tracking effort of Job 1 is accomplished, attempts will be made to track individual fish in the outfall area in order to obtain additional patterns of migration. Data will be processed as in Job 1.

SUPPORTED BY: U.S. Dept. of Commerce - N.O.A.A.

2.1516. PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM)

H.C. DAVIS, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Milford, Connecticut* 06460

The development of routine methods for rearing bivalve larvae has enabled us to determine the effect of various ecological factors on larvae of the American oyster, *Crassostrea virginica*, and the hard clam, *Mercenaria mercenaria*. Studies have been made of the effect of the type and quantity of food, salinity, temperature, turbidity, pH, and of various pesticides and detergents on embryonic development and on growth of the larvae of these two species. In some studies we have observed the combined effect of varying two or more of these factors simultaneously.

We are currently experimenting to determine the pH range for spawning of oysters and the effect of the pH at spawning on viability of the sperm and eggs. We are also currently studying the effect of keeping oysters at lowered salinities, during gonad development and spawning, on subsequent embryonic development and larval growth at different salinities. We expect to soon have methods developed for studying the behavior of larvae and the effect of light, gravity, temperature, salinity and currents on the behavior of larvae of different ages and sizes. Such studies are urgently needed to develop an informational basis for field work on distribution of larvae.

SUPPORTED BY: U.S. Dept. of Commerce - N.O.A.A.

2.1517. ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM)

R. UKELES, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Milford, Connecticut* 06460

Recent interest in aquaculture as a means of increasing the world's food supply and saving commercially valuable species from extinction, has focused attention on the role of unicellular algae in the aquatic environment. The methods of shellfish culture being developed for commercial hatcheries make it necessary to devise means of raising food organisms, namely unicellular algae. We are producing large amounts of unialgal cultures for a pilot plant hatchery and also working on more efficient methods of culture, harvesting and storing algal cells. We have investigated the effects of pollutants found in the environment, as pesticides, herbicides and detergents, on algal growth. The nutritional requirements and effects of antimetabolites on growth of various species are under study, as well as physical factors important in growth, such as pH, temperature, and light.

SUPPORTED BY: U.S. Dept. of Commerce - N.O.A.A.

2.1518. COHERENT AREA RESEARCH PROGRAM IN ECOLOGY

G.E. HUTCHINSON, Yale University, Graduate School, *New Haven, Connecticut* 06520

A variety of research projects in the general area of ecology are to be carried out by advanced graduate students. Among these will be: interspecies interactions between corals and the effect on succession in a coral reef; sexual maturity and growth as influenced by dominance relationships in poecilid fishes; ecology and form of gorgonians; biogeochemical cycle of the major cations in successional stages in a tropical forest; intra- and interspecific variation of shell ornamentation in relation to habitat in a number of genera of littoral marine gastropods; hypereutrophication and pollution; and behavior ecology of surface living insects.

SUPPORTED BY: U.S. National Science Foundation.

2.1519. EXPERIMENTAL STUDIES OF AIR AND WATER INTERFACIAL INTERACTION

J.D. LIN, Univ. of Connecticut, School of Engineering, *Storrs, Connecticut* 06268

The proposed research is an experimental study of the interaction on the air-water interface to be conducted in the Hydraulic Laboratory of Civil Engineering Department by utilizing most of the existing wind tunnel and instrumentation facilities. A test section, consisting of a wind tunnel over a channel of variable depth and of sufficient fetch, will be constructed for this investigation. The transient and equilibrium surface waves generated by various turbulent wind profiles with zero pressure gradient along the tunnel will be investigated. The turbulence in the wind and possibly in the water will be measured in addition to the mean quantities and the surface wave spectrum as previously studied by other investigators. The wind generated wave theories and previous experiments under somewhat different conditions will be examined. The correlation of experimental data among the wind, waves and water should provide a basic understanding and the mechanism of dispersion, mixing and perhaps diffusion of contaminated surface water or pollutant spreading over the surface of water under the action of turbulent wind.

SUPPORTED BY: U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1520. EFFECTS OF SIMULTANEOUS VARIATIONS OF DIEL CHANGES OF TEMPERATURE, DISSOLVED OXYGEN, SALINITY & A POLLUTANT ON THE GROWTH OF WHITE PERCH

W.R. WHITWORTH, Univ. of Connecticut, School of Agriculture, *Storrs, Connecticut* 06268

The primary purpose of this work is to estimate the effects of simultaneous variations of diel changes of temperature, dissolved

oxygen, salinity and a pollutant on the growth of white perch (Morone americanus). The experimental design will be a 2 x 2 x 2 x 3 with [illegible] replications. Temperature, dissolved oxygen and salinity will each have two levels, both fluctuating on a diurnal basis, and the toxicant will have 3 levels (number of times/day will be part of the level).

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1521, ENVIRONMENTAL CONTROL SYSTEM FOR OYSTER FARMING
O.R. HARMAN, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00146-AGE)

OBJECTIVE: Design and develop and analyse a controlled environment system for the culture of oysters.

APPROACH: A system will be designed to allow temperature, water flow, and nutrient addition control in a step-wise fashion from the induction of spawning to maturation of the oyster. Throughout the process, analyses will be made of the contribution of various alternate equipment use in terms of economics and in terms of equipment contribution to pollution. In addition, where natural water sources are used, pesticide and other contaminants will be assayed.

PROGRESS: Hot, cold and ambient temperature seawater is now available in the shellfish laboratory at Lewes, Del. A 250,000 BTU per hour oil-fired heater was added to raise the temperature of incoming salt water. Also, 10 tons of refrigeration were installed and is used in the spawning phase of oyster culture. Mixing different temperature water provides temperature controlled seawater for other phases of oyster farming. A mixing unit is still needed to provide temperature control automatically. In the laboratory in Newark, different sizes and shapes of tanks are being tested. Flow rates are varied in the tanks in order to find flow rates required by the oyster in a closed system. The closed system provides recirculated filtered water and the oysters are fed with corn starch, corn meal, and other artificial foods. Also chemical analysis of the water will provide useful data, showing the chemical change caused by the oysters.

SUPPORTED BY U.S. Dept. of Agriculture

2.1522, THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER
M.S. SHANE, Univ. of Delaware, School of Arts, *Newark, Delaware* 19711

The ecology of LPP phyco-viruses will be studied in relationship to pollution in the Christina River. Samples of water from designated stations in the river will be examined for the presence of LPP phyco- viruses and also the host genera of algae. Water quality studies will be performed on the same samples used for biological studies. Parameters like biochemical oxygen demand, dissolved oxygen, total nitrogen or phosphorus, pH, alkalinity, and hardness will be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1523, COLUMBIA RIVER THERMAL EFFECTS STUDY
E.N. KARI, U.S. Dept. of the Interior, Federal Water Quality Admin., *Washington, District of Columbia*

The Columbia River Thermal Effects Study consists of twenty-five separate studies by the three participating agencies. The purpose of the study is to provide a scientific basis for the evaluation of the temperature regime of the main stem Columbia River and its effect on the river's ecology, particularly upon the economically important anadromous and resident fish of the Columbia River.

The study consists of two parts: biological effects and temperature prediction. The objective of the biological effects portion is to develop additional factual data on the water temperature requirements and tolerances of fish of commercial and sports value in the Columbia River. Titles of the biological studies are given on the attached sheet.

The temperature prediction study is by Federal Water Pollution Control Administration and Atomic Energy Commission, with the objective of applying mathematical models of the thermal regime of the Columbia River to allow evaluation and prediction of the overall temperature effects of thermal input and the water management system and to develop an operational plan to minimize temperature effects, and obtain possible benefits.

The biological effects study was commenced in June 1968, and will terminate July 1970.

The mathematical model project was commenced in April 1969, and will terminate June 1970.

Budget data for the project are given on the attached sheet.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1524, SYNERGISTIC EFFECTS OF SUB-LETHAL POLLUTION ON THE DEVELOPMENT OF SELECTED WARM-TEMPERATE AND SUB-TROPICAL FISHES AND CRUSTACEANS
F.A. KALGER, Aquatic Sciences Incorporated, *Boca Raton, Florida* 33432

This project will utilize the output of an established culture facility to determine the synergistic subiethal effects of temperature, oxygen, salinity, and a chlorinated hydrocarbon on the development of selected warm-temperate and subtropical species of fishes and crustaceans. The experimental species have been chosen because they represent forms which occupy subtropical fresh, brackish, or marine waters for all or part of their life histories, such waters and specific habitats being subject to several forms of potential environmental toxicants, their real or potential economic values as sports species, and their adaptability to being cultured with success in the laboratory.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1525, BENTHIC COMMUNITIES
J.L. TAYLOR, U.S. Environ. Protection Agcy., Office of Res. & Monitoring, *Gulf Breeze, Florida* 32561

The chief purpose of estuarine benthic studies is to assess the effects of hurricane barriers, dams, spoil banks, contaminants and other types of artificial alteration. The benthic species-habitat relation is under investigation to correlate fauna and flora with bottom type, salinity, depth and organic distribution. Benthic sediments and biota are obtained by steel traps and dredges at stations located on transects in estuarine systems and neretic areas. Specimens are picked from bottom samples and identified to species. Sub-samples of bottom material are analyzed for raw weight in each size fraction of the texture, weight percent in each size fraction, and percentage of organic carbon. Mean, standard deviation, skewness, and kurtosis of size distribution are obtained.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1526, IRRIGATION OF CITRUS WITH WASTE WATER
R.C. KOO, Univ. of Florida, Agricultural Experiment Sta., *Lake Alfred, Florida*

The proposed research plan involves laboratory, greenhouse and field investigations to determine the feasibility of irrigating citrus with waste water or sewage effluent from citrus processing plants. The main approach will be to grow citrus plants in greenhouses and irrigate them with waste water from citrus processing plants from several locations.

The waste water will be analyzed for appropriate constituents and applied to potted trees of several scion-rootstock varieties of citrus in various amounts for 2 to 3 years. Measurements of plant growth and mineral composition of leaves will be done periodically.

Another facet of the project will involve collecting the leachate of water that has washed over the roots of potted citrus trees. By analyzing the water and subtracting from the known content of the water applied, the removal of various constituents by the roots can be determined.

A young tree field experiment will be initiated on land where waste water is presently disposed. This will be a field test on the use of waste water for citrus and to obtain information on necessary adjustments in cultural practices for citrus.

2. WATER QUALITY

SUPPORTED BY U.S. Dept of Interior - O. Wtr. Res. Rch.

2.1527, AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT
R.G. BADER, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149 (AT(40-1))

This is a study of th ecology of south Biscayne Bay with particular attention to the environs of the Turkey Point power station. The existing damaged and relatively unspoiled areas are being studied with regard to hydrology, chemistry, phytoplankton, zooplankton and benthic organisms. The biology of the organisms will be considered in relation to temperature, salinity, and some gross chemical characteristics. Also, the effect of potentially higher temperatures on the dominant and subdominant species will be studied in the field and in the laboratory. Information presently available in relevant areas of study is being analyzed and utilized in this program.

Because the first two units of the Florida Power and Light Company plant are now in operation, it is necessary to sample several control sites in order to monitor the changes which have already occurred. Some rise in temperature and in the copper and iron content of the water near the effluent have been observed during studies made by this Institute. Damage to the flora and fauna has been noted in an area of about 300 acres off the effluent canal.

SUPPORTED BY U.S. Atomic Energy Commission

2.1528, PHARMACEUTICALS RESEARCH
W.B. DEICHMANN, Univ. of Miami, School of Medicine, *Miami, Florida* 33124

The project will be directed toward: (a) Investigating the role of the blue green algae in the food chain leading to the production of toxins in the barracuda. It is known that certain localities may become toxic because they are favorable to accumulations of wind- or current- driven algae. The role of the increase in water temperature at the Turkey Point nuclear power installation will be investigated. (b) A portion of the meat and organs of large barracuda will be fed to experimental animals. When signs of toxicity develop, the remaining portion of the barracuda will be subjected to chemical analysis and pharmacological and toxicological studies. Various hospitals in the Dade County area will be requested to bring to our attention any cases of barracude poisoning, and to supply us with any remaining barracude meat which was the cause of the intoxication, for analysis and study. (c) An investigation of therapeutic agents from Gorgonians will be initiated. The proposed study will include the determination, localization, distribution, and variation of prostaglandin A2 content in P. homomalla. The products of gorgonian metabolism will be tested for possible therapeutic value.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1529, BIOLOGICALLY ALLOWABLE THERMAL POLLUTION LIMITS - A PHYSICO-CHEMICAL APPROACH
W. DROSTHANSEN, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

It is proposed to search the literature thoroughly for temperature dependent biological and biochemical phenomena for possible evidence of relative abrupt changes in such systems at discrete temperatures. The data and information collected will be studied in connection with the possibility of delineating 'safe ranges' over which temperature may be varied (in thermal pollution: generally increased), and 'critical temperatures' near which more or less abrupt, and occasionally drastic, changes may take place. Specific attention will be paid to such processes which are likely to be of importance in the maintenance of the ecological balance. Preliminary results show that it appears safe to increase the environmental temperature from ambient, to say, 27 degrees C, whereas an additional increase of 3 degrees might have catastrophic results.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1530, THE BIOLOGY OF THE INFAUNA OF A TROPICAL SOFT BOTTOM AREA
H.B. MOORE, Univ. of Miami, School of Marine Science, *Miami Florida* 33149

A study is in progress on the biology and ecology of the infauna of the soft bottom of Biscayne Bay, Florida. This is considered typical of a tropical estuarine area. Papers have been published on the heart urchin Moira atropos, and the lamellibranch, Tagelus divisus. Papers are in press on Chione cancellata, on the fauna of intertidal muds, on sublittoral polychaetes and the biological effects of pollution in the bay. Studies are in progress on various mollusks, echinoids and brittle stars.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1531, THE BIOLOGY OF TROPICAL BOTTOM INVERTEBRATES
H.B. MOORE, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

Studies of the effects of pollution in tropical seas requires the basic information of how representative animals live under normal conditions. There is little such information for the tropics. This is a continuing project in which we have published accounts of the ecology of Lytechinus, Tripneustes, Eucidaris, Echinometra, Moira, Chione, and Balanus spp. Studies are in progress on other species of urchins, brittlestars, mollusks and barnacles. Each such study has to be continued for a number of years in order to see associations with varying environmental conditions.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1532, STUDIES OF THERMAL POLLUTION IN BISCAYNE BAY
D.C. TABB, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

Specific Aims - The overall objective of the research program is to determine the effects of thermal effluent on the macrofauna and -flora of Biscayne Bay, south Florida as successive generators (both conventional and nuclear) come into operation at the Florida Power and Light Company plant site at Turkey Point (Figures 1 and 2). 1. To describe the plant and animal communities in the vicinity of the Turkey Point power plant site in qualitative and quantitative terms, and to relate qualitative and quantitative changes in these communities to changes in environmental parameters, principally temperature. This will be accomplished by utilizing standardized quantitative sampling methods already tested for statistical validity in recent studies for U. S. Public Health Service. These studies were carried out in Florida Bay where the habitat and faunal elements are essentially the same as those expected in southern Biscayne Bay. The sampling will provide accurate data on the kinds and numbers of macroscopic animals and plants in the study area. New information thus obtained will be related to data already gathered from a number of other studies to interpret the fluctuations which will be observed. 2. To integrate all this information plus that in the literature for the development of an accurate estimate of the thermal depth point for the fauna and flora, and to estimate the maximum heat load that the bay can carry while, at the same time, maintaining the ecological status quo. These estimates will be translated into specific recommendations to the proper Federal authorities as to the best disposition of the heated effluent.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1533, INVESTIGATION OF THE EFFECTS OF COMMERCIAL HYDRAULIC CLAM DREDGING ON VARIOUS BOTTOM HABITATS OF SELECTED ESTUARINE AREAS
E.A. JOYCE, State Board of Conservation, *Saint Petersburg, Florida* 33731

Phase II: Objectives - Determine the effects of a commercial hydraulic clam dredge on various bottom habitats of selected

estuarine areas and to learn which species are first to recolonize the disturbed areas.

Procedures: Areas of various habitats selected for dredging will first be surveyed to determine the ecology and sedimentation of the bottoms. Samples of animal and plant life will be taken by various methods so that relative abundance and size of dominant species may be determined prior to dredging.

Ecological analysis of the areas, after dredging, will be made at specific intervals to determine the immediate bottom alterations and subsequent changes in the benthic communities as compared to the results obtained prior to dredging. Time intervals between dredging, and a return to conditions approximating the undisturbed state will be carefully noted. Some of these areas selected from various habitats will be periodically re-dredged to determine the effects of continued harvesting, both on bottom habitats and clam production.

Part 2 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1534, IMPLEMENTATION OF HABITAT ALTERATIONS

R.L. WILBUR, State Div. of Game & Fish, *Tallahassee, Florida* 32301

Objectives: The objective is to implement and record habitat alterations in each study lake.

Procedures: Habitat alterations will be implemented in three study lakes ; 1. Trout Lake. 'The Mud Cat' (a dredge made by Inland Service Co.) will be used to remove as much of the bottom muds as possible. The amount of mud removed will be limited by finances, water and mud depths, types of muds, obstacles, size of sump area, etc. Detailed records will be kept of the types, depths, and locations of the muds removed. Changes in the aquatic flora will be documented by frequent observaton. Changes in the benthos associated with the altered habitats will be investigated (before and after Ekman dredge samples). Three before and three after samples of the water quality will serve as an indication of changes in the latter. 2. Lake Carlton. A sand dredge will be used to pump sand from central lake areas to areas immediately adjacent to the existing littoral zone. The pumped sand will be used to convert these deep (8' to 14') muck-bottom areas to shallower (4' to 6') sand-bottom areas and may thereby serve to expand the littoral zone. The holes or trenches left by the dredge will hopefully collect muck sluffed into the holes by bottom currents. Attempts will be made to document the extent to which this occurs. Changes in the depth contours, bottom types, etc. will be fully documented. Invasion of aquatic plants into the pumped sand areas will be recorded, if such occurs. If not, attempts may be made to stimulate plant growth. Changes in the invertebrate population will be studied. Water quality samples will be taken three times before and three times after the dredging operation. 3. Maxwell's Pond. A 2- acre cove (presently 10' deep) will be filled to depths of 3 to 6 feet with sand obtained from a sand dredge which will pump from the center of the lake. Attempts will be made to stimulate growth of submergent and emergent aquatic plants in the filled area, the purpose being to create a marsh area. Changes in the flora and invertebrate populations in the altered areas will be monitored. Water quality will be sampled three times prior to dredging and on a quarterly basis following dredging.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1535, POLLUTION OF THE HUISME

UNKNOWN, Sogreah, *Grenoble, France*

Study of polluted waters in Huisme basin.

SUPPORTED BY Loire & Bretagne City Govt. - France

2.1536, PARABIOTIC GROWTH CHARACTERISTICS OF SELECTED SEWAGE BACTERIA

E.L. FINCHER, Georgia Inst. of Technology, School of Biological Sciences, *Atlanta, Georgia* 30332

Microbial ecosystems constitute a fundamental basis for the chemical dissimilation of natural and artificial wastes in aqueous systems. The qualitative and quantitative changes which occur in these systems are the expression of successive populations developing under the influence of nutritional substrates and in response to chemical pressure between different types of microorganisms present in the system.

The proposed research will be concerned with design, construction, and evaluation of a parabiotic growth system and the study of population dynamics of quasi-mixed bacterial cultures.

Pure cultures of heterotrophic aerobic bacteria isolated from raw sewage, activated sludge, and sludge effluent will be grown in the parabiotic growth system. Design of this system will maintain physical separation of the developing populations but will permit complete and constant chemical interchange between the populations.

Growth dynamics of multiple populations will be determined by growth rates and biomass and the conditions of growth system characterized by measurement of hydrogen-ion concentration and dissolved oxygen. Synthetic and natural substrates, including sewage extract will be studied for effects on population interactions. Initial studies are planned to determine the response of these characterized ecosystems to specific chemical pollutants.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1537, EFFECT OF A KRAFT PAPER MILL ON THE ECOLOGY OF A GEORGIA ESTUARY

M. DAHLBERG, Univ. of Georgia, Marine Institute, *Sapelo Island, Georgia* 31327

This study surveys the ecology of a natural Georgia estuary in an attempt to determine possible effects of a newly established kraft paper mill located at the head of the estuary. This study will analyze the impact of the mill by studying seasonal and zonal distributions of fishes and invertebrates and by analyzing chemical and physical parameters including salinity, temperature, current, pH, color, turbidity, dissolved oxygen, COD and BOD. Toxicity bioassays are conducted in the laboratory.

SUPPORTED BY Georgia State Government

2.1538, A STUDY OF ECOLOGICAL SUCCESSION FOLLOWING NATURAL AND MAN-INDUCED CHANGES ON A TROPICAL REEF

R.S. JONES, Univ. of Guam, Graduate School, *Agana, Guam* 96910

A new oil-fired power plant is now under construction at Tanguisson Point on the west coast of Guam. The primary objectives of this study are to identify and measure the effects of changes on the reef organisms and ecosystem caused by natural changes and those induced by pollution in this area. The major categories of changes anticipated are as follows: Intake and outfall channels are to be blasted through the reef flat to provide them with an access to seawater for a condenser coolant. These channels offer a unique opportunity to measure successional changes on their newly denuded surfaces. Baseline data established at this time on the normal rate to denote changes in the ecosystem that may be induced when the plant becomes operational and heated waters are released. In addition to the man-induced changes, the Tanguisson Point study area falls within a zone of previous biological catastrophe. In the past three years, there has been an invasion of the crown-of-thorns starfish, Acanthaster planci. This animal has destroyed most of the living coral in the area. The study will consider the deleterious effects of A. planci on the reef ecosystem and will seek to determine the rate of reef recovery and components of succession in the devastated area.

These problems are to be attacked using a variety of transecting methods and in situ oceanographic instruments. We intend to establish baseline data for physical parameters, such as current patterns, temperature regime, topography, water characteristics, and biological parameters such as species composition and biomass.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1539, THE EFFECTS OF THERMAL LOADING ON THE HAWAIIAN MARINE BIOTA
V.E. BROCK, Univ. of Hawaii, Hawaii Inst. of Marine Biology, *Honolulu, Hawaii* 96822

A wide variety of Hawaiian shallow-water marine organisms will be subjected to a free flow of freshly pumped and warmed sea water at several temperature levels above ambient and at ambient as controls for extended periods of time. Measurements of preferred temperatures of mobile marine organisms will be made in a vertical thermal gradient apparatus in which the gradient levels can be rapidly and accurately changed. Temperature reactions of both acclimatized and naive organisms will be measured.

Lethal temperatures will be determined and both short and long term responses to sublethal temperatures will be measured as it affects various biological processes. These determinations and responses will also be made for various life history stages. These measurements will give new information on the responses of the experimental organisms to warmed sea water and insights into possible changes in nearshore marine ecosystems which the important components of flows of warmed effluents may occasion.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1540, POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII
L.S. LAU, Univ. of Hawaii, Water Resources Research Ctr., *Honolulu, Hawaii* 96822

Determination of the absorptive and adsorptive capacities of Hawaii soils and fractured rocks with respect to certain potential pollutants of the underlying basal ground water bodies, including sewage constituents and selected pesticides that are applied through agricultural uses. Determination of quantitative and qualitative effects of recharge of the basal ground water by non-potable waters, including quantity and head increases, flow pattern and dispersion, fate and travel of pollutants after reaching the ground water bodies.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1541, SAND RECOVERY
R.Q. PALMER, Univ. of Hawaii, School of Engineering, *Honolulu, Hawaii* 96822

Work will be concentrated in two areas:

(1) Recovery Technology: To date the majority of offshore sand mining ventures have been carried out using conventional channel and harbor dredges. Improvement and modification of this equipment as well as development of new concepts to operate efficiently in the offshore zone are needed. A model test facility will be set up in the lab with the intention of working with the dredging industry toward the improvement of technology in this area. Promising concepts might then be ocean-tested as dictated by available funds.

(2) Ecological Effects: The possible ecological effects of offshore sand mining in Hawaii will be examined with particular emphasis on reef and marine life and disturbance of recreational use of the coastal zone. Close cooperation will be sought with the departments of Marine Biology, Zoology, and Oceanography.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1542, EFFECTS OF SILTATION AND COARSER SEDIMENTS ON DISTRIBUTION AND ABUNDANCE OF STREAM-INHABITING INSECTS
M.A. BRUSVEN, Univ. of Idaho, School of Agriculture, *Moscow, Idaho* 83843

The proposed research will involve laboratory and field investigations to determine the effects of artificially introduced silt and coarser sediments on the distribution and abundance of stream insects. Insects will be quantitatively and qualitatively evaluated before and after artificial sediment introduction. Correlations will be made between sediment displacement and recolonization by insects.

Laboratory investigations will employ the following methods: (1) Artificial streams with differing bottom types will be used to study micro-distribution of principal stream insects. (2) Relative tolerances of insects to different sediments will be investigated.

Field Investigations: (1) Different sediment gradients will be artificially introduced into streams. (2) Temporal changes in standing crop of insects will be measured and correlated with sediment displacement. (3) Insect tolerances to different types and degrees of sedimentation will be studied. (4) Recolonization rate in relation to sediment displacement will be studied.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1543, DISTRIBUTION AND ECOLOGY OF AQUATIC INSECTS OF IDAHO
M.A. BRUSVEN, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00542)

OBJECTIVE: Inventory the aquatic insects of Idaho to determine their distribution and abundance. Study the biology of the aquatic insects, life histories, ecological habitats, inter-and intraspecific relationships with other animals, parasites and predators, food habits, and importance to man and domestic animals. Study population dynamics of insects in selected aquatic habitats to evaluate biological and physical effects of the environment on the population.

APPROACH: The fauna, distribution, biology and ecology of aquatic insects in streams, lakes, ponds, reservoirs, drainage and irrigation ditches. Various techniques for collecting employed; bottom scrapers, Surber bottom samplers, aquatic seines, nets and dredges. An evaluation will be made of water chemistry, substrate, depth of water, turbidity, temperature, food and inter- and intraspecific relationships.

PROGRESS: The food habits and ecology of mayflies of the St. Maries River was completed. Drift samples collected during squawfish eradication on the St. Joe River have been sorted and evaluated volumetrically. One paper has been published and another is in preparation from the latter study. Aquatic insect distribution and abundance studies in relation to the evaluation of the before, during and after effects of logging on stream insects were continued for the second year. Bottom samples, stream profile, bottom type and sediment classification were made in July and August. Similar studies to evaluate the effect of silt pollution from mining on stream insects was initiated. Stream-sediment simulation studies were conducted in the laboratory commensurate with the field studies to more critically evaluate insect tolerances to siltation.

SUPPORTED BY U.S. Dept. of Agriculture

2.1544, POLLUTION EFFECTS ON ADULT STEELHEAD MIGRATION
D.W. CHAPMAN, Univ. of Idaho, Cooperative Fishery Unit, *Moscow, Idaho* 83843

Water quality conditions on the now free-flowing lower Snake River downstream from Lewiston, Idaho are expected to change after the proposed impoundment by Lower Granite dam.

Migrational patterns of adult steelhead now passing through the lower Snake River are being studied and compared with existing water quality parameters to find significant correlations between migrational patterns and water quality before and after impoundment by Lower Granite dam.

Impoundment is expected to cause the following changes: (1) lowered dissolved oxygen levels with extreme diel fluctuations; (2) higher mean temperatures; (3) localized accumulations of sludge deposits; (4) locally high nitrogen levels; and (5) reduced guiding influence of water current. Anticipated changes in the Lower Granite pool are even greater, however, because of Kraft pulping waste input high in biochemical oxygen demand, suspended solids, and organic compounds significantly toxic or confusing to the olfactory senses of fish. Steelhead migrational paths and travel rates are being assessed in the pre-impoundment phase by sonic tags while associated water quality conditions are being measured and mapped. Similar tracking and water analysis after impoundment will establish the impact of altered water quality upon total numbers, migrational rates, and paths of adult steelhead through the reservoir.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1545, POLLUTION EFFECTS ON ADULT STEELHEAD MIGRATION

D.W. CHAPMAN, Univ. of Idaho, Cooperative Fishery Unit, *Moscow, Idaho* 83843

Migrational behavior of adult summer steelhead trout in the middle Snake River is being correlated with water quality before and after limnological conditions are altered by construction of Lower Granite Dam on the middle Snake River. Anticipated changes in the Lower Granite pool area (lowered dissolved oxygen levels with extreme diel fluctuations, higher mean temperatures, reduced guiding influence of water current, and localized accumulations of sludge deposits) are even greater because of a Kraft process pulp and paper operation at Lewiston, Idaho. The 40 mgd Kraft pulping waste output is typically acidic, high in biochemical oxygen demand, suspended solids, and compounds significantly toxic so as to confuse the olfactory senses of fish. Steelhead are being fitted with ultra-sonic transmitters and tracked to compare the following parameters before and after impoundment: (1) Mean travel times through this stretch of river; (2) General migration pathways; and (3) Behavior at specific points in the channel. Travel paths of individual fish will be mapped and then related to specific aspects of water quality. Significant correlations are then to be tested under experimental conditons in artificial stream channels.

This impact of industrial pollution upon anadromous fish in fresh water will be of value in predicting the outcome of impounding other free flowing polluted streams.

The pre-impoundment phase of this project was initiated in September, 1968 and will be completed in August, 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1546, GREAT LAKES ECOLOGY STUDY

P.F. GUSTAFSON, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-26)

This is a new program whose objective is to conduct field and laboratory research to examine the influence of nuclear power plant operations on the physical and biological systems in Lake Michigan. The environmental stress from nuclear plants discharging cooling water in the lake is two-fold; thermal and radiation. Field measurements will be made at existing steam generating (coal-burning) plants to examine thermal effects on lake chemistry, and biota including benthic, floating, and free swimming organisms. Temperature and current measurements in and around the thermal discharge (plume) will be made. Baseline data for radioactivity will be obtained in water, sediments, and biota. These efforts will be closely coordinated with similar new and ongoing work at universities and other institutions in the Lake Michigan area.

Results to date: Since this is a new program, the only accomplishments to date have been to assemble staff, equipment, and to develop a research plan.

SUPPORTED BY U.S. Atomic Energy Commission

2.1547, LAKE MICHIGAN THERMAL STUDIES

L.E. LINK, Argonne National Laboratory, *Argonne, Illinois* 60439

The purpose of this effort is to determine the short and long range effects of nuclear power plant siting on Lake Michigan and consists of three basic activities: 1) Publication and updating of state-of-art reports on analytical and physical scale modeling techniques for prediction of temperature profiles in the vicinity of the outfall and review of field studies of thermal discharges at actual power plant sites. 2) Development of analytical techniques for predicting the dispersion characteristics, temperature field, and gross behavior of the thermal plume produced by a lakeshore power plant. 3) Design and analysis of field experiments to measure temperature and lake current patterns in the vicinity of power plant outfalls.

The recent ANL report - 'Effects of Thermal Discharges on the Moss/Energy Balance of Lake Michigan'- discussed the large scale impact of man-made thermal discharges into Lake Michigan and concluded that the increase in average lake temperature and water loss due to evaporation as a result of these heated discharges are 'negligible and will continue to be so for the rest of this century.'

SUPPORTED BY U.S. Atomic Energy Commission

2.1548, APPLICATION OF SEWAGE SLUDGE TO FIELD CROPS

R.I. DICK, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

Investigations are being carried out to evaluate the effect of digested sludge constituents on crops, land, and on ground and surface water. Particular attention is being given to the fate of nitrogen in sludge. Possibilities for removing nitrogen by ammonia volatilization before and during application are being evaluated as are the possibilities for removal by denitrification following nitrification in the soil.

SUPPORTED BY Chicago City Government - Illinois

2.1549, POLLUTION TOLERANCE OF SELECTED ALGAE

T.M. MCCALLA, Univ. of Udaipur, *Udaipur, Rajasthan, India* (A7-SWC-83)

OBJECTIVE: Determine the physiological and ecological factors determining growths of algae in polluted waters and study the pollution tolerance of selected species of algae.

APPROACH: Detailed physical and chemical analysis of the waters with special reference to organic matter and other pollutants. A comparison will be made between algal abundance in waters immediately after the site of intake of industrial effluents with that in waters distal to the point of discharge, and differences between algae of polluted water and those of relatively clean water.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

2.1550, MICROBIOLOGY OF THERMALLY POLLUTED ENVIRONMENTS

T.D. BROCK, Indiana University, School of Arts, *Bloomington, Indiana* 47401 (AT)

This study concerns effects of temperature on the growth and metabolism in nature of bacteria and algae which live in thermal environments. Both natural and man-made thermal environments will be studied. Specific areas to be investigated: Microbial colonization of environments with wide fluctuations in temperature; Rate of adaptation to the new temperature after a sudden increase in temperature; the use of Thermus aquaticus as a possible indicator of thermal pollution; the relationship between temperature responses and the pH of the water.

THe effects on microbial activity of thermal pollution of the Wabash and Jordan Rivers in Indiana have been studied. Isotope methods have been used to determine the temperature optima of the resident bacteria.

SUPPORTED BY U.S. Atomic Energy Commission

2.1551, ACID MINE POLLUTION EFFECTS ON LAKE BIOLOGY

D.G. FREY, Indiana University, Water Resources Research Ctr., *Bloomington, Indiana* 47401

This study is designed to yield comparative information about the ecosystems of coal strip-mine lakes. It will afford as complete a description as possible of the physical and chemical nature of a series of these lakes at different stages of recovery from acid-mine pollution, including the seasonal changes which occur.

The nature of the biological communities of these lakes will be intensively investigated in order to document the effects of acid-mine pollution on the structure and dynamics of ecosystems. Thus, a detailed understanding of both the seasonal (short-term) and successional (long- term) changes in community structure, diversity, abundance, and amounts and rates of energy flow in strip-mine lake ecosystems will result. This will also constitute a contribution to the theory of ecosystems in general.

2. WATER QUALITY

The study will attempt to determine, by field and laboratory experiments in addition to the observations outlined above, (1) the degree of recovery from acid pollution necessary to allow establishment of healthy aquatic ecosystems (including fish) in strip-mine lakes and (2) practical methods of treatment for mine lakes to promote the establishment of such communities.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1552, EFFECT OF HEATED WATER DISCHARGE FROM IPALCO'S PETERSBURG PLANT ON THE WATERS OF WHITE RIVER, INDIANA

D.G. FREY, Indiana University, Water Resources Research Ctr., *Bloomington, Indiana* 47401

The project area is in southwestern Indiana, just below the junction of the East Fork and West Fork of the White River, Pike County, Indiana.

A thorough investigation of the physical, biological, and chemical characteristics of the river will be made over a three-year period, including one year before construction of the new steam-electric generating plant, and one year after, in order to determine the effects of thermal pollution.

It is anticipated that this investigation will result in information that will be useful not only to the power-producing company but also to the power-regulating State agency.

The investigation of several parameters, such as temperature, dissolved oxygen, fishes, BOD, plankton, turbidity, and bottom fauna has produced significant data in the past three years. The continuation of the project for another three years will permit us to continue to assess the effect of Unit No. 1, and the added effect of Unit No. 2 beginning in 1969.

This project will also include a microbiologic study by Thomas D. Brock and Warren Silver as part of an AEC contract.

SUPPORTED BY Indiana University - Bloomington

2.1553, THE RESPONSE OF FISH POPULATIONS TO HEATED EFFLUENTS

J.R. GAMMON, Depauw University, School of Liberal Arts, *Greencastle, Indiana* 46135

1. To describe the qualitative and quantitative changes in the species composition of fish in a segment of the Wabash River which will receive waste heat from an electric power generating station beginning in 1970.

2. To examine the effect of the thermal additions on the production of fish by comparing growth rates and condition factors of species populations prior to and after the introduction of heated effluents.

3. To measure the harvest of fish by sport and commercial fishermen in relation to the standing crop and to evaluate the impact of the changed population composition on the fishery.

4. To explore the use of the RNA:DNA ratio of fish liver as a possible biochemical indicator of short-term thermal effects.

5. To examine the thermal requirements of some important sport and commercial species of fish in laboratory investigations from egg development, hatching and early fry stages.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1554, THE EFFECT OF INORGANIC SEDIMENT ON STREAM BIOTA

J.R. GAMMON, Depauw University, School of Liberal Arts, *Greencastle, Indiana* 46135

Large quantities of sediment annually carried to the oceans complicate water treatment, reduce recreational values of water, shorten reservoir life and probably affect aquatic life also. Since quantitative studies are lacking the populations of fish in pools and macroinvertebrates in riffles of a small stream were studied in relation to a crushed-rock quarry. During years of heavy sedimentation the populations become much reduced in density, while recovery occurs during summers of low sedimentation. Few organisms are tolerant of the sediment and carpsuckers and gizzard shad appear to be notably intolerant. Standing crop fluctuate in inverse relation to the quantity of sediment introduced, but diversity indices exhibit no uniform pattern. Age and growth analyses and the length-weight relationships may reveal individual organismic responses to sedimentation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1555, DETERMINE THE EFFECT OF ORGANIC WATER POLLUTION AS IT EXISTS IN THE AREA OF DES MOINES, IOWA, ON GROWTH OF THE TURTLE CHRYSEMYS PICTA.

J.L. CHRISTIANSON, Drake University, School of Liberal Arts, *Des Moines, Iowa* 50311

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Amer. Assn. for the Advancement of Sci.

2.1556, WATER QUALITY - CEDAR BLUFF IRRIGATION DISTRICT, KANSAS

R.B. LEONARD, U.S. Dept. of the Interior, Geological Survey, *Lawrence, Kansas*

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with the State of Kansas.

Purpose: To determine the effect of irrigation on the chemical quality of ground water and of streamflow in and adjacent to the district.

Methods: Chemical-quality data with related measurements are collected periodically at about 90 observation wells. The effect of effluent ground water and irrigation waste water on the quality of streamflow is evaluated by a combined seepage-salinity surveys of the Smoky Hill River at the beginning and end of each irrigation season. Continuous conductivity and stage records, and daily records of irrigation releases are used to evaluate the amount and quality of water moving through and adjacent to the district.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1557, EFFECTS OF POLLUTION, ESPECIALLY FROM FEEDLOTS, ON FISHES IN THE UPPER NEOSHO RIVER BASIN

F.B. CROSS, Univ. of Kansas, State Biological Survey, *Lawrence, Kansas* 66044

Ascertain status of fish populations in the upper Neosho River Basin, Kansas; interpret species-composition relative to pollution caused by livestock wastes, utilizing similar data obtained before and immediately after extensive fish-kills in 1967 (caused by feedlot wastes). Obtain information on habitats, reproduction, size and age- composition, and food habits of one species of fish that proved especially sensitive to pollution in 1967, and one species that proved especially tolerant of it.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1558, EFFECTS OF FEEDLOT RUNOFF ON FISH FOOD ORGANISMS IN THE COTTONWOOD RIVER

C.W. PROPHET, State Forest. Fish & Game Com., *Pratt, Kansas* 67124

Objective: To assess the effects of feedlot runoff on benthic macroinvertebrates in the lower Cottonwood River.

Procedure: 1. An attempt will be made to identify other major sources of pollution in addition to commercial livestock feedlots along the lower Cottonwood River: 2.Diversity per individual (d) of benthic macroinvertebrates will be determined periodically for selected reaches of the Cottonwood River and the Neosho River from Elmdale to Hardford:3.Sampling sites used during the previous segment will again be used and new sites will be selected to evaluate relative ecological effects of municipal and industrial discharges directly into the river as well as effects of discharges from sources along major tributary streams: 4.Differences between d values from each sampling station will be analyzed to determine their significance.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1559, INFLUENCE OF THE EFFLUENT FROM A CONCENTRATED INDUSTRIAL COMPLEX ON A LARGE RIVER - FISH DISTRIBUTION
H.M. HANCOCK, State Dept. of Fish & Wl. Rso., *Frankfort, Kentucky* 40601

Objectives: To determine if industrial complex effects distribution of fishes.

Procedures: Distribution of fishes will be studied using gill net and hoop net sets in the control area (mile 19 or above) and in various stations below the outlets of the industrial plants (mile 17.7 - mile 2.5). Net sets will usually be made horizontally at or near mile points.

Part 1 of 7.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1560, INFLUENCE OF THE EFFLUENT FROM A CONCENTRATED INDUSTRIAL COMPLEX ON A LARGE RIVER
H.M. HANCOCK, State Dept. of Fish & Wl. Rso., *Frankfort, Kentucky* 40601

Objectives: To determine if effluent is harmful to any species of fish.

Procedures: Effect of the industrial effluent on fishes will be studied by placing fishes caught in Job A into wire cages which measure 3 ft. x 5 ft. These cages will be located in the control area and in at least three stations in the effluent fan. Physical condition of caged fishes, after various periods of entrapment, will be compared.

Part 2 of 7

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1561, INFLUENCE OF THE EFFLUENT FROM A CONCENTRATED INDUSTRIAL COMPLEX ON A LARGE RIVER - WATER QUALITY EFFECTS
H.M. HANCOCK, State Dept. of Fish & Wl. Rso., *Frankfort, Kentucky* 40601

Objectives: To determine the water quality in the control section of the river and in the affected area.

Procedures: Water quality will be determined from samples taken at various mile points above and below the industrial complex. Dissolved oxygen, pH, total hardness and conductivity will be determined in the field. Duplicated samples will be returned to Murray University chemistry laboratories in inert containers to be analyzed for inorganic chemicals by atomic absorption and for organic chemicals by gas chromatography. Approximately 437 hours chemical consultation will be required for this job.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1562, INFLUENCE OF THE EFFLUENT FROM A CONCENTRATED INDUSTRIAL COMPLEX ON A LARGE RIVER - BENTHOS DISTRIBUTION
H.M. HANCOCK, State Dept. of Fish & Wl. Rso., *Frankfort, Kentucky* 40601

Objectives: To determine the effects on the industrial complex of the distribution of benthos.

Procedures: The distribution of benthos will be determined by taking bottom samples by use as many mile points and also as many stations across the river as possible. These samples will be identified as to micro and macro benthos in Murray University biology laboratory. Approximately 435 hours of biological consultation will be required to complete this work.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

2.1563, INFLUENCE OF THE EFFLUENT FROM A CONCENTRATED INDUSTRIAL COMPLEX ON A LARGE RIVER
H.M. HANCOCK, State Dept. of Fish & Wl. Rso., *Frankfort, Kentucky* 40601

Objectives: To determine chemical content of the muds of the control section of the river and of effected area.

Procedures: Chemical content of bottom muds will be determined from selected mud samples by atomic absorption and gas chromatography. Differences between control and influenced area muds will be recorded. Approximately 334 hours chemical consultation will be required for this job.

Part 5 of 7.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1564, INFLUENCE OF THE EFFLUENT FROM A CONCENTRATED INDUSTRIAL COMPLEX ON A LARGE RIVER - CHEMICAL CONCENTRATION IN FISH
H.M. HANCOCK, State Dept. of Fish & Wl. Rso., *Frankfort, Kentucky* 40601

Objectives: To determine if fishes are concentrating in their tissues any effluent chemicals.

Procedures: Fish tissues will be ashed and tested for organic and inorganic materials to determine if fishes are concentrating any of these components of the industrial complex's waste. Most of the fish tested will be taken from the fish cages (Job B). Approximately 334 hours chemical consultation will be required for this job.

Part 7 of 7.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1565, DETERMINATION OF THE EFFECTS OF OIL IMMERSION ON SWAMP RABBITS
L.K. NELSON, State Dept. of Fish & Wl. Rso., *Frankfort, Kentucky* 40601

Objective: To determine the effects of oil immersion on swamp rabbits.

Procedure: In order to gather data on the effects of oil immersion on individual swamp rabbits from oil pollution occurring during flooding periods in the bottomlands, visits will be made by boat in search of rabbits so affected. Some of these rabbits will be netted, ear tagged for future identification, and placed in the same spot as originally found. An attempt will then be made to check the condition of these individual rabbits by daily visits, if practical, to the area where they were found. Records will be kept on their physical condition, as determined by the observer, and on their fate. If deemed necessary, necropsies or autopsies will be performed to determine their physical state or cause of death.

The facilities of the Animal Diagnostic Laboratory of the Kentucky Department of Agriculture at Hopkinsville, Kentucky will be utilized when necessary.

Experimentation may be conducted on swamp rabbits collected by netting during flooding periods in the bottomlands in pens constructed on the Higginson-Henry Wildlife Area near Morganfield, Kentucky. Rabbits will be immersed in crude oil and the effects of such immersion on the condition of the animal and its fate will be observed and recorded. Attempts will be made to conduct this experimentation during periods of varying weather, including cold and wet weather, when the effects of exposure would be expected to be the greatest.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1566, TOXICITY OF POLLUTANTS TO STRIPED BASS
J.S. HUGHES, State Wildlife & Fish Comm., *Baton Rouge, Louisiana* 70804

Objectives: (1) To determine the toxicity of pollutants to various sizes of striped bass.

Procedures: Striped bass ranging in size from fry to six inches in length will be used for these toxicity studies. Standard bioassay techniques will be followed. Dilution water will be from Bayou DeSiard, a lake adjacent to the laboratory. The water quality will be checked before each series of tests. Bioassays will be run at 22 degrees Centigrade.

Pollutants that will be included in this study are paper mill wastes; oil well effluents; wastes from sugar cane mills; rotenone; antimycin A; and pesticides, such as, 2,4-D, 2,4,5-T, silvex, endothal, diquat, dylox, methyl parathion, DDT, and endrin.

Total survival, total mortality and the TLm will be reported for 24, 48, 72, and 96 hours.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1567, BIOLOGICAL CHARACTERISTICS OF WORM POPULATIONS IN GROWING AREAS
E.P. CREASER, State Dept. of Sea & Sh. Fish., *Augusta, Maine* 04330

Objective: To determine certain biological characteristics of worm populations in different types of growing areas.

Procedure: The growth rates of bloodworms will be determined from monthly length-frequency data. The age composition of sandworms and bloodworms will be established by both length and weight distribution for various areas in the Sheepscot River. A continued investigation of the sexual maturity characteristics, spawning behavior, migration and mortalities will be conducted during the spring and early summer. Evidence of a prespawning mortality of mature bloodworms will be checked out. The male, female, nonspawner ratio for all lengths of sandworms will be checked. Diving techniques will be employed in the study of spawning behavior and the estimations of subtidal worm populations. Studies of sandworm and bloodworm eggs and sperm will continue for the Sheepscot River, and include the Sasonoa River where it is thought that the addition of warm water from a nuclear power plant under addition of warm water from a nuclear power plant under construction may affect egg development or spawning.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1568, THE EFFECT OF HEATING WATER EFFLUENTS ON THE LOWER NEUSE RIVER ESTUARY
D.B. HORTON, Res. Inst. of the Gulf of Me., *Portland, Maine* 04103

The objectives of the project are to provide a description of the physical characteristics and structure of the water column of the estuary and a survey of the benthic invertebrate population before the installation of a nuclear-fueled power plant. A major objective is to predict by simulation, the effect of passage of small fish and invertebrates through the reactor condenser tubes.

SUPPORTED BY No Formal Support Reported

2.1569, WATER QUALITY - BENTHIC INVERTEBRATE RELATIONSHIPS IN ESTUARIES
D. DEAN, Univ. of Maine, Ira C. Darling Ctr. for Res., *Walpole, Maine* 04573

This project proposes to investigate the relationships between water quality and benthic invertebrates in Maine estuaries. Studies will be conducted in three estuaries, the Penobscot, the upper reaches of the Damariscotta and the Sheepscot, representing heavily polluted, moderately polluted and unpolluted conditions, respectively. Comparable portions of each estuary will be studied to determine the benthic communities present, the settlement of benthic invertebrate larvae, larval metamorphosis, and the growth and survival of juvenile forms. Hydrographic, chemical and geological parameters of the waters and sediments will be measured and used as guidelines for controlled laboratory experiments on larval settlement.

The results of this project should aid 1) in the interpretation of fish distribution patterns in estuaries subject to different levels of pollution and 2) in predicting biotic changes that would occur in an estuary subjected to increased or decreased pollution loads.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1570, AN ENVIRONMENTAL SURVEY OF THE DAMARISCOTTA RIVER ESTUARY, LINCOLN COUNTY, MAINE
B.J. MCALICE, Univ. of Maine, Ira C. Darling Ctr. for Res., *Walpole, Maine* 04573

The present environmental characteristics of the Damariscotta River may be significantly altered by the construction of a sewage treatment plant in the upper estuary.

Temperature and salinity distribution, the volume of fresh water entering the estuary, current velocities, and basin topography are being used to derive a picture of the salt balance, exchange rates, and circulation patterns. The summer flushing time is on the order of 3 weeks. Maps of 37 bottom grab samples have used to construct a preliminary sediment distribution in the estuary.

Intensive sampling of inorganic nutrient species is being carried out to determine the nutrient distribution in the estuary and the influence of present small quantities of raw sewage on the distribution.

Hydrographic and nutrient data will be used to predict the effect of the proposed treatment plant on the environmental characteristics of the estuary.

SUPPORTED BY Maine State Government

2.1571, DETERMINE EFFECTS OF RESERVOIRS ALONG SUSQUEHANNA RIVER ON SEDIMENT BEING DISCHARGED INTO CHESAPEAKE BAY AT HAVRE DE GRACE, MD.
J.H. MANNING, State Dept. of Ches. Bay Afrs., *Annapolis, Maryland* 21404

The objectives of this study are to determine the effects of the Susquehanna reservoir on the sediment being discharged into the Bay by the Susquehanna River.

During the fall of 1968 samples will be collected from the water and from the bottoms of several of the reservoirs. Samples will also be collected during the spring freshet of 1969. The mineralogic composition of each of the samples will be determined microscopically and by x-ray diffraction. The size distributions will be determined by sedimentation using a standard pipette method and a Mine Safety Appliance Particle Size Analyzer. The results will be used to evaluate the role of the reservoirs in the downstream fractionation of the Susquehanna River's sediment load.

This study will be conducted by Dr. J. R. Schubel, Chesapeake Bay Institute, The Johns Hopkins University.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1572, COOLING WATER DISCHARGE PROJECT (RP-49)
L.D. JENSEN, Johns Hopkins University, School of Arts, *Baltimore, Maryland* 21218

Study the physical and biological impacts of discharging central electric power station condenser cooling water into rivers, lakes and estuaries. Eleven utilities are collecting temperature and meteorological data which is sent to project for analysis. Biological studies are being conducted at two sites and two more sites are to be activated in Summer 1969. Cooperation of industry and public agencies is very significant. Project will serve in coordinating capacity in other industry studies of cooling water problems.

Data collection and surveys conducted at 12 plus or minus sites throughout the U.S.A. All analytical work is at the University.

SUPPORTED BY Edison Electric Institute - New York, N.Y.

2.1573, AN ECOLOGICAL STUDY OF THE PATUXENT ESTUARY
R.G. BROWN, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-F-020)

OBJECTIVE: Study the effect of heated water from the Chalk Point plant of the Potomac Electric Power Company on the plants.

APPROACH: Ecological and taxonomic study of the vascular plants of the Patuxent estuary.

PROGRESS: Yield and mineral content of the four marsh species Typha, Spartina, Phragmites and Zizania are being studied. Six quarter meter quadrates along a transect line were laid out and replicated three times. Harvest was biweekly, all plants were harvested at ground level to give yield records.

SUPPORTED BY Maryland State Government

2.1574, EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES
J.A. MIHURSKY, Univ. of Maryland, Natural Resources Institute, *College Park, Maryland* 20740

A multidisciplinary investigation is proposed to study thermal pollution of an estuarine community. Laboratory studies of behavioral, metabolic and growth responses to heat stress will be integrated with field experiments to evaluate the overall impact of thermal pollution on an estuarine ecosystem.

Specifically, the laboratory phase will study representative species from the phytoplankton and planktonic herbivores. Growth of algae and intrinsic rates of increase of copepod populations will be used to evaluate thermal stress separately and when other environmental components are varied. At the same time, survival, behavior and metabolism of vertebrates and macro-invertebrates will be measured in gradients of temperature and salinity.

Field experiments will determine the influence of heat pollution on several trophic levels. Rates of mortality, biomass turnover or production and energy flow will be used to evaluate the impact of pollution. An ideal field situation has been provided by the newly constructed electrical generating plant at Chalk Point on the Patuxent river estuary.

The field experiments may be divided into those which test the direct effect of the passage of a part of the estuary through the power plant. The indirect effect of effluent water on the planktonic community adjacent to the power plant may be determined by correlation and comparison with pre-existing patterns of biomass, production and species structure of the plankton. Similarly, pre-pollution-phase measurements of vertebrate and macro-invertebrate standing stocks may be correlated and compared with those existing under thermal pollution.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1575, THE EFFECTS OF THERMAL LOADING AND WATER QUALITY ON ESTUARINE PRIMARY PRODUCTION
J.A. MIHURSKY, Univ. of Maryland, Natural Resources Institute, *College Park, Maryland* 20740 (C-1401)

The proposed research plan involves field and laboratory investigations directed towards determining the effects on estuarine primary production and standing crops by a) steam electric station operation, and b) nutrient additions. In addition, field studies will also examine the ecological role of fresh tidal marshes with regard to the utilization of nutrients from domestic sources.

Field investigations will include routine determinations of: (1) primary production by carbon-14 uptake (2) chlorophyll a (3) temperature (4) conductivity (5) salinity (6) methyl orange alkalinity (7) pH (8) inorganic PO4 (9) total PO4 (10) NH3 (11) NO2 (12) NO3 (13) dissolved organic nitrogen (14) particulate nitrogen (15) particulate carbon (16) dissolved carbon (17) particulate carbohydrate. The above determinations will be made on a tidal system ranging from fresh water to about 15 parts per thousand salinity.

Laboratory investigations will examine (1) the effects of temperature changes on natural estuarine and uni-algal populations held in specially designed incubation chambers and thermal gradient blocks and (2) the effects of nutrients viz. NO3, PO4 etc. on primary activity of natural estuarine and uni-algal populations. Measurements of photosynthetic activity under laboratory conditions will be made by the carbon-14 technique, chlorophyll a content and density estimates by packed cell volume.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1576, THE THERMAL REQUIREMENTS AND TOLERANCE OF KEY ESTUARINE ORGANISMS
J.A. MIHURSKY, Univ. of Maryland, Natural Resources Institute, *College Park, Maryland* 20740

The program will employ temperature as the major variable in monofactorial design and temperature-time and temperature-salinity as variables in poly-factorial design work. Estuarine invertebrates and vertebrates will be tested using three basic approaches: (1) temperature - mortality bioassay, (2) temperature - performance and (3) temperature - metabolic. Steam electric station operational characteristics will be used to influence experimental design.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1577, WATER QUALITY CRITERIA TO PROTECT THE FISH POPULATION DIRECTLY BELOW SEWAGE OUTFALLS
C. TSAI, Univ. of Maryland, Natural Resources Institute, *College Park, Maryland* 20740

The proposed research plan is to establish water quality criteria to protect fish population directly below the sewage outfalls in streams. The criteria will be used as one measurement of sewage pollution assessment and control.

Field investigation will be made at about 120 secondary sewage treatment plant outfalls throughout the State of Maryland during the summers of 1968, 1969 and 1970. At each plant outfall, two stations (one upstream and one downstream, each 300 yards from the outfall) will be designed for determining the water quality (DO, CO2, ammonia, pH, temperature, turbidity, conductivity, nitrite, nitrate, phosphate, and chloride ions) and the fish population (species diversity and fish abundance). The degree of water quality degradation and the degree of fish population depletion by sewage effluents in a stream will be determined from their difference between two stations. Water quality criteria will be established from the relationship between the degree of water quality degradation and the degree of fish population depletion at all plant outfalls studied.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1578, BIOGEOCHEMISTRY OF ESTUARINE ECOSYSTEM WITH EMPHASIS ON HEAVY METALS AND SHELLFISH
J.T. VANDERSLICE, Univ. of Maryland, School of Arts, *College Park, Maryland* 20740

A study of biogeochemistry of estuaries with emphasis on the effects of metal ion and organic pollution on the oyster of the Chesapeake Bay. Selected oyster beds will be analyzed for metal elements and organic compounds in the substrate, silt and fluid portions. Oysters from the same beds will be analyzed for metal content. Mechanisms of retention and storage of metals by the oyster will be studied. A detailed characterization of the lipids in oyster flesh and organs and comparative study of lipid characteristics as functions of age, season and location will be made.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1579, EFFECTS OF SURFACTANTS IN WATER ON BLACKBIRD METABOLISM
M.I. DYER, U.S. Dept. of the Interior, Bureau of Sport Fish. & Wlfe., *Laurel, Maryland* 20810

Objectives: (1) To measure basic and normal metabolic response of blackbirds to a series of different temperature environments. (2) To measure abnormal metabolic responses of blackbirds after treatment with a series of surfactants in water.

Procedures: (1) Assemble physiological apparatus (O2 and CO2 detectors, Beckman Bio-Monitor) to provide metabolic data. (2) Construct empirical avian curve, at least for temperatures of 0.5 degrees, 10 degrees, 15 degrees, and 20 degrees C. (3) Run initial trails non-selective for surfactant, the only criterion being 100 percent effectiveness of wetting qualities of treated Water. (4) Place bird in metabolism suite, monitor for standard response, then treat with surfactant (atomizer system needed). (5) Check CO2 consumption, CO2 production, body temperature parameters before and after treatment. (6) Calculate: R.Q. (use Bio-Monitor); delta T equal (TB - TE minus TE); heat production rate (cal/(gram x hr); and conductance (k cal oird x hr /delta T. (7) Test surfactants as mixtures in water

and as concentrates followed by water treatment-immediately after treatment at intervals during several ensuing days.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1580, COLLABORATIVE RESEARCH IN STRUCTURE, FUNCTION AND EXPORT OF A SALT MARSH
I. VALIELA, Boston University, Graduate School, *Boston, Massachusetts* 02215

This grant supports a study of the structure and function of a New England salt marsh-tidal creek ecosystem subjected to nutrient enrichment by the addition of sewage sludge and chemically defined fertilizers. The consequences of enrichment will be followed in the main structural components of the marsh, particularly primary producers and secondary consumers. These two elements are crucial to the energy exchange between the marshes and adjacent creeks. The research will concentrate on gas exchange in marsh grasses, production of benthic diatoms, populations of benthic animals, especially fiddler crabs and mussels, and growth of fish.

SUPPORTED BY U.S. National Science Foundation

2.1581, WATER RESOURCES POTENTIAL OF AN URBAN ESTUARY
J.J. COCHRANE, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

An investigation of the physical, chemical and biological parameters pertinent to the development of an urban estuary for recreation and flood control. Specific objectives are: Effects of nitrogen and phosphorous on the development of estuarine algae. Influence of bottom deposits, including nutrients and toxic materials, on the balance of the ecosystem. Determination of background levels of physical, chemical and biological data to ascertain the impact on the estuary of the proposed construction of a flood control detention basin. Development of improved methodology for characterization of an estuarine environment including data collection frequency and computer graphics.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1582, PHOSPHATE EXCHANGE WITH SEDIMENTS
W. STUMM, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138

The proposed study is a part of a broad investigation on chemical factors in limnological transformations of phosphate. It is proposed specifically to investigate the kinetics of the reaction CaCO3 plus HPO4 ion yields phosphate substituted CaCO3 (Ca-Phosphate Apatite).

A better knowledge on the distribution of phosphate between the sediments and the overlying waters is relevant for interpreting the eutrophying effect of phosphates introduced into a receiving water. The results of such an analysis should also be of predictive value in establishing whether and how fast the process of eutrophication can be reversed by reducing the introduction of phosphate bearing wastes into the receiving waters.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1583, NAVY ENVIRONMENT--SURFACE FILM EFFECTS ON APPARENT INFRARED TEMPERATURES
P. TWITCHELL, New England Aquarium Corp., *Cambridge, Massachusetts* 02139 (N00014-69-C-0380)

Technical Objective: The Navy's ASW Research Program requires examination of the air-sea interface with respect to infrared emission and reflection from the water. Surface pollutants mask the apparent surface temperature and distort ship wake signatures. The thermal energy exchange, and thus thermal structure important in ASW, is also affected by these pollutants.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.1584, INTERACTION BETWEEN MARINE ORGANISMS AND OIL POLLUTION
P.M. FYE, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

I. Marine hydrocarbons derive in part from living organisms and in part from pollution. We plan to establish sensitive criteria to distinguish hydrocarbons from either source. This knowlege is essential if we are to measure in the oceans the spread of the true pollutants and not of the ubiquitous natural hydrocarbons.

II. Many stable pollutants, especially hydrocarbons, pass through the marine food chain with little alteration but often with a rise in concentration. We plan to study the persistence and accumulation by marine organisms, especially human food, of objectionable and hazardous compounds derived from pollution.

III. Natural organic compounds in the sea play an important ecological role as stimuli in the attraction of the sexes, in the finding of food and in short and long distance migration. Marine pollution is likely to interfere with many of these processes. Because of the extreme sensitivity of the organisms to these stimuli, such interference may be more subtle and still have a more catastrophic long term effect than the gross toxicity of bulk pollution. We plan to study the extent to which marine pollution interferes with these processes and the concentrations which are harmful.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1585, NAVY ENVIRONMENT - ENVIRONMENTAL EFFECTS OF DEEP WATER ORDNANCE DISPOSAL
B.H. KETCHUM, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543 (N00014-66-C0241)

Technical Objective: Evaluation of the environmental effects of Navy ordnance disposal in the deep ocean is essential to prevent inadvertent pollution of the marine ecosystem. Woods Hole Oceanographic Institution is providing investigative and consultative assistance to the US Naval Ordnance Laboratory in determining the ecological consequences of deep ocean ordnance disposal off the northeast coast of the United States.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.1586, COLLABORATIVE RESEARCH IN STRUCTURE, FUNCTION AND EXPORT OF A SALT MARSH ECOSYSTEM
J.M. TEAL, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

This grant supports a study of the structure and function of a New England salt marsh-tidal creek ecosystem subjected to nutrient enrichment by the addition of sewage sludge and chemically defined fertilizers. The consequences of enrichment will be followed in the main structural components of the marsh, particularly primary producers and secondary consumers. These two elments are crucial to the energy exchange between the marshes and adjacent creeks. The research will concentrate on gas exchange in marsh grasses, production of benthic diatoms, populations of benthic animals, especially fiddler crabs and mussels, and growth of fish.

SUPPORTED BY U.S. National Science Foundation

2.1587, ENVIRONMENTAL CHANGES IN LAKE ERIE
J.F. CARR, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Ann Arbor, Michigan* 48107

Lake Erie has experienced major changes in the benthos and fish populations. Analyses of physicochemical data show that concentrations of most major ions have increased significantly, very low dissolved oxygen concentrations occur during the summer, and mean annual water temperatures have increased. Present studies are directed toward documenting the extent of change in the benthos and studying the factors which result in the oxygen depletion of the hypolimnetic waters. Laboratory and field studies are being made of the exchange of nutrients and the oxygen demand at the mud-water interface.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1588, LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES
M.E. BENDER, Univ. of Michigan, School of Public Health, *Ann Arbor, Michigan* 48104

The long-term effects of parathion and endrin exposure to aquatic invertebrates are being studied under continuous flow conditions. Test organisms include: the stonefly Acroneuria, the caddisflies hydropsyche and Chimarra, the dobsonfly Corydalus and crustaceans Asellus and Gammerus, measurement of effects is being evaluated by: mortality rates, growth, time of molting, success of emergence and reproduction success of crustaceans.

The acute and chronic effects of the hydrolysis products of malathion, parathion, and sevin are also being studied.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1589, EFFECT OF WATER TEMPERATURE AND/OR DISSOLVED OXYGEN REQUIREMENTS ON SELECTED MOLLUSKS

H. VANDERSCHALIE, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan* 48104

Eight species of gastropods representing a variety of habitats, ability to survive within several ecological situations, susceptibility to pollution, and significance in the food chain have been selected for study: Physa gyrina, Lymnaea stagnalis appressa, L. emarginate, Helisoma trivolvis, H. campanulatum, Goniobasis livescons, Pleurocera acuta, Amicola limosa.

The temperature tolerance for short periods of time will be determined for the eight species listed above. Three principal factors of several are involved; tolerance to sudden temperature changes, acclimation rates, and upper physiological limits. These three factors will be tested in a manner to separate their importance. An animal migrating or swimming down a river is subject to sudden temperature change at the mixing zone; sensitivity will be tested in this parameter. Rate of acclimation tests are important for ascertaining how fast a temperature changes without adverse effect on the animal, and upper physiological limit ascertains maximum limit of temperature change without death.

Further growth rate over a wide range of temperature changes, freezing, to barely possible survival limits will be investigated. Thus, rate of growth at optimum temperature will be determined. Finally, studies will include the effects of various elevated temperatures on the reproduction of the snail.

This contract was started Fiscal Year 1968-69 and is scheduled to end 1971-72. Quarterly reports are to be submitted to the contract officer in order to keep him posted on the progress of the study. All raw data will be furnished in a final report so that no data are lost for future reference and study.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1590, ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM

R.C. BALL, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00961)

OBJECTIVE: Develop methods of evaluating effects of low levels and chronic input of pesticides in an aquatic habitat. Study of pathways and mechanisms of movement through the aquatic ecosystem, and identification of biotic effects at each trophic level.

APPROACH: The precision, reliability, and specificity of 'stress' analysis technic tested on insecticides in two artificial streams. Criterion will be changes in the mobile fraction of the plasma proteins in fish. Study movement of the toxic materials from the soil into the ponds and follow through the organisms that constitute the food chain leading to game fish.

PROGRESS: The fate of DDT was studied in a productive farm pond and in three artificial pools. The effect of fish and food organisms on the degradation and distribution of DDT was assessed in the pools by placing both trophic levels in one pool, just food organisms in another pool and fish without food organisms in a third pool. DDT applied to the experimental units was lost from the units, apparently by codistillation with evaporating water. DDT in the water was rapidly taken up by the flora, fauna and sediments. DDT deposited on the bottom was degraded to DDD. Both DDD and DDT were recycled back into the water from the bottom. Invertebrates and fish degraded DDT and DDE. Biological transfers of DDT facilitated its degradation to DDE. Increasing the biological productivity of the lentic ecosystem appeared to promote DDT degradation to DDE. The concentration of DDT-R (DDT, DDD and DDE) persisting in the flora and fauna was mediated by the concentration of DDT-R in the water. DDT-R was concentrated from the water about 1 x 10 times by algae, 1 x 10 times by invertebrates and 1 x 10 times by lean fish.

SUPPORTED BY U.S. Dept. of Agriculture

2.1591, TOXIC ACTION OF WATER SOLUBLE POLLUTANTS ON FRESHWATER FISH

P.O. FROMM, Michigan State University, School of Medicine, *East Lansing, Michigan* 48823

Fish subjected to chronic low level stress (hexavalent chromium) and forced exercise exhibited a transitory increase in plasma cortisol which returned to control levels after one week exposure. Animals treated with exogenous cortisol by implanting pellets in the body cavity had plasma cortisol levels of over 100 micrograms. Fasted fish so treated had elevated liver glycogen and excreted more waste nitrogen than controls. Plasma glucose was not elevated. Animals similarly treated but fed during the experimental period had liver glycogen stores and nitrogen excretion rates similar to controls. A seasonal variation in plasma cortisol levels of untreated trout was found.

Rainbow trout were placed in solutions of ammonium chloride containing 0,1,3,5 and 8 micrograms ammonia (total)/ml. After 24 hours' exposure the blood levels for total ammonia showed a direct linear correlation with ambient ammonia and ranged from 38 to 71 micrograms/ml. Expressed in terms of non-ionic ammonia (NH_3): fish exposed to 0 to 1 micrograms ml had blood levels which ranged from 0.06 to 1.3 micrograms ml. The daily excretion of total waste nitrogen showed an inverse relationship with starting ambient levels of ammonia as did the data for excretion of ammonia nitrogen. The relatively greater decrease in ammonia nitrogen excretion nitrogen over total nitrogen excretion in fish exposed to the higher concentrations of ammonia suggests that excretion of other nitrogenous compounds occurred to partially compensate for decreased ammonia nitrogen excretion.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1592, PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS

P.O. FROMM, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00122)

OBJECTIVE: Determine physiological cause of death in aquatic animals most susceptible to pollutants, establish the symptoms of sublethal amounts of pollutants. Identify responses which have value as diagnostic symptoms of pollution toxicity. Determine validity of findings in predicting population changes in habitats subjected to pollution.

APPROACH: Kinetics of surface binding of chromium to cells made and studies of metabolic respones of fish. Investigation of pathway(s) of excretion by fish of two radionuclides (Cr and I) permeability of fish skin.

PROGRESS: Studies using the isolated-perfused trout gill preparation have indicated that when perfused with Ringer solutions having sodium concentrations less than normal plasma levels there was a net uptake of sodium from the bath solution. Perfusion fluid sodium level and epinephrine both appear to control the rate of sodium uptake by isolated gills. Experiments with various inhibitors indicated that sodium uptake is an oxidative metabolism dependent and an ATP dependent system which may be independent of rate and pattern of fluid flow through the gill. In gills exposed to dieldrin, rotenone and MS-222 (tricainemethanesulfonate) flow rates in muL/min dropped significantly, whereas exposure to methoxychlor had no effect. Histological sections of india ink perfused gills exposed to these test chemicals have not yet been completely evaluated and results will be reported later. Studies of the effect of these same chemicals on sodium transport by isolated gills were made using flame photometric analytical procedures but the results were generally unsatisfactory. New studies using radiosodium and radioiodine labeled protein are now underway and reliable data should be obtained. Studies of the effect of ammonia on nitrogen excretion by intact fish have been terminated. When ambient ammonia was increased total-N and ammonia-N excretion decreased, excretion

of urea remained relatively constant and the excretion of waste protein-N showed a slight increase. Some five per cent of the total waste-N excreted remained unidentified.

SUPPORTED BY U.S. Dept. of Agriculture

2.1593, EFFECTS OF LIMNOLOGICAL FACTORS ON UPTAKE OF 137CS BY FISH

N.R. KEVERN, Michigan State University, Institute of Water Research, *East Lansing, Michigan* 48823 (AT(11-1))

Limnological factors that directly or indirectly influence the uptake of 137Cs by fish are being investigated in six contrasting lakes. The factors include concentrations of 137Cs, stable cesium and potassium, and the conductivity and alkalinity. The relationships will be determined by multiple regression analysis. Analyses are being made on samples of largemouth bass and water from each lake and will allow demonstration of the importance of the specific activity of the water on the uptake of 137Cs. Very low concentrations of stable cesium in freshwater dictate the development of methods to concentrate water samples. Investigations on this will include removal by and elution from exchange columns using cobalt ferrocyanide compounds. The final analytical step for cesium is by flame emission techniques. The influence of trophic position on the accumulation of cesium 137 is being studied also. Samples of plants, invertebrates and several fish species in a trophic level series will be collected from a single lake. These samples will be analyzed for 137Cs and potassium. Analysis of variance will be used to test for differences in 137Cs concentrations among trophic levels. The overall objective is to gain sufficient knowledge to allow prediction of maximum concentrations of 137Cs in food fishes when given estimates of radio-nuclide inputs to the water.

SUPPORTED BY U.S. Atomic Energy Commission

2.1594, AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS

V.A. KNUDSON, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00959)

OBJECTIVE: Assess the influence of total alkalinity, pH and temperature of the water on the effectiveness of several widely used herbicides. Test the effect of weed control by chemical means on fish- food organisms. Evaluate fertilization as a method of controlling higher aquatic plants.

APPROACH: Preliminary work in the laboratory will include study of influence of water quality on effectiveness of various herbicides. Toxicity of herbicides to fish will be studied in conjunction with the laboratory, experiments. While some fertilization studies can be done in the laboratory, the major effort here will be in farm ponds and small lakes.

PROGRESS: Bioassays were run with two genera of cladocerans, Simocephalus sp. and Ceriodaphnia- sp., an ostracod, and Vivaparus purpurea, a large snail. Herbicides tested included copper sulfate, sodium arsenite, diquat, silvex, 2,4-D, endothal, and Hydrathal-47. The tests generated several conclusions: snails were generally unaffected by all herbicides tested except for copper sulfate, while cladocerans and ostracods were particularly susceptible to H-47, copper sulfate, and sodium arsenite at all levels tested; copper sulfate, even at 0.15 ppm, proved lethal to most organisms tested and should be studied in greater detail, since it apparently is used at toxic levels in the environment. Endothal, silvex, 2,4-D, and, in most cases, diquat, appeared to be relatively harmless to the organisms tested.

SUPPORTED BY U.S. Dept. of Agriculture

2.1595, MONITOR FISH POPULATIONS IN THE VICINITY OF THE PALISADES NUCLEAR POWER PLANT SITE ON LAKE MICHIGAN

M.H. PATRIARCHE, State Res. & Dev. Division, *Lansing, Michigan* 48926

Objectives: Determine whether or not the heated effluent of about 1,000 cfs from this power plant will have pronounced effects on the fish population in the vicinity of the plant, with respect to species composition, abundance, and growth.

Procedures: For 2 years prior to the start of plant operations (spring of 1970) and 3 years thereafter, gill nets will be fished for two 24-hour periods (longer intervals if weather interferes) four times a year. These sampling periods coincide with a limnological study plan carried on by a private consultant, and occur in mid-May, late June, late August, and mid- October. Approximately 1,000 feet of gill nets of assorted mesh sizes are fished in four gangs at eight stations located 1/2 and 1 mile out from the plant site, on transects radiating out from shore. Water depths range from 20 to 40 feet. All fish captured are measured and counted; many are scale sampled, sexed, and weighed. Shoreline seining (day and night) with a 125-foot bag seine will be done when conditions permit. Also, fish will be collected by trawling when the schedules of either the Department research vessel 'Steelhead' or the Bureau of Commercial Fisheries vessel 'Cisco' permit. The field data will be used to determine species and age composition, catch per unit of effort indices, and seasonal growth rates.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1596, MONITORING FISH POPULATIONS IN THE VICINITY OF THE PALISADES NUCLEAR POWER PLANT SITE

M.H. PATRIARCHE, State Res. & Dev. Division, *Lansing, Michigan* 48926

Project and Job Objectives: To determine if there is a pronounced change in the species composition of the fish stocks and their growth rates after heated plant discharges enter Lake Michigan.

With the advent of many nuclear power plants on the Great Lakes, information is needed on the effects on the fish populations of the heated discharges into these large cold bodies of water. Activities such as fishing (both commercial and sport) and stocking salmonids might be affected by fish reactions to temperature and other possible environmental changes. Inasmuch as Consumers Power Company, the owner of the plant, is financing a 4-year limnological study and the Michigan Department of Natural Resources is furnishing a vessel and manpower for same, it was decided to also sample the local fish population during these surveys to detect any gross changes that might occur.

Procedures: Under one job, population sampling will be done concurrently with the seasonal limnological surveys. Gill netting, shorelines seining (in summer), and trawling (by the Bureau of Commercial Fisheries vessel 'Cisco') will be done before and after the plant goes into operation. Seasonal and annual data on population structure and fish growth will be compared.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1597, CHRONIC EFFECTS OF HEAVY METALS ON FISH

R.W. ANDREW, U.S. Dept. of the Interior, Federal Water Quality Admin., *Duluth, Minnesota* 55804

The overall objective of this work is to develop analytical and toxicological techniques for relating the chronic effects of heavy metals and heavy metal wastes to observable short-term metabolic and physiological effects. The acute, subacute, and chronic effects of Cr, Cu, Cd, and Zn will be studied with Brook Trout, Yellow Perch, and for Bluegills as possible test species. Emphasis will be placed on the effects of the metals on the respiratory and reproductive systems, growth rates, and overall production efficiency of the fish. Tracer and radiotracer techniques will be used to determine modes of metabolism (intake/disposition/excretion) and physiological effects of one or more of the metals. Ultimately, attempts will be made to correlate the chronic physiological and toxicological effects with measurable short- term (acute) effects.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1598, MULTIPLE SCLEROSIS AND THE QUALITY OF DRINKING WATER

M. ALTER, U.S. Veterans Administration, Hospital, *Minneapolis, Minnesota* 55417

Epidemiologic evidence is being collected and analyzed relating various parameters of environmental sanitation to the distribution of multiple sclerosis. So far, almost all data collected

support the hypothesis that a positive correlation exists between the quality of environmental sanitation and the frequency of MS. It has been shown that a) communities which are technologically advanced but have poor sanitation have a low rate of MS, b) socio-economically disadvantaged individuals (Negroes) have a lower rate of MS than socio-economically favored individuals (Caucasians) living in the same area, c) groups reared in an area where sanitation is improving tend to have an increase in frequency of MS as compared to immigrants to the same region reared in less sanitary environments, d) communities having a frequency of MS different from what would be expected on the basis of their geographic latitude, are not 'discrepant' if the sanitation in the community is taken into account, e) the distribution of sanitation parameters such as quality of drinking water, sewage disposal, crowding, tuberculosis, correspond well with the distribution of deaths due to MS.

If the hypothesis is valid that sanitation and MS are directly 'linked,' it might mean that the agent causing MS is transmitted via contaminated water or food. As was the case in poliomyelitis, in areas with poor sanitation, an agent was transmitted early in life and individuals infected then developed immunity. Individuals in sanitary environments were affected later and developed clinical signs of the disease. A similar mechanism might be operating in MS.

SUPPORTED BY U.S. Veterans Administration

2.1599, POLLUTION AND THE ECOLOGY OF NEAR-SHORE PERIPHYTON OF LAKE SUPERIOR
T.A. OLSON, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

Representative areas of the North Shore and other adjacent waters will be examined for the purpose of characterizing the periphyton which prevails in shallow water areas and at the shore-water interface: for the purpose of comparison, concurrent samples of periphyton will be collected from deeper waters. In addition, simultaneous field and laboratory experiments will be carried on to ascertain the growth response of the periphyton community as affected by contamination or enrichment of the water. Flow-through, temperature controlled photosynthetic units used in earlier pigment studies on deeper water periphyton will be utilized for this work. Certain in situ experiments dealing with controlled eutrophication are also planned. Estimates of productivity and growth rates will be made and reported on the basis of dry and ash-free dry weight.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1600, CONTROLLED TEMPERATURE REGIMES IN OUTDOOR EXPERIMENTAL PONDS
E. SILBERMAN, Univ. of Minnesota, School of Engineering, *Minneapolis, Minnesota* 55414

The Water Quality Laboratory of the Federal Water Pollution Control Adminstration located at Duluth, Minnesota, proposes to build and operate a number of outdoor experimental ponds for the study of aquatic life under the effect of variable water temperatures. The ponds would be located near the electric power generating plant presently under construction near Monticello, Minnesota, and owned by Northern States Power Company. Waste heat from the plant and local groundwater supplies would be available for establishing controlled temperature regimes in the ponds. The ponds are to represent natural conditions insofar as this is compatible with maintaining the desired experimental temperature regimes.

Personnel of the Heat Transfer Laboratory, Department of Mechanical Engineering, University of Minnesota, are to assist in the study of the means whereby artificial heating (or cooling) may be applied to maintaining predetermined temperature regimes in large outdoor ponds. The objective of the study will be to devise a method whereby the requirements for temperature control in the experimental ponds of the Water Quality Laboratory can be met as nearly as possible. A secondary objective will be to establish modified requirements for the ponds if certain of the preliminary requirements turn out to be impracticable.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1601, SECONDARY PRODUCTION IN RUNNING-WATER ECOSYSTEMS
T. WATERS, Univ. of Minnesota, Graduate School, *Minneapolis, Minnesota* 55455

This project is concerned with the study of secondary production in streams, including production rates, growth and survival rates, and quantitative life-history information for stream invertebrate animals primarily. The emphasis on invertebrates is significant, because it is this group that is the most sensitive to the quality of the aquatic habitat and to environmental disturbances. Studies will be made in streams of eastern Minnesota, including both field sampling and laboratory experiment. Production rates will be determined according to the growth method of Ricker and Allen, for which instantaneous growth rates and field standing crops are required. Growth rates will be determined from laboratory culture of invertebrates in running-water aquaria and small laboratory streams at normal season-specific water temperatures. Additional growth information for confirmation will be derived from size-frequency analyses of bottom samples. The new Hynes-Coleman-Hamilton procedure of estimating production rate will be tested; turnover ratios will calculated for all species and streams.

Aquatic ecologists in the past have focused most attention on lakes, large reservoirs, and the oceans. Relatively little effort has been applied to the running-water ecosystems, except that of a descriptive nature. This resource is delicate and easily disturbed, and recovery is often difficult and slow. Therefore, the continued viability of streams as sources of domestic water supply, waste dispersal, recreation, and natural beauty, will depend on intensive management, the expected significance of the research is in providing knowledge that will permit such management on a sound basis.

SUPPORTED BY U.S. National Science Foundation

2.1602, MISSISSIPPI RIVER ECOLOGY ASSOCIATED WITH HEATED POWER PLANT EFFLUENT
A.J. HOPWOOD, Saint Cloud State College, Graduate School, *Saint Cloud, Minnesota* 56301

Construction of a large power plant on the Mississippi River near Monticello, Minnesota, is scheduled for completion in February, 1970. Heated water will be discharged from the plant during operation causing changes in the environment with subsequent alterations in aquatic life. The study described herein is designed to determine existing ecological conditions in the Mississippi River before operation of the plant and to monitor environmental changes due to thermal discharge from the generator.

The above purpose can best be served by attainment of the following objectives: A. Prior to operation, February, 1970: 1. Determine existing physical and chemical factors of water quality; 2. Determine existing species, and temporal and seasonal abundance; 3. Determine general physical condition, food habits, life cycles & energy relations of species in the river ecosystem. B. During operation: 1. Compare physical and chemical water quality with that which was present before plant operation; 2. Compare species structure and abundance with data collected prior to operation; 3. Observe physical condition, food habits, life cycles and energy interactions of all species.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1603, EFFECT OF HEATED DISCHARGE WATER FROM POWER GENERATING PLANT ON FISH POPULATIONS & FISHING IN LAKE ST. CROIX (ABBREV)
H. KROSCH, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

Objectives: To collect, compile and evaluate information about fish populations and fishing success in the vicinity of the Allen S. King power generating plant at Oak Park Heights for two years prior to and three years after the plant goes into operation to determine the effects of heated discharge water on fish and

fishing in Lake St. Croix. This information will be used to help formulate regulations governing operations of other power plants.

SUPPORTED BY Minnesota State Government - Saint Paul

2.1604, DOMESTIC WATER PROBLEMS AS RELATED TO TEXTILES

S. DAVISON, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-20-095)

OBJECTIVE: Investigate the effect of water of various mineral content on fabrics composed of cotton, chemical fibers or blends. Study the problems arising from the methods of laundering used by a selected group of homemakers in water problem areas.

APPROACH: State Extension specialists will assist in selection of water problem areas and Home Agents will assist in choosing homemakers participating in study. The garment selected will be worn and laundered by homemakers with their other apparel. They will be returned to laboratory at specified intervals for evaluation by nondestructive measures. Information on washing methods, equipment, agents, water supply, etc. will be obtained. Laboratory investigation will parallel wear study as a means of determining how's and why's of problems encountered and as a control of work underway at cooperative stations. As garments are withdrawn evaluation will include such measures as stiffness, residual strength, elongation, weight, thickness, and dimensional stability.

PROGRESS: Through the cooperation of the Agricultural Extension Services polyester cotton fabrics, with and without permanent press, have been laundered with family white wash loads from one to 25 times. There are 20 participants in a hard water area of each state. Mrs. Ruth Kent, Home Economics Agent in Itasca County, has assisted in supervision of the Minnesota study. Swatches were withdrawn at specified intervals. Factors held constant were the type of detergent, and type of washer (top loading). Water samples were analyzed for hardness minerals and iron content. Using paper thermometers enclosed in glass, temperature of wash water was obtained periodically. Reflectometer readings to determine whiteness or grayness are in progress. Swatches of the same fabric as that used by the participants have been artificially soiled. These are being laundered in a controlled laboratory study using four levels of water hardness, three water temperatures, two types of detergent (anionic and non-ionic) and five concentrations.

SUPPORTED BY U.S. Dept. of Agriculture

2.1605, EFFECT OF PAPER FIBER WASTES ON FISH EGGS AND JUVENILES

L.L. SMITH, Univ. of Minnesota, School of Agriculture, *Saint Paul, Minnesota* 55101

Suspended wood fiber is to be tested for its effects on fish eggs, fry and fingerlings. Effects of wood fiber mats in Rainy River on fish and invertebrates will be tested. Decomposition products of wood fiber mats will be tested in laboratory. Effect of Sphaerotilus natans on fish eggs and fry is to be tested. Deleterious effects of low oxygen levels in connection with fiber decomposition products will be determined.

SUPPORTED BY U.S. Dept. of Interior - Wtr. Qua. Adm.

2.1606, EFFECT OF WATER POLLUTANTS AND WATER QUALITY ON EARLY LIFE HISTORY AND POPULATION DYNAMICS OF MINNESOTA FISHES

L.L. SMITH, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-17-076)

OBJECTIVE: Determine the influence on fish production of various water pollutants of industrial and domestic origin; specifically, what such materials as H(2)s, detergents, paper mill wastes and similar materials have on growth rate, fecundity, and survival of fish. Fish food organisms are also included in investigations.

APPROACH: Field observation in polluted areas are made to determine limits of major parameters such as temperature, O(2) pollutant levels and fish survival. Laboratory bioassays, long-term tests at sublethal levels of various materials, and fecundity tests will be made in the laboratory under controlled conditions to separate out effects of various factors and to define subtle lont-term effects of pollutants that will influence level of annual harvestable crop of fish.

PROGRESS: This project has been devoted during the present calendar year to long term studies of low level hydrogen sulfide concentrations and their effect on various life history phases of five species of fish. These studies, which were in progress for the entire period, have examined growth, spawning characteristics, and survival of fathead minnows, walleye pike, goldfish, bluegills and suckers. It has been determined that sublethal levels of hydrogen sulfide reduce growth, inhibit spawning, and inhibit food conversion efficiency on these species. It is planned that these studies will be continued through at least two full life history cycles. Short-term acute bioassay tests have been run on these species to determine the relationship of the TLM values to demonstrate deleterious effects of long term exposure at lower levels.

SUPPORTED BY Minnesota State Government - Saint Paul

2.1607, HEMATOLOGY OF FISH

B.A. FISCHER, Univ. of Southern Mississippi, School of Arts, *Hattiesburg, Mississippi* 39401

Study of whether there is a significant difference in the hematology of fishes from polluted and nonpolluted streams in the State of Mississippi.

SUPPORTED BY University of Southern Mississippi

2.1608, WATER AND SEDIMENT, SUPPLY AND ACCUMULATION IN THE ESTUARY, ST. LOUIS BAY, MISSISSIPPI

C.M. HOSKIN, Univ. of Southern Mississippi, School of Arts, *Hattiesburg, Mississippi* 39401

Texture, origin and sites of sedimet accumulation will be studied for the Wolf and Jordan Rivers and Bay St. Louis estuary. Sediment accumulation in estuaries has multiple impact because of the strong control on distribution of aquatic creatures of commercial importance to man and because of potential interference with man's exploitation of estuaries in water use, recreation and industry.

SUPPORTED BY University of Southern Miss. - Hattiesburg

2.1609, A SURVEY OF THE VERTEBRATES OF THE PEARL RIVER RESERVOIR

J.P. MCKEOWN, Millsaps College, Undergraduate School, *Jackson, Mississippi* 39210

Population studies of the relative densities of the vertebrates in the Pearl River Reservoir are being made. The effects of various pollutants on natural populations are being determined.

SUPPORTED BY Millsaps College

2.1610, A SYSTEMS APPROACH FOR THE STUDY AND CONTROL OF FACTORS AFFECTING WATER POLLUTION

R. ANOUR, Mississippi St. University, School of Engineering, *State College, Mississippi* 39762

The proposed research plan is directed toward using a systems approach technique for the determination of various activities and their effects on water pollution.

The main purpose of these investigation is to build a systems approach including all ecosystem pollution factors and to find through operational analysis the interrelationships between or among these factors. This could be the first step toward optimization of water pollution problems as a whole instead of suboptimization of each individual pollution problem.

The proposed plan will be done in three stages: 1. General review of the literature for the pollutants which enter the main stream from point sources and dispersed sources. 2. Field investigations of sources, type of pollutants and their associated risks in a selected, small river basin. 3. Development of a general systems approach through mathematical modeling and operational analysis.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1611, THE EFFECT OF SALINITY ON THE OXIDATION OF HYDROCARBONS IN ESTUARINE ENVIRONMENTS

L.R. BROWN, Mississippi St. University, Graduate School, *State College, Mississippi* 39762

It is known that petroleum products are adsorbed on the surfaces of various materials including silt and sand and find their way to the bottom of bodies of water. Ultimately, these materials are utilized by microorganisms, but very little is known about the rate of decomposition, the products formed from their utilization, or the effect of the environment on the microbial hydrocarbon utilization.

The overall objective of this proposal is to study the effect of salinity on the oxidation of hydrocarbons in estuarine environments. More specifically, studies will be conducted to determine (1) the effect of various salinities on the aerobic utilization of petroleum products, (2) the effect of salinity on the anaerobic decomposition of petroleum products, and (3) the microflora that predominate at various salinities.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1612, ENVIRONMENTAL STUDIES ON THE MISSISSIPPI RIVER

W.T. MCKIE, Mississippi St. University, School of Engineering, *State College, Mississippi* 39762

A study of the effects of the discharge of heated effluents on the aquatic life of the Mississippi River. A mathematical model for the thermal energies as related to the electrical load demand, the river conditions, and the expected water temperatures will be developed.

SUPPORTED BY Mississippi Power & Light Co. - Jackson

2.1613, THERMAL GRADIENTS ASSOCIATED WITH DISCHARGE OF HEATED EFFLUENTS

A. SHINDALA, Mississippi St. University, School of Engineering, *State College, Mississippi* 39762

Although there has been a considerable amount of work on the qualitative effects of heated waters on aquatic life and some qualitative work on thermal gradients, there is relatively little published information on the analysis of hydraulic factors and their influence on thermal gradients. The writer does not know of any successful attempt at a generalized method for the prediction of thermal gradients.

It is the purpose of this proposed study to gather and analyze prototype data on thermal gradients in the receiving waters and to relate those gradients to the hydraulic characteristics of the entering and receiving streams. A procedure for the prediction of thermal gradients which result from the entry of heated effluents from thermal power plants into natural streams will be developed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1614, DETERMINATION OF AQUATIC ECOSYSTEM RESPONSE TRENDS RESULTING FROM MAN-IMPOSED ENVIRONMENTAL STRESSES

J.W. KEELEY, U.S. Army, Corps of Engineers, *Vicksburg, Mississippi*

Technical Objective: Determine functional relations between the biotic and abiotic elements of select aquatic ecosystems. In particular, the research is directed toward the development of a capability for predicting the response trends of ecosystems that result from environmental stresses imposed by man's activities. Results of this study may be used to plan military and construction activities that will not adversely affect the ecological environment.

SUPPORTED BY U.S. Dept. of Defense - Army

2.1615, IMPACT OF CORPS OF ENGINEERS CONSTRUCTION ACTIVITIES ON THE ECOLOGICAL ENVIRONMENT

J.W. KEELEY, U.S. Army, Corps of Engineers, *Vicksburg, Mississippi*

Technical Objective: The objective of this work unit is to provide consultant services and to define areas and capabilities for environmental research as related to the U. S. Army Engineer Waterways Experiment Station in particular and the U. S. Army Corps of Engineers in general with emphasis on the extreme importance of developing an in- house capability for a coordinated systems approach to meet military as well as civic needs. Army interests in ecology include but are not limited to the conduct of military and construction activities so that the ecological environment will not be adversely affected. Military reservations together with theaters of operations encompass all aspects of ecology such as water resources, land and forests which together contain all species of fish and wildlife.

SUPPORTED BY U.S. Dept. of Defense - Army

2.1616, EFFECTS OF RECENT AND PAST PHOSPHATE FERTILIZATION ON THE AMOUNTS OF PHOSPHORUS PERCOLATING THROUGH SOIL PROFILES INTO SUBSURFACE WATERS.

R.W. BLANCHAR, Univ. of Missouri, School of Agriculture, *Columbia, Missouri* 65201

The proposed work is a laboratory investigaton of the phosphorus chemistry of two similar soil profiles. One profile has received no fertilizer phosphate and the other has been maintained at a phosphate level judged adequate for maximum crop production since 1889. The profiles will be sampled to a depth of nine feet and divided into appropriate horizons.

The chemical characteristics of the soil profile which influence the solubility of phosphorus will be determined. Total, organic, inorganic, aluminum, calcium, iron, occluded, available, and water soluble phosphates in the profile will be measured. The kinetics of phosphate adsorption and equilibration with the water phase will be measured. Equilibrium extracts will be evaluated in terms of mineral components responsible for phosphate solubility.

A model will be developed and tested to estimate the amount of phosphate which will percolate through heavily and non-fertilized soil profile. This information will be related to chemical properties of the soil profile and to predictions of the probability of percolation conditions for Missouri soils. These data will act as a guide to predict the probable contribution of fertilizer level to the effectiveness of phosphate from farm fields in terms of water pollution.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1617, RECOVERY FROM ACID POLLUTION IN FOUR STRIP-MINE LAKES

R.S. CAMPBELL, Univ. of Missouri, Graduate School, *Columbia, Missouri* 65202

The purpose of this research is to determine the successional changes in strip-mine lakes during recovery from acid pollution. This series of lakes created by strip-mining in 1919-21 show widely divergent biological and chemical characteristics which are related to differences in acidity ranging from pH 3.0 to pH 8.6. Total acidity ranges from 5090 to 98 mg/liter $CaCO_3$.

These lakes were first investigated in 1940-41 and again in 1949- 50. The present study dates from 1960. Successional changes are therefore documented within individual lakes and inferred from lake to lake as the acid climate is slowly altered.

In addition to seasonal physical, chemical and biological investigations, special effort is directed toward: (1) Evaluation of chemical stratification, and of the iron (Fe II - Fe III) complex; and (2) Measurement of water quality, of comparative primary and secondary production of community metabolism and of energy flow.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1618, THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER

M.R. QUERRY, Univ. of Missouri, Water Resources Research Ctr., *Columbia, Missouri* 65201

A study is proposed to determine the effects of herbicides, pesticides, and fertilizers on water's capacity to reflect and absorb electromagnetic radiant flux.

The objectives of the project are: (1) The measurement of the reflectance and transmittance of water solutions of herbicides, pesticides and fertilizers with infrared radiant flux. (2) The computation of the optical constants, i.e. the index of refraction and the extinction coefficient from the reflectance and transmittance data. (3) The computation of the absorptance and reflectance of radiant energy for these solutions, and to relate these results to possible long range changes in the thermodynamic equilibrium of rivers, lakes, and coastal waters. (4) The further study of the intermolecular interaction of solutes with the water substance.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1619, THE EFFECT OF WATER TEMPERATURE ON ECOLOGICAL PROCESSES IN A RESERVOIR RECEIVING HEATED WATER

A. WITT, Univ. of Missouri, School of Arts, *Columbia, Missouri* 65202

Thomas Hill Reservoir is subject to thermal loading in one of its two lower arms. This provides control and experimantal arms in which environmental alterations, due to thermal loading, can be studied. Acid mine drainage occurs in the upper end of the lake.

Field investigations will determine the effects of thermal loading on: 1. Photosynthetic rates of planktonic algae. 2. Rate of accumulation of organic matter by 'Aufwuchs'. 3. Community metabolism. 4. Temperature effect on water quality. 5. Contribution of limited acid inflow to the ionic compositions of the water. 6. Effect of heated water on benthos. 7. Growth rates of young-of-the-year and yearling fishes. 8. Culture of fishes in floating baskets in the heated water. 9. Movement of fishes in response to heated water.

A laboratory will investigate: 1. Temperature tolerances of fishes. 2. Rates of ingestion, food conversion efficiencies and growth of channel catfish under controlled temperatures. The results of this study will lead to a better understanding of the alteration of environmental processes due to heat and acid inflow, and how it may be managed for the benefit of man.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1620, HARVEST OF FISH IN THOMAS HILL RESERVOIR

W.D. HANSON, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To determine the fishing pressure, rate of success, and the hook-and-line yield by season. To determine what influences a warmwater discharge from a power plant has upon angling success and seasonal angler-use patterns.

Procedures: One job-trained creel census clerk will conduct a census on the entire reservoir on a one-half time basis. He will count boat and shore fishermen twice daily, according to a prearranged schedule, with the counts being started at opposite ends of the census area alternately. The lake will be divided into five areas, each area being treated as a separate unit for later comparative purposes. During the remainder of the working day, the clerk will contact fishermen both on shore and in boats in each of the five areas. Only those creels inspected by the clerk will be reported. In addition, the clerk will obtain lengths, scales and stomachs for designated species as the need arises. A record of air and water temperature, Secchi readings, and lake levels will be kept daily for each area. When tagging operations are conducted on the lake, the clerk will solicit the cooperation of anglers, Conservation Agents and local people for tag return information.

Calculations of species composition of the catch, fish per hour, average length of fishing trips, total trips, per cent successful anglers, and the average size of each species taken will be made directly from the creel census records. For composition of yield, the data will be divided into seasonal periods. For each period, the estimated total catch will be equal to the product of mean daily count averages, length of census day, number of days in the period, and rate of catch in fish per hour. Data from weekdays and weekend days will be treated separately. Information will be compiled and summarized each quarter by data processing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1621, THE FISHERY OF THOMAS HILL RESERVOIR

W.D. HANSON, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To evaluate the effects of a warm water discharge and the introduction of northern pike on the fishery of Thomas Hill Reservoir.

Procedures: Thomas Hill Reservoir, a water supply impoundment for a steam power plant, was stocked with northern pike in 1966 and annually since. The effect of the warmwater discharge and the introductions on the fishery will be evaluated in the following investigations: 1. Harvest of fish in Thomas Hill Reservoir (Job No. 1), 2. Evaluation of the introduction of northern pike (Job No. 2).

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1622, WATER QUALITY SURVEYS

M.D. MCDANIEL, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To evaluate the effects of water quality on biological productivity.

Procedures: Quality of water and its effects on biological productivity will be evaluated by measurement of the benthos in the following situations: 1. Southeast Ozarks mining water quality survey (Job No. 3) 2. Effects of scouring on benthos populations (Job No.6). 3. Water quality of the North, Salt and Cuivre River basins (Job No. 7).

SUPPORTED BY Missouri State Government

2.1623, SOUTHEAST OZARKS MINING WATER QUALITY SURVEY

M.D. MCDANIEL, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To measure the benthic fauna so that the effects of effluents from present and future mining operations can be evaluated.

Procedures: A series of 21 stations are located on streams above and below present mines. Biological data were collected at these statons during 1966, 1967 and 1968. In 1969, a visit will be made to each area and samples of benthic macroinvertebrates will be collected. Physical and chemical factors and rate of flow were measured by the Missouri State Water Pollution Board and U.S. Geological Survey personnel in conjunction with the initial survey.

Qualitative benthos samples (which are semi-quantitative) will be collected on the riffles at each station with a bottom net. The riffles and pools will be checked for mussels, crayfish and snails. Fishes were surveyed once at all stations to determine species present during 1967-68 field season.

A standard form will be used to record kind and relative number of organisms present at each station. Identification of organisms will be as follows: (a) Flatworms, annelids, and roundworms will be identified to class. (b) Flies (Diptera) will be identified to family or genus, depending on the organism. (c) Stoneflies, mayflies, caddisflies, crayfish and mussels will be identified to species when practicable. (d) Snails, crustaceans and insect group other than those named will usually be identified to genus when practicable.

Data from the stations will be tabulated and compared to determine quality and relative quantity. Results will be compared to similar studies elsewhere.. In the written final report the relationships of the benthos to the physical and chemical quality of the water (not reported by cooperating agencies) will be emphasized. The report will be arranged as an integral part of the report for the over-all project.

SUPPORTED BY Missouri State Government

2.1624, POLLUTED WATERS
W.L. REDMON, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To document the extent and severity of pollution in the state and evaluate the effects on fish and aquatic habitats.

Procedures: The results of pollution of the waters of the state will be studied as follows: 1. Pollution investigations (Job No. 1).

SUPPORTED BY Missouri State Government

2.1625, POLLUTION INVESTIGATIONS
W.L. REDMON, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To evaluate the effects of water pollution on fish and aquatic habitat.

Procedures: Fish kills will be investigated to determine the cause and duration of the kill.

In cases of pollution by toxic substances, bioassays will be conducted to determine the concentration and relative toxicity of the toxicant.

When total fish kills occur over long stretches of a stream, observations will be made to determine the time required for repopulation.

Reported water pollution will be investigated to determine the source and quantities of pollutants. These data will be supplied to state and federal agencies charged with enforcement of water pollution laws.

Experiments will be conducted on the feasibility of various methods of combating oxygen depletion fish kills.

An annual report will be prepared for comparison with previous years and to furnish data to the Federal Water Pollution Control Administration.

SUPPORTED BY Missouri State Government

2.1626, GEOCHEMICAL EFFECTS OF MINING POLLUTION ON THE STREAMS OF SOUTHEAST MISSOURI
E.A. BOLTER, Univ. of Missouri, Graduate School, *Rolla, Missouri* 65401

The proposed research aims at determining the influence of developing lead-zinc mining operations on the quality of stream waters in the 'New Lead Belt' of SE Missouri.

The investigation will include the following parts: 1) Determination of possible pollution of stream waters by heavy metals. 2) Determination of the 'self-cleaning capacity' of the streams by adsorption or precipitation. 3) Determination of the uptake of heavy metals by aquatic life species.

Samples will be collect at about 20 sampling stations. The chemical analysis of water samples, stream sediments and aquatic life species will be performed by atomic absorption spectroscopy.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1627, EFFECT OF ENVIRONMENTAL FACTORS ON DESIGN AND OPERATION OF OPEN-AIR SLUDGE DRYING BEDS
J.C. JENNETT, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

In order to develop rational techniques for the design of open-air sludge drying beds, it is necessary to understand the effect environment has on the process. The main approach of this investigation is to study the fundamental aspects of sludge drying and how environment is a factor.

The specific objectives of this project are to develop laboratory procedures which will allow the quantitative evaluation of the effects of environment on sludge drying; to evaluate the experimental results gained from the laboratory to determine how and to what degree environment and sludge bed design affect the rate and extent of sludge drying; and to develop a rational approach to the design and operation of these drying beds.

Laboratory investigations will be performed using model sludge drying beds in environmental chambers which allow the control of the physical environment so that each variable may be held constant or changed as desired. Laboratory and field data will be correlated to allow practical application of the results.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1628, STREAM POLLUTION IN THE NEW LEAD BELT OF SOUTHEAST MISSOURI
B.G. WIXSON, Univ. of Missouri, Environmental Health Res Ctr, *Rolla, Missouri* 65401

The proposed research plan involves field and laboratory investigations to determine the initial and cumulative effects of lead- zinc mining wastes on the water quality and aquatic biota of the presently unpolluted streams in the 'New Lead Belt' of S. E. Missouri. The unpolluted water quality and natural ecological background data have already been established since mining activity is scheduled to start in the immediate future. The unique study area makes possible a before, during, and after pollution investigation. Specific objectives are: 1. To study and evaluate the initial shock of mining pollution on the water quality and aquatic biota of affected streams. 2. To study and evaluate the cumulative effects of increasing amounts of mining pollution upon water quality and ecological systems. 3. To determine water quality and aquatic biota in control unpolluted streams in the area which will not be affected by increased population of new industry. 4. To evaluate and correlate all the investigative data and relate the findings to the unpolluted control streams and initial background survey of the streams in the study area.

Pollution effects on water quality would be evaluated by changes in pH, dissolved oxygen, turbidity, color, alkalinity and water hardness. Pollution effects on the biota would be evaluated by the response or changes in bacteria, algae, snails, crayfish, and fish.

The evaluation of all investigative data would provide information which will help conserve and protect healthy streams and biotic communities from futrue lead-zinc mining pollution.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1629, ENERGY EXCHANGE WITHIN ECOSYSTEMS
D.M. GATES, Missouri Botanical Garden, *Saint Louis, Missouri* (AT(11-1))

Objective: We wish to test a theoretical model for plant productivity by means of experiments with labelled CO2. A valid model for productivity is vital in understanding plant competition, the original goal of this project. It will also be important in understanding the interactions of herbivores and carnivores in the production cycle, and in assessing the effects of thermal pollution on plants. Scientific Background for Study: In the past few years, Gates and co-workers have worked out the energy budgets of leaves. The total energy environment of a leaf is considered and results in the temperature of a leaf being described as a function of incident radiation and several environmental variables. A model of photosynthesis has recently been worked out and is now in preparation for publication. The combining of the energy budget with the model for photosynthesis results in a model for productivity.

Proposed Procedure: We intend to thoroughly test our model by measuring plant photosynthesis, respiration and transpiration as a function of various environmental variables.

Test Objects and Agents: To do this we need an air-tight chamber in which to place the leaf or plant, an infrared gas analyzer to monitor CO2 concentration, a thin window geiger tube for monitoring labelled CO2 concentration a water vapor guage to measure transpiration rate, and a computer to assist in reducing the data.

Results: Our preliminary approach and results were presented at Proc. International Symposium 'Productivity of Photosynthetic Systems.' Moscow, U.S.S.R. September, 1969.

Since then the model has been refined. Also application of the model to relatively simple systems, such as that of corn (where total respiration in the light is apparently zero or very close to it) has yielded encouraging results.

SUPPORTED BY U.S. Atomic Energy Commission

2.1630, STUDY OF POSSIBLE EFFECTS OF STRIP COAL MINING ON THE HYDROLOGICAL REGIMEN IN EASTERN MONTANA

W.A. VANVOAST, Montana Coll. of Min. Science, State Bur. of Mines & Geology, *Butte, Montana* 59701

This project is designed to analyze the effects of strip mining of coal on the hydrologic system including changes in water quality, artesian pressure, ground water storage and surface water runoff. The hydrologic changes due to strip mining can be both detrimental and beneficial.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1631, PLUMBISM IN MIGRATORY WATERFOWL FROM FOOD CHAIN ACCUMULATION OF LEAD

M.J. BEHAN, Univ. of Montana, School of Arts, *Missoula, Montana* 59801

Lead poisoning in migratory waterfowl has been observed for nearly 100 years, and has been attributed to the ingestion of lead shotgun pellets. This project will determine the significance of lead ingestion via the food chain as a contributor to the plumbism that has been documented. The hypothesis that the lead pellets deposited in the bottom sediments of ponds are subject to chemical changes will be tested. The lead is then absorbed and accumulated by bottom-rooted aquatic plants which form the principal food source of certain migratory waterfowl in some seasons. The lead accumulated in these plants may provide an important additional source, and in some cases may be the principal source of lead ingestion. Evidence in support of this hypothesis has been shown by the presence of lead pellets in gizzards of ducks which have succumbed to plumbism.

This hypothesis will be tested by: 1. The Collection and analysis for lead content of bottom-rooted aquatic plants from areas of known high incidence of plumbism. 2. The culture bottom-rooted aquatic plants in an aquaria designed to simulate the environmental conditions of natural pond sediments but heavily impregnated with fine Pb pellets or Pb powder to determine whether lead can be absorbed by these plants from this source. 3. If lead can be detected in these artificially cultured aquatic plants, feeding experiments will be conducted to determine whether plumbism can be induced when lead is supplied solely as that in these artificially grown plants.

Results of this research may suggest significant alternative recommendations in the reclamation procedures now proposed for certain National Refuges of known regular occurrence of die off due to plumbism. In addition, information concerning the cycling of an important industrial pollutant will be provided.

SUPPORTED BY U.S. National Science Foundation

2.1632, AN INVESTIGATION OF THE WATER QUALITY AND PRODUCTIVITY OF POLSON BAY, FLATHEAD LAKE, MONTANA

A.R. GAUFIN, Univ. of Montana, School of Arts, *Missoula, Montana* 59801

This project is designed to determine the variability in productivity in various areas within Flathead Lake and to determine to what extent variations in productivity are due to local pollution rather than to natural variations in the aquatic environment. Ever increasing requirements for water make it extremely important that our water sources be kept in the best possible condition for human consumption and enjoyment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1633, EFFECTS OF WARM-WATER DISCHARGES ON FISH IN THE MISSOURI RIVER

L. MORRIS, State Game & Parks Commission, *Lincoln, Nebraska* 68509

This job is one part of a comprehensive study to measure various chemical, physical and biological factors of the Missouri River before and after operation of two nuclear power plants. By comparing the results of these measurements, it should be possible to determine some of the environmental effects of the warm-water discharges from the plants. In each plant river water will be diverted through the plants, and used for cooling, raising its temperature about 18 degrees F. above ambient before being released back into the river. One plant will use approximately 800 cfs of water while the other plant requires about 1440 cfs of water.

Objective: To direct and participate in field work, laboratory work, data analysis and reporting of the fishery portion of the comprehensive study.

Procedures: Field work will be initiated in July of 1970 and completed in July of 1974. In the pre-operational phase field work consists of one weeklong sampling period in each of the following months: July, September, and November of 1970; and April and July of 1971.

It is anticipated that both plants will begin operation sometime between September of 1971 and June of 1972. Field work for the post- operational phase will then begin in July of 1973 and terminate in July of 1974 with the last week of each of the following months comprising the five sampling periods: July, September, and November of 1973, April and July of 1974. 1. Insure that sufficient equipment and personnel are scheduled and available at the proper times to accomplish fish and laboratory work for the fishery portion. 2. Adjacent to each nuclear plant establish the boundaries for the use of each fish collecting device. 3. Design data sheets that will insure uniform and accurate recording of all fishery data during each collecting period. 4. Supervise and participate in actual field work on the fishery portion of the comprehensive study. 5. Coordinate the laboratory work and reporting of the fishery data.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1634, EFFECTS OF WARM-WATER DISCHARGES ON FISH IN THE MISSOURI RIVER

L. MORRIS, State Game & Parks Commission, *Lincoln, Nebraska* 68509

Procedures: Field work will be initiated in April and will continue through November. Each nuclear site will be visited once weekly and fish collections will be by boat shocking, telephone shocking, seining and hoop netting at stations above and below the power plants. Although the location of these stations is determined by the location of existing stabilization structures (pile dikes and trail dikes) none of the stations will be more than five miles above or below the entrance of warm water. In order to catch adequate numbers of fish and to maintain a constant unit of sampling effort, all samplings must be confined to the pile dikes and trail dikes.

We will establish six stations for boat shocking along the trail dikes near each nuclear site. Each station will be one-half mile in length. On each side of the river, one station will be upstream and two will be downstream of the entrance of warm water. At both nuclear sites we will establish two stations (each will encompass five pile dikes) for telephone shocking. Both stations will be on the same side of the river as the nuclear site with one upstream and one downstream of the entrance of warm water. The pile dikes at each station will be shocked once weekly with the telephone shocking device during the summer season in order to collect flathead catfish. All fish will be measured, fin- clipped in a pre-determined manner and released. A nested analysis of variance will be used to detect changes in gross numbers and possibly in abundance of some species before and after operation of the power plants.

At both nuclear sites we will establish two stations (each will encompass five pile dikes) for seining and hoop netting. Both stations will be on the same side of the river as the nuclear site with one upstream and one downstream of the entrance of warm water. By seining the sandbar downstream of each pile dike we will collect forage species (mostly cyprinids). By hoop netting in the deeper water near the pile dikes we will capture several larger species including the channel catfish. Forage will be identified, counted and released. The larger species will be measured, fin-clipped, and released.

Changes in movement patterns before and after operation of the power plants will be monitored through the recapture of marked fish.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1635, INFLUENCE OF FERTILIZER PRACTICES ON WATER AND THE QUALITY OF THE ENVIRONMENT
R.A. OLSON, Univ. of Nebraska, School of Agriculture, *Lincoln, Nebraska* 68503

The project studies the fate of applied nitrogen and phosphate with different systems of fertilizer management and with particular reference to nutrient movement from the zone of root activity. Additionally; ground, surface and rain waters of Nebraska are being analyzed and chemical character of the waters related to human and livestock densities, inherent soil properties and history of fertilizer use. Nutrient accumulations from the soil surface to the underlying water table are measured by ecological regions and in relation to topography and varied soil, water, and crop management practices.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1636, EFFECTS OF ENVIRONMENTAL STRESSES ON BEEF CATTLE
H.J. WEETH, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00303)

OBJECTIVE: Investigate water and electrolyte metabolism of dehydrated animals as a means of recommending methods for alleviating natural stress conditions. Determine water and electrolyte metabolism in animals as influenced by various inorganic salts.

APPROACH: Individually penned heifers will be offered drinking water containing various concentrations of sulfate. Experimental designs will be Latin Squares. The usual meteorological, feed consumption, water consumption and body weight observations will be taken. For renal studies urine will be collected via indwelling catheters. The effects of sulfate on glomerular filtration rate and the clearance of pertinent electrolytes will be evaluated. Hemoglobin and its metabolites will be quantitated. Where expedient laboratory rats will be used for preliminary studies.

PROGRESS. A study of the effects of sulfate-contaminated water on cattle has been initiated. In preliminary work it was found that growing rats were unaffected by 7500 ppm sodium sulfate in their drinking water. They did not develop detectable methemoglobin or sulfhemoglobin. Hereford heifers would drink little or no water containing 7500 ppm sodium sulfate, but water containing 5000 ppm was consumed. This amount (5000 ppm) of sodium sulfate in the drinking water reduced feed consumption, water consumption and growth rate. The salt induced a relative diuresis. Total hemoglobin was unaffected by sulfate-water, but the heifers developed a mild methemoglobinemia and sulfhemoglobinemia. The sulfhemoglobin was detectable for at least 2 months. These effects of drinking 5000 ppm sodium sulfate water were due to the sulfate ion.

SUPPORTED BY U.S. Dept. of Agriculture

2.1637, EFFECTS OF TEMPERATURE ON THE BEHAVIOR OF ADULT ATLANTIC MACKEREL
B.L. OLLA, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Highlands, New Jersey* 07732 (AT(49-7)3045)

We have previously established normal activity patterns of adult bluefish, Pomatomus saltatrix, held in a tank under simulated diurnal changes of light, and subsequently used norms to measure temperature effects on activity rhythms. As an extension of this work we propose to study in a similar fashion the effects of temperature on activity rhythms of adult Atlantic mackerel, Scomber scombrus, and compare the results with those for bluefish. Our intention is to gain a better understanding of the responses of different species of marine fishes to thermal stress.

Beginning at an acclimation temperature of 12-13 degrees C and under a light regimen corresponding to the natural seasonal photoperiod, temperature will be raised 0.5 degrees C per day until behavioral changes occur which indicate sublethal stress. These changes might affect, a) swimming speed, b) schooling tendency, c) variability in speed and schooling, and d) rhythmic activity. The temperature at which these changes occur will be considered the upper behavioral limit. We will continue to raise the temperature to compare these significant behavioral changes with those occurring as the ultimate upper incipient lethal level is approached. These results will establish an upper behavioral limit to temperature and describe quantitatively the subtle changes which are caused by gradually increasing temperature.

Results: Observations on a small school of 8 adult Atlantic mackerel held at an acclimation temperature of 12 degrees and under a naturally changing photoperiod, have shown that they (1) have a distinct diurnal swimming speed rhythm and (2) show greater school cohesiveness at night than during the day. Part 3 of 3.

SUPPORTED BY U.S. Atomic Energy Commission

2.1638, EFFECTS OF THERMAL ADDITIONS ON MARINE ECOSYSTEMS
J.B. PEARCE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Highlands, New Jersey* 07732 (AT(49-7)3045)

Summary of proposed work: The objective of this project is to determine the sublethal effects of thermal additions on marine ecosystems particularly communities. The lethal effects of heated discharges are reasonably well documented in scientific literature; the importance of the subtle effects of artificially heated marine waters are, however, poorly known. If future steam- and nuclear-electric plants are to be sited in an ecologically appropriate manner, subletnal effects must be well-known.

We are studying the effects of thermal additions in two dissimilar marine ecosystems; in one case we are observing the effects of a plant (Northport, Long Island) sited on the open coast of Long Island Sound. At this site there is an adequate supply of rapidly circulating, cool water. The second site is located on Barnegat Bay, New Jersey, where the circulation is restricted and ambient summer temperatures may naturally exceed 90 degrees F.

Results: Results to date: Our earlier investigations indicated that temperatures well below those which are lethal markedly affected the behavior and ecology of many marine organisms. Sublethal temperatures affected the mobility and bysal attachment of mussels and thus indirectly affected their survival under predation. We have recently observed that elevated but sublethal temperatures affect the rate of development of a marine community in Long Island Sound and probably the ultimate diversity of this community.

We are investigating the effects which elevated water temperature have on planktonic larval stages of attached and motile benthic organisms and their subsequent settling attachment, growth, survival, succession and reproduction.

Our studies in the field involve the use of artificial substrata which are placed in heated and controlled environments and periodically collected by SCUBA techniques and examined in the laboratory; the fauna associated with the substrata is fixed and preserved in a standard manner so that we can histologically assess the impact of added heat on reproductive and other tissues.

In addition, living organisms are observed in special laboratory aquaria to determine the effects of sublethal temperatures on normal patterns of behavior.

SUPPORTED BY U.S. Atomic Energy Commission

2.1639, EFFECTS OF SEWAGE SLUDGE ON FINFISH AND BENTHIC AND PLANKTONIC COMMUNITIES
J.B. PEARCE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Highlands, New Jersey* 07732

Currently 5 million cubic yards of sewage sludge per annum are dumped at a site 4.5 nautical miles SE of Ambrose light. This practice has been continuous for the past 4 decades. Effects of sewage sludge on benthic and planktonic organisms important to the economy of sport and commercial finfishes is not known. From a grid of collecting stations bounded by longitudes 73 degrees 15' W and 74 degrees 0'W and latitudes 40 degrees 10'N and 40 degrees 32'N. We are 1) using species diversity and community stability as indices for environmental well being, 2) study-

ing movements of the sludge to determine increase in area effected, and 3) measuring viral, bacterial, and heavy metal contamination of shellfish and sediments near the center of the sewage sludge dump area.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1640, BIOLOGICAL EFFECTS OF DREDGE SPOIL AND WASTE ACID DISPOSAL PRACTICES
J.B. PEARCE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Highlands, New Jersey* 07732

Since 1948, 2.5 million cubic yards/year of dilute acid and iron industrial wastes have been disposed of approximately 10 nautical miles SE of Ambrose Light. The peculiar yellow stain from these wastes can extend for over 20 miles in a north-south direction and up to 5 miles in width. The area provides excellent catches of pelagic sport fishes. We are studying planktonic communities to determine effects of these wastes on components of the food chain.

Collections obtained at various depths are to be compared with organisms from surrounding natural waters. Preliminary findings indicate smaller zooplankton populations exist inside the polluted water masses. We will determine experimentally lethal and sublethal effects of acid wastes. We will study a dredge spoil dump site 4.5 miles south of Ambrose Light employing techniques similar to the Sewer Sludge Study (2518-01).

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1641, EFFECTS OF THERMAL AND OTHER FORMS OF POLLUTION ON SOME ANADROMOUS FISHES
J.R. WESTMAN, Rutgers the State University, School of Agriculture, *New Brunswick, New Jersey* 08903

This research is divided into two parts: (1) the temperature tolerance and preference ranges of juveniles of four species of anadromous fishes will be determined. The species are: the striped bass, Roccus saxatilus, the American shad, Alosa sapidissima, the blueback herring, Alosa aestivalis, and the alewife, Alosa pseudoharengus (2) The dissolved oxygen requirements of the four species will also be measured at three water temperatures, and at two salinities in addition to 'fresh' water. Oxygen requirements will also be measured in the presence of various concentrations of petroleum products, of ammonia, and in the presence of both.

A temperature preference tank will be employed for determining preference ranges; and oxygen reduction will be obtained by the use of nigrogen, and by helium for comparative purposes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1642, ENVIRONMENTAL FACTORS AFFECTING FISHERIES
J.R. WESTMAN, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00533)

OBJECTIVE: Obtain size, age, sex and percent repeat spawners of the adult shad runs in the Delaware River. Determine chief spawning and nursery areas. Determine effects of temperature on the development and survival of eggs and young. Determine effects of flow and velocity on movement of eggs. Determine oxygen and temperature requirements of the winter Flounder, Common Spearing and Northern Swellfish.

APPROACH: Sample adult shad runs each week. By observation and sampling determine spawning and nursery areas. Temperature and temperature changes and stream flow and velocity will be done experimentally at DeBruce, N.Y. Oxygen and temperature requirements for the flounder, common spearing and northern Swellfish will be conducted under controlled laboratory conditions.

PROGRESS: Striped bass, white perch and herring were studied for oxygen tolerance, avoidance of low oxygen areas, diural variation and temperature tolerance. Mortality usually appears at oxygen levels below 3 mg/l. Thermal studies included determinations of avoidance temperatures, temperatures of avoidance breakdown and death temperatures (LD 50's) of Atlantic Silversides exposed to increasing thermal gradients in our experimental gradient tank. The effects of acclimation temperature, salinity, fish size and rate of temperature change on this species thermal responses were examined. Effect of anticipated hot water discharge on fish in Barnegat Bay below reactor. Data on species composition, relative population size, and distribution of fish populations collected since 1967 will be compared to conditions after operation on stream. Relationship of nitrifying bacteria to sea water studied. Results suggest the existence of 3 different populations, namely, freshwater-adapted: Grows best in fresh water medium inhibited in 25% sea water. Tolerant: Grows in fresh water intermediate salinities and full strength seawater media. Sea Water adapted: No growth in medium containing less than approximately 5% sea water.

SUPPORTED BY New Jersey State Government - Trenton

2.1643, THE PREDICTION AND OPTIMIZATION OF STREAM RESPONSES TO POLLUTANT WASTES
R. DRESNACK, Found. for Adv. of Grad. Study, *Newark, New Jersey* 07103

The ability of the mathematical models presently used to predict the effects of pollutant loads upon the resultant stream biochemical oxygen demand (BOD) and dissolved oxygen (DO) profiles is questionable. The problem is complicated by the fact that some of the stream parameters are difficult to measure and that the mathematical models presently used do not, in many instaces, adequately describe the physical conditions they model.

In this research, a previously developed model is presented which makes use of measured BOD and DO stream values for particular loading conditions to evaluate those stream parameters which cannot be easily measured, and then uses them, in turn, to predict the effects of future loading situations. By testing selected streams, the effectiveness of the proposed mathematical model will be evaluated.

SUPPORTED BY U.S. National Science Foundation

2.1644, TEMPERATURE REGIMEN IN TIDAL WATERS
P.K. MACEWEN, Delaware River Basin Comm., *Trenton, New Jersey*

The purpose of this study is to evaluate the short term and long term effects of heated wastes in the Delaware River Estuary. A one dimensional temperature model will be developed to predict 16 effects of heated discharges on the long term temperature of the Estuary and the effects that such heated wastes and related temperature increases have on reaeration rates, organic waste assimilative capacity and the stream ecology. Available records of local agencies (Weather Bureau, U.S. Geological Survey and State Health Departments) will provide basic input for the model.

River sampling above and below heated outfalls will be conducted to determine the size and shape of areas affected by heated wastes. These data will be used to develop mixing areas to permit controlled and regulated discharge of heated wastes into the Delaware Estuary in accordance with Commission Water Quality Regulations.

SUPPORTED BY Delaware River Basin Comm. - Washington

2.1645, EVALUATION OF WATERFOWL MORTALITY FACTORS (EXCEPT HUNTING)
S. BROWNE, State Div. of Fish & Wildlife, *Albany, New York* 12226

Objectives: To appraise the effect and extent of mortality of waterfowl by agents other than hunting.

Procedure: Factors detrimental to waterfowl, such as oil, water pollution, disease and chemicals used in pesticide work, frequently cause losses or are suspected of causing losses. Under this job indications of such losses will be investigated and, if necessary, the assistance of the Department's Water Pollution Control Unit, N.Y.S. Health Department or others will be called upon to aid in determining the cause, extent and source of the trouble. Law enforcement and Regional personnel will be requested to report cases of loss, as will sportsmen's groups through the Waterfowl Committee of the Conservation Council. Specific data on the frequency of occurrence and severity of oil-

ing will be obtained from records made at certain banding stations, hunter bag-check stations, from newspaper accounts and from other sources.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1646, DYNAMIC WATER QUALITY FORECASTING AND MANAGEMENT
D.J. OCONNOR, Manhattan College, School of Engineering, *Bronx, New York* 10471

The primary purpose of this research project is to evaluate the effects of treated effluents on the quality of the receiving waters, particularly with reference to the effects of nutrient compounds on both the dissolved oxygen conditions and on the dynamics of algal systems. A time-variable water quality analysis of the Great Lakes, a preliminary analysis of the dynamics of algae systems has been formulated, and a completed study of the effects of nitrification and algal photosynthesis and respiration on the dissolved oxygen in rivers has been completed. Statistical analyses of data on waste effluents has been carried out for several representative treatment plants to provide background information on waste discharge variability. It is planned to complete the nitrification study, including denitrification and other feedback effects and to develop the time variable analysis of the phytoplankton dynamics. Verification of these models will be stressed. The time variable analysis of such parameters as river flow, waste water discharge and temperature will be further pursued, particularly with reference to seasonal treatment on advanced levels.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1647, PHYSIOLOGICAL ADAPTATION OF TWO SPECIES OF FISHES, FUNDULUS HETEROCLITUS AND SALMO GAIRDNERI, TO ALTERED WATER QUALITY PARAMETERS
E.J. MASSARO, State University of New York, School of Medicine, *Buffalo, New York* 14214

The objectives of this project are the characterization of: (a) the effects of altered water quality parameters (temperature, pH, ionic strength, light transmission and mercury content) on the development, and viability of freshwater fishes (Fundulus heteroclitus, Salmo gairdneri, Perca flavescens, Osmerus mordax) and (b) the physiological and biochemical responses of these fishes to altered water quality parameters.

In regard to the second objective, a unique biochemical or morphological phenotype resulting from a particular set of environmental conditions would function as an 'environmental fingerprint' simultaneously characterizing the nature of the environment and the organism. It may be possible to relate a particular phenotype (morphlogical, biochemical, or both) to a particular set of environmental parameters (i.e. the conditions under which the fish has developed or is living). From acquired knowledge of the viability, growth rate, reproductive capacity, etc. (i.e. the adaptability) of fishes 'tagged' in this manner, it would be possible to make predictions concerning the future history of these species in particular environmental situations. Furthermore, the development of a characteristic 'fingerprint' would serve as a sensitive indicator of incipient water pollution and function as a built-in monitor of the existing level of pollution.

Recently, I have observed extremely high concentrations of mercury (over 2 ppm) in the skeletal muscle of the yellow perch (Perca flavescens) while the American smelt (Osmerus mordax) taken from equally contaminated waters contained only 0.2 ppm. I plan to investigate the kinetics of uptake and release of mercury (as dimethyl mercury), the mechanism of its sequestration and concentration in tissues, and its effect on the development, growth rate and viability of these species (1-11).

The biochemical phenotypes of the species to be studied will be determined by well established electrophoretic, chromatographic and enzyme kinetic techniques (12-27). Tissue and environmental concentrations of mercury will be determined by neutron activation analysis and protein binding studies will be carried out employing standard equilibrium dialysis techniques (28) in conjunction with electrophoretic and chromatographic methods and isotopic analyses.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1648, THE EFFECT OF TEMPERATURE AND CHEMICAL POLLUTANTS ON THE BEHAVIOR OF SEVERAL ESTURAINE ORGANISMS
E.C. RANEY, Ichthyological Associates, *Ithaca, New York* 14850

The proposed research plan is a laboratory study to determine the limit of habitable conditions in thermal effluents for estuarine fishes and macroinvertebrates. These limits will be expressed in terms of behavioral avoidances and swimming capabilities. The study is ecologically based and will be conducted under conditions commensurate with those of the Delaware River estuary.

Seven ecologically and/or commerically important species will be tested with respect to conditions which occur in thermal effluents of nuclear generating stations. Beginning with standard static bioassays, lethal concentrations of copper, zinc, and chlorine will be determined for temperatures extending from river ambient to lethal. Lethal temperatures will also be determined for these sub-lethal concentrations of copper, zinc, and chlorine. These bioassays will establish the limits for behavioral testing.

Avoidance reactions to the interactions of sub-lethal temperatures and chemical concentrations will be conducted in a factoral design for two light levels, three salinities, and two levels of dissolved oxygen. Tests of maximum sustained swimming speeds and endurance will be conducted under the same combination of conditions.

Data acquired from these tests will then be used to formulate biological (behavioral) models of the interaction of these conditions for the species under study.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1649, EFFECT OF WATER QUALITY ON FIRST-YEAR MORTALITY OF LARGEMOUTH BASS
A.W. EIPPER, State University of New York, New York Coop. Fishery Unit, *Ithaca, New York* 14850

The objective of the proposed project is to contribute to establishment of water quality standards by determining the effects of temperature, oxygen concentration and other aspects of water quality on mortality of largemouth bass during the egg and larval stages. Information on factors affecting first-year mortality of game fish species is also essential for management of populations necessary to increase the capacity of water resources to produce food and recreation. Investigations of causes of first-year mortality conducted by the New York Cooperative Fishery Unit will be continued and expanded. Additional equipment for temperature and oxygen control and monitoring will be employed to study survival of eggs and fry at various levels of temperature and dissolved oxygen. The relationships of turbidity, pH, and alkalinity to mortality will also be evaluated. Studies of the effects of water quality on predators, kinds and quantity of food available to fry, and other ecological phenomena are also planned. After preliminary observations and monitoring in nature, mortality factors will be evaluated under controlled laboratory conditions, and attempts will then be made to determine if relationships observed in the laboratory apply in earthen ponds and natural waters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1650, BASIC RESEARCH IN THE AQUATIC ENVIRONMENT EFFECTS OF EUTROPHICATION ON PLANKTON ALGAE AND BENTHIC PLANTS COMMUNITIES
H.F. MULLIGAN, State University of New York, School of Agriculture, *Ithaca, New York* 14850

The composition of submerged and planktonic aquatic plant communities will be examined to determine the effects of different levels of enrichment over a period of 3 years. Six species of submerged aquatic plants will be established in the bottoms of twenty, one-quarter acre earthen ponds containing 200,000 gallons of water. Species selected include Potamogeton pectinatus, P. crispus, Myriophyllum exalbescans, Chara Vulgaris, Ceratophyllum demersum and Elodea canadensis. These plants have world wide distributions and commonly occur in abundance in the local aquatic plant flora.

2. WATER QUALITY

Three levels of a mixture of soluble organic and inorganic fertilizers containing nitrogen and phosphorus will be added to the water of specific ponds weekly for a period of twelve weeks during the summers of 1968 and 1969. The growth of each plant species will be observed under the different enrichment regimes. The movement of the fertilizer within the aquatic ecosystem will be followed.

By beginning with an unmodified environment and adding known quantities of enrichment material, it will be possible to isolate the effects of eutrophication on planktonic and benthic plant populations and make predictions of the effects of current cultural practices.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1651, THE EFFECTS OF ENVIRONMENTAL STRESS ON THE COMMUNITY STRUCTURE AND PRODUCTIVITY OF SALT MARSH EPIPHYTIC COMMUNITIES

J.J. LEE, City University of New York, Graduate School, *New York, New York* 10031 (AT(30-1)-3995)

We are studying the microbiota of marine salt marsh epiphytic communities in order to gain insight into the changes which take place, or could take place, as the result of radionuclide, thermal, organic, pesticide, and herbicide pollution. These studies, when correlated with energy-flow experiments and experimental manipulation of model microcosms, should assist in the interpretaton of the non-random distribution of foraminifera in nature and the adaptive processes in community structure which occur as a response to stress and resource changes. Identification of the structure-function relationships may give clues to the more effective use and management of this important marine habitat.

Results: Eleven papers were written or published on subprojects of this contract during the past year. The standing crop end ecological bases for species diversity of littoral foraminifera was studied. Radionuclides proved excellent tools to measure the feeding rates and growth of representative herbivores such as foraminifera and nematodes. The removal rates of Ca45 and Sr89,90 from coastal marine environments by calcareous foraminifera have been estimated. The rates of growth and reproduction of foraminifera and epiphytic algae in various experimental situations including stress were measured. Foraminifera have a complex position in the food web; they require large quantities of food for optimum rate and grow best on a varied diet. Marine bacteria have a metabolite essential to the growth of foraminifera which is unavailable in algal food. The carbon budget of the community is under study. The nutritional requirements of 11 representative epiphytic algae has been studied. All have heterotrophic capabilities but each species has a different nutritional pattern. The growth of 9 of 11 organisms was stimulated by either arginine or alanine.

SUPPORTED BY U.S. Atomic Energy Commission

2.1652, PHYSIOLOGICAL ECOLOGY OF MARINE NEMATODES FROM SALT MARSH EPIPHYTIC COMMUNITIES

J.L. LEE, City University of New York, School of Liberal Arts, *New York, New York* 10031

Funds from this grant support investigations of the biology of the most abundant, yet least known group of marine benthic invertebrates: free-living marine nematodes. The investigators concern themselves with an assessment of the ecological niche that these organisms occupy in shallow marine ecosystems, particularly in the epiphytic communities of estuarine macrophytes located near salt marshes. In addition nematode life histories, feeding habits, physiological habits, and relationships with other epiphytic organisms are being studied. These investigations are aimed at assessing energy flow through shallow water nematode populations, interspecific nematode competition under various conditions of environmental stress including crowding, physical stress, organic enrichment and other pollutants. The information gained from these investigations will add significantly to our knowledge of the ecology of coastal marine waters.

SUPPORTED BY U.S. National Science Foundation

2.1653, A STUDY OF BAY SCALLOP GROWTH DURING FALL, WINTER AND SPRING IN HEATED SEA WATER

R.C. BATSON, State Div. of Marine Resources, *Old Field, New York*

The objective is to determine the usefulness of heated discharge water from power stations and desalination plants in promoting bay scallop growth.

A sample of Bug Bay scallops collected in early fall will be divided into four equal subsamples. The scallops will be measured, and statistical analysis will be made to determine whether or not these subsamples are derived from the same population. If they are not from the same population, random divisions of a sample into four subsamples will be made until it is established that they are from the same population. One subsample will be placed in an aquarium receiving 34 gallons per hour of salt water at 50 degrees F., 60 degrees F., and 70 degrees F. Each week from early fall to spring, the scallops will be measured and returned to the aquaria. These measurements will be treated by analysis of variance and a test of critical differences to determine the effect of temperature on scallop growth.

At the same time that the study is going on in the laboratory aquaria, a field study will be made. Bug Bay scallops will be collected in early fall. Procedures described above will be used to make certain that the two subsamples of scallops come from the same population. These subsamples will be suspended from anchored floats. One will be placed near the heated salt water discharge at a power plant; the other will be placed nearby and in water not affected by the heated effluent. Each week the scallops will be measured and returned to the floats. The measurements will be treated statistically as previously described to determine the effect of power plant heated effluent upon scallop growth.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1654, EFFECT OF INCREASED TEMPERATURE ON CELL PROLIFERATION KINETICS OF THE GOLDFISH

H.A. JOHNSON, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

It has been shown that increased temperature shortens the lifespans of poikilotherms. The question arises as to whether this life shortening also occurs at the cellular level, i.e., whether increasing the temperature shortens the generative cycle. We have begun a study of the generative cycle of intestinal epithelium and hemopoietic tissue of the goldfish adapted to temperatures of 22 degrees, 30 degrees, 35 degrees and 38 degrees centigrade.

SUPPORTED BY U.S. Atomic Energy Commission

2.1655, TEMPERATURE AND LENGTH OF LIFE IN THE ANNUAL FISH, NOTHOBRANCHIUS GUENTHERI

A.J. ROTERMUND, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

There is evidence that alteration of environmental temperature affects the lifespan of poikilothermic organisms.

We are trying to demonstrate a life shortening in annual fish at elevated temperatures. Fish are maintained at 20 degrees, 25 degrees, and 30 degrees C. and mortality data are recorded along with causes of death when they can be determined.

SUPPORTED BY U.S. Atomic Energy Commission

2.1656, ENERGY RELATIONS IN ESTUARINE ECOSYSTEMS

R.B. WILLIAMS, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Beaufort, North Carolina* 28516 (AT(49-7)-5)

Information on the abundance, ecology, and physiology of organisms in estuarine ecosystems is necessary to construct mathematical models simulating the energy flow through the system and suitable for predicting the systems responses to environmental stresses. Knowledge of the responses of the ecosystem to man-induced stresses, such as thermal pollution, as

well as under natural conditions, is needed for the rational management of our estuarine resources. We have chosen higher plants, plankton, benthos, and fish for laboratory and field studies. These groups are important in the overall flow of energy and cycling of nutrients; yet sufficient detailed information on these groups is not available. Our field studies are conducted in the Newport River, N.C., and adjoining estuaries, and consist of describing species composition, standing crop, and ecology. Interrelations between losses of zinc 65 from fish and their metabolic rates are being sought to obtain a method for estimating the overall metabolism of fish populations in nature. Chemical composition and decay rates of estuarine plants are analyzed as an index of nutrient contribution to the estuary through degradation processes. Laboratory research will deal with the energy content, metabolism, and growth of fish, plankton, and benthos under environmental and elevated temperatures, so that ultimately we will have the information required to model natural responses and predict responses to environmental stresses.

Results: Energy requirements of zooplankton, eelgrass invertebrates, and benthos accounted for 12, 38, and 22 percent of the net plant production in the estuaries. Routine metabolism of the pinfish population in the Newport River was 11 cal./m.2/day. The greatest part of net plant production in the estuary was dissipated as microbial respiration, and decomposer production was estimated to be larger than herbivore production. This suggested the possibility of increasing the production of commercially valuable species by manipulating food chains to direct a greater energy flow into herbivores. Part 3 of 3.

SUPPORTED BY U.S. Atomic Energy Commission

2.1657, RESPONSE OF NATURAL PHYTOPLANKTON POPULATIONS TO THERMAL SHOCK

C.M. WEISS, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

The project will attempt to determine the effects of power plant operation on the primary productivity of the water used for condenser cooling. The experimental design will attempt to examine three different increases in temperature resulting from plant operating procedures, as well as effects of three lengths of discharge canal be simulation of time-temperature cooling curves. Productivity will be measured as carbon fixed per ml sample per hour using carbon 14 tagged NaHCO3. Special incubators will be used to simulate cooling rate curves as well as providing constant illumination for phytoplankton photosynthesis. Seasonal effects due to changes in phytoplankton populations will be monitored by conducting standard experiments through one full year.

SUPPORTED BY Duke Power Company - Charlotte, N.C.

2.1658, THE EFFECTS OF TEMPERATURE ENRICHMENT ON THE ECOLOGY OF STREAMS

C.M. WEISS, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

Using artificial stream channels, the effect of thermal stress will be determined by examination of changes in stream metabolism. The effect of organic waste from sewage treatment plants will simultaneously be evaluated. Varying amounts of organic and heat stress will be used to establish thresholds beyond which irreversible changes in the aquatic system take place.

Artificial stream channels will be constructed of fiberglass with bottom to be covered with natural stream materials. Water from a nearby stream will be pumped into the channels. Treated sewage will be introduced to provide organic loading. One to two days flowthrough will be set depending upon specific experimental conditions with 50% of the channel flow to be heated by diversion through a high-rate hot water heater fueled by bottled gas. The heated fraction will be discharged back to the stream and will flow out over the stream surface in a plume. Heat increments of 10, 20, and 30 degrees C above ambient temperature are planned. The stream channels will be monitored to establish thermal dispersion, oxygen level, pH, cycling of plant nutrients and die-off of index organisms. The photosynthesis--respiration function of the stream, will be determined as a function of the experimental conditions. Project start is scheduled for July 1970 with construction of the artificial streams.

SUPPORTED BY North Carolina State Government - Raleigh

2.1659, A COMPARATIVE STUDY OF THE RESPONSES OF THE AQUATIC WEEDS, ZANNICHELLIA PALUSTRIS & RUPPIA MARITIMA, TO DIFFERENT TEMPERATURES AND SALINITIES

G.J. DAVIS, East Carolina University, School of Arts, *Greenville, North Carolina* 27834

Research to determine the growth responses of two useful estuarine plants (Ruppia maritima and Zanichellia palustris) to various temperature and salinity conditions is proposed. This would involve laboratory experiments with supplementary field observations. The research should be useful in predicting the effects of thermal pollution and explaining certain field observations.

SUPPORTED BY No Formal Support Reported

2.1660, HYDROLOGY OF THE CRYSTALLINE ROCK SYSTEM IN SOUTHEASTERN STATES

H.E. LEGRAND, U.S. Dept. of the Interior, Geological Survey, *Raleigh, North Carolina*

To determine relationship between the geohydrologic factors and occurrence and movement of water in crystalline rocks in unglaciated areas in Piedmont and Blue Ridge Provinces between Maryland and Alabama. Particular attention is being given to the factors governing the yields of wells in these rocks and to factors relating to ground- water contamination in the region.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1661, ESTUARINE ECOSYSTEMS AND HIGH TEMPERATURES

J.E. HOBBIE, Univ. of North Carolina, Graduate School, *Raleigh, North Carolina* 27607

Estuarine microcosms will be set up in 4,000 gallon pools and maintained 5 degrees C above controls. Both flowing and standing water systems will be tested with each experiment lasting 3 months. The following observations will be made throughout each experiment: phosphate, nitrate, pH, total alkalinity, particulate carbon, salinity, respiration and photosynthesis of the whole community. At the end of experiments, measurements will be made of the survival or replacement of varies species, the growth of shellfish, the biomass of algae, growth of rooted aquatics, and size and weight of fish. The object of the research is to test whether or not this approach can be used to examine the effects of nuclear power effluents in the estuary

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1662, BIOLOGY OF AQUATIC HETEROTROPHIC BACTERIA AS AFFECTED BY PHOSPHATE MINING IN AN ESTUARY

J.E. HOBBIE, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03279)

OBJECTIVE: Study the ecology of the Pamlico River so that changes due to phosphate mining may be quantified and long-term predictions made.

APPROACH: Add differing amounts of a substrate, such as glucose-C, to a series of subsamples from natural water. After incubation, the plankton is filtered and the activity is counted. Respired CO(2) may be trapped in a basic amine and counted by liquid scintillation. The concentration of natural substrate is measured by standard chemical techniques. Laboratory bioassays of effects of various pollutants on common estuarine organisms will use variables such as temperature, salinity, phosphate, nitrate, and fluoride concentrations.

PROGRESS: The amount of nitrate nitrogen entering the Pamlico River Estuary has been measured at 30 stations over 5 months bi-weekly. The concentrations were 20-50 times higher than the usual found in estuaries. It is likely that the source is both sewage treatment plants and farm fertilization. Where the excess nitrogen mixed with high amounts of phosphate from mining operations, there was growth of phytoplankton as indicated by oxygen and pH measurements. Because there are no regulations about these levels of nitrogen and because the amount of agricul-

tural fertilization and domestic sewage will increase many fold in the next decade or so, this finding must be regarded as the first signs of pollution in the estuaries. If continued, the valuable fishing and recreation industries would be seriously damaged.

SUPPORTED BY U.S. Dept. of Agriculture

2.1663, PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA

G.C. MILLER, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03291)

OBJECTIVE: Study the ecology and life histories of parasites in our native fresh-water fishes, especially those of economic importance and their possible relationship to man and his domesticated animals.

APPROACH: Host animals from various parts of the state will be collected and studied for the prevalence of parasitism. These host fishes will be collected by the use of setpoles, trotlines traps, angling, netting and seining. In addition, some hosts may be obtained from the North Carolina Wildlife Commission and the North Carolina Cooperative Fishery Unit. Fishes from lakes, ponds, and streams will be examined to study the effect of environmental influences on parasite burden in the host. Some smaller, non-game fishes are directly implicated in the life histories of parasites of some economically important hosts. Parasitic helminths, leeches, and copepods will be the primary organisms investigated but protozoans also may be included if they show significant parasitism.

PROGRESS: This project was just initiated in October, 1969 and therefore there is little to be reported at this time. Contacts were established with fishery biologists at Lake Norman and at Kerr Scott Lake. Samples of various species of fishes were surveyed from both lakes to determine the incidence and types of parasites in these hosts. Lake Norman especially offers some unique possibilities. The presence of the Duke Power Plant and its associated thermal 'pollution,' or rather thermal effects, offers an opportunity to study these effects on the parasitic fauna as compared with other parts of the lake and other comparable lakes. Studies have been initiated in this direction. Small samples of fishes from ponds and streams have been surveyed for parasites since it is our intention to identify and determine the importance of these parasites in fresh-water fishes in North Carolina.

SUPPORTED BY U.S. Dept. of Agriculture

2.1664, ENVIRONMENTAL EFFECTS OF COASTAL ZONE POWER GENERATION

D.A. ADAMS, Coastal Zone Resources Corp., *Wilmington, North Carolina* 28401

The contract provides for consulting services and such other assistance as Carolina Power and Light Company may request in the area of: 1. Environmental effects from coastal power generator installations. 2. Coordination and negotiation of environment related issues involving the company and Federal and State permit granting agencies. 3. Such other advice and consultations on ecological and environmental matters as Carolina Power and Light Company may desire.

SUPPORTED BY Carolina Power & Light Co. - Raleigh, N.C.

2.1665, EFFECTS OF SUGAR REFINING LAGOON EFFLUENTS ON BIOLOGICAL, PHYSICAL, AND CHEMICAL PROPERTIES OF FARGO CLAY

B.R. FUNKE, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103

The proposed research plan involves use of soil columns and greenhouse experiments to determine the effects of applying sugar refinery lagoon effluents to Fargo clay. The chief objectives of the investigations will be to: 1. Determine any changes in the ability of Fargo clay to allow infiltration of sugar lagoon effluents, for example, slowing due to clogging from biological or other causes. 2. Determine the effectiveness of Fargo clay in eliminating biologically degradable components of these wastes. 3. Determine effect of such wastes on selected chemical properties of Fargo clay. 4. Determine the practicality of cropping soils treated with such lagoon effluents with various types of plants.

The methods to be used would involve application of liquid wastes to soil columns of Fargo clay, both cropped and uncropped, and determining any changes in infiltration rates. Tests would be aimed at correlating any clogging with biological accumulations and physical and chemical changes in the soil. The continuing effectiveness of the soil in purifying the wastes would be determined by testing for changes in Biological Oxygen Demand and Chemical Oxygen Demand. Greenhouse pot experiments would determine effects of waste applications on growth of various plants.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1666, EFFECTS OF SUGAR REFINING LOGOON EFFLUENTS ON FARGO CLAY

B.R. FUNKE, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-S-08-003)

OBJECTIVE: Determine the feasibility of disposing of sugar refinery effluents by spreading on Fargo clay soil.

APPROACH: Rate of infiltration of sugar refinery effluents thru soil lysimeters. Tests for possible biological origins of clogging effects. Changes of BOD after infiltration of soil. Effects on various soil chemical constituents. Investigation of types of cropping possible on soils receiving sugar refinery effluents.

PROGRESS: Infiltration rates were very slow but no significant short term clogging attributable to effluents noted. No significant difference noted between growth of alfalfa or soybeans treated with effluent or distilled water. Sudan grass did slightly better with effluent, barley did much better. Alfalfa disposed of the most water by transpiration (three successive croppings), Sudan grass slightly less (two croppings). Soybeans good but only one crop, barley poor. Comparisons of soil lysimeters treated with effluent and with distilled water showed: electrical conductivity doubled, calcium, magnesium, potassium, increased somewhat but no cause for immediate concern. Sodium increased substantially but still below level of immediate concern. Soil lysimeters treated with effluent and distilled water respectively showed: no difference in carbon:nitrogen ratio (13:1) or nitrate levels; phosphorous levels increased slightly; no change in pH with water, increase from 6.5 to 7.5 with effluent. Tests with respirometers showed rapid metabolism of organic matter in effluent when applied to soil. Metabolic activity very high, subsiding to normal soil levels in 3-4 hours.

SUPPORTED BY North Dakota State Government

2.1667, DISTRIBUTION AND ECOLOGY OF RIVER MOLLUSKS IN CENTRAL AND WESTERN NORTH DAKOTA

A.M. CVANCARA, Univ. of North Dakota, Graduate School, *Grand Forks, North Dakota* 58201

This investigation has two objectives, 1) to determine the distribution and ecology of mollusks in the rivers of central and western North Dakota, and 2) to determine the effects of water pollution in the rivers of this area as indicated by these mollusks.

This study is to be initiated and completed before natural drainages are altered by the Garrison Diversion Unit of the Missouri River Basin Project. The diversion project will effectively mix the waters of the Missouri River and Hudson Bay Drainage basins.

Ecologic factors affecting mollusk distribution, once known, can be further evaluated by ecologic impact studies after the natural drainages are altered physically or by possible water pollution. Also, present ecologic data can be related to paleoecological conditions of Pleistocene mollusks. Distribution data of the mussels may be applied to tracing former stream confluence in central and western North Dakota.

Numerous sampling stations will be established on each river system, with at least five stations on each minor tributary. At each station, all species of mollusks will be collected and their relative abundance estimated. Light penetration, turbidity, water temperature, dissolved oxygen, alkalinity, hardness, chloride content, nitrate and nitrite content, pH, and other factors will also be analyzed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1668, FISH OPERCULAR RESPONSE TO ENVIRONMENTAL VARIABLES

W.A. SPOOR, Univ. of Cincinnati, Graduate School, *Cincinnati, Ohio* 45221

To define water quality favorable for aquatic organisms it is necessary to know for each environmental component the range over which its concentration or intensity may vary without adverse effects, and how any one component is related to the rest within their permissible ranges, not only directly, but also indirectly through their effects on the organisms. Relatively little of the literature on the effects of various agents on aquatic life is germane to water quality criteria at present; the major deficiencies are (1) the tests have been acute, with endpoints (usually death) too crude to be relevant to life history and productivity, (2) the effects of combinations of environmental components have received relatively little attention, (3) few species have been tested extensively, and (4) even a few have been studied at more than one or two stages of the life cycle. My research objectives are to help correct these deficiencies by using opercular movements* to detect and measure a fish's responses to changes in dissolved oxygen concentration, carbon dioxide and temperature varied alone and in combination. These three will be studied first because of their primary importance. The goldfish and the fathead minnow will be tested to begin with, the former because of its relatively slow opercular movements and because of the numerous papers on goldfish, the latter because it may be possible to relate short-term tests on opercular rate to long-term tests on life-history now being conducted at the Fish Toxicology Laboratory at Newton, Ohio. The study will include, also, an attempt to develop an improved method for measuring free carbon dioxide in water.

*The sensitivity and utility of the opercular response have been known for many years, but until recently technical problems have discouraged its use. Now that the frequency (and probably the amplitude) can be detected and recorded electrically without disturbing or damaging the fish, the technical problems seem to have been solved.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1669, TOXICITY OF SELECTED METALS TO CONDITIONED FISH

F.W. WEIR, Ohio State University, School of Medicine, *Columbus, Ohio* 43210

The concentrations of copper, zinc, cadmium, and malathion which impair conditioned responses of fish after short-term exposure will be compared with the concentrations which produce deleterious effects on the life cycle of fish after chronic exposures. Research will begin June, 1970, and is expected to continue through May, 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1670, HYDROLOGIC INFLUENCES OF STRIP MINING, BEAVER CREEK, KENTUCKY

F.F. SCHRADER, U.S. Dept. of the Interior, Geological Survey, *Columbus, Ohio* 43212

The purpose of this study is to determine the effect of strip mining for coal on the soil, water, and other natural resources. The main study area consists of two small stream basins in the headwaters of Beaver Creek tributary to Cumberland River in McCreary County, Kentucky. The study area includes one watershed in a natural state and the adjacent watershed which has been extensively strip mined.

Strip mining is a common operation in large areas of Kentucky and adjacent states. It is important to all phases of water development in the Appalachia Region to know the effects of strip-mining on the hydrologic system. This study is designed to determine both the nature and the magnitude of the effects.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1671, THE DETERMINATION OF GROUND WATER INFILTRATION & THE EFFECTS OF INTERNAL CHEMICAL SEALING OF SANITARY SEWERS

G.E. CRONK, Montgomery Co. Bd. of Comrs., *Dayton, Ohio* 45401

We wish to determine the effect of a rising water table on defective main line sanitary sewers in combination with sewer services with probable interior house basement drains connected to sewer service. It is proposed to construct small diameter observation wells adjacent to sanitary sewers and to monitor elevation of water table with relation to invert line of sanitary sewer for long periods of time in all types weather. Test section would be about one mile long. It is proposed to expose and observe flow of some service pipes for basement houses. Construction of this phase of work is to be done by contract and observations will be done by our Consulting Engineers. Test section will be cleaned and inspected by television equipment operated by our personnel to determine condition of sewer pipes. Based on findings, we will make repairs using internal chemical sealing methods, both pressure grouting and liquid sealers. Lines will be inspected after sealing program to determine physical effects on sewer. Discharge from test section of sanitary sewers will be gauged so quantities of flow can be determined at all times, both prior to work during inclement weather and after program has been completed.

Elevation of water table and flow in sewer will be monitored during period of study. This should result in data which will show amount of benefit of process as sections of sewer are sealed. This effect should be able to be noted between sections of sewer under water table conditions and under dry conditions.

Hopefully, a byproduct of study will be data showing how sewage flow is affected in a basement home with interior foundation drains connected to cellar drains. Such information should support the County's position in further attempts to alter local building codes which permit this practice.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1672, THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE IN LAKE ERIE

V.C. APPLEGATE, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Sandusky, Ohio* 44870

The recent decline of walleye stocks in Lake Erie following a man- induced acceleration of the eutrophic process in the lake demands investigation of the many environmental factors which might influence the survival of young walleyes. Temperature monitoring stations were established on three known walleye spawning grounds (reefs) in the Western basin; with the object of determining the effect of temperature regimes during spawning and fry development in the success of walleye hatches. These records will also be used to determine the effects of temperature on the timing and abundance of food organisms that may be essential to the survival of walleye fry when they first begin feeding.

In addition, automatic devices for the regular and periodic sampling of plankton organisms on the reefs have been devised and incorporated into this study. Qualitative and quantitative examination of these samples will be compared with the planktonic diet of fry captured during their first weeks after hatching.

The temperature study which was started in 1963 will be continued through 1969, at which time sufficient data will have been collected to indicate the relationship, if any, between temperature variance and the success of hatch and survival of walleye fry. Temperature data from the thermograph tapes have been plotted through 1967.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1673, SUBLETHAL INFLUENCE OF POLLUTANTS ON FISH METABOLISM

J.J. OHARA, Central State University, Graduate School, *Wilberforce, Ohio* 45384

Metabolic alterations due to the presence of copper ions are being investigated for a range of concentrations from lethal to a level of no effect.

Fish are tested in a sealed controlled environment chamber using recycled water. Response to the toxicant is determined using oxygen uptake as the metabolic indicator. This is monitered through an oxygen meter built into the system.

Oxygen uptake is probably the most sensitive measure of metabolic alterations and these kits provide data on toxicity, recovery periods and levels of no effect for bluegill sunfish.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1674, COMPARISON OF ENERGY FLOW PARAMETERS OF MIDGE POPULATIONS IN BIOLOGICAL OXIDATION PONDS

J.L. WILHM, Okla. St. Univ., Graduate School, *Stillwater, Oklahoma* 74075

The proposed research involves a study of the effects of pollution on the flow of energy through populations of midge larvae (bloodworms). Midge larvae are extremely abundant in enriched areas and have a pronounced effect on the ecosystem. The experimental area is a series of 10 biological oxidation ponds which are the terminal treatment of effluent from an oil refinery in Ponca City, Oklahoma. Thus, it will be possible to compare bioenergetics of the populations under varying degrees of pollution.

The procedure includes the following: 1) Measure energy content in the diet items, in the standing crop of the different instar stages of bloodworms, and in the major predators of the bloodworms in four of the series of 10 ponds. 2) Measure aerobic respiration rates in the different instar stages of bloodworms inhabiting the different ponds. 3) With the data accumulated in the study and in a concomitant study of bloodworm populations, construct energy flow models for the bloodworm populations living under different levels of environmental stress. 4) Discern variations in water quality as reflected in energy flow and in ecological ratios in bloodworm populations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1675, COMPUTER SIMULATION OF EUTKOPHICATION

D.A. BELLA, Oregon State University, School of Engineering, *Corvallis, Oregon* 97331 (C-1819)

The Project seeks to develop digital computer simulation methods of eutrophication in lakes, rivers and estuaries. The methods will include algal growth, nutrient regeneration, predator removal, mixing and other factors which influence algal population dynamics.

The study will begin with an examination of different growth models. Satisfactory growth models will then be combined into food chain models. Models will then be expanded to include the effects of mixing and water movement. Comparisons to existing experimental data will be made throughout the study. Through these models the interrelationships between the numerous factors influencing algal growth will be studied. The sensitivity of assumptions made will be tested. Methods of simulating alternate abatement measures will be developed and studied.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1676, EFFECTS OF CHEMICALLY AND BIOLOGICALLY MODIFIED PULPING EFFLUENTS ON THE PRODUCTION OF FISH

R.O. BLOSSER, Oregon State University, School of Engineering, *Corvallis, Oregon* 97331

To determine whether various chemical and biological modifications of pulp mill effluent are effective in reducing their toxicity to finned fish.

Progress to Date: The effect of biological modifications of kraft effluents on short term acute toxicity has been initiated. This work will be expanded to include detailed characterization of other effluents and assessment of biological and chemical modification on short term acute toxicity and productivity of finned fish.

SUPPORTED BY Oregon State Government

2.1677, CONTROLLING THERMAL POLLUTION IN SMALL STREAMS

G.W. BROWN, Oregon State University, School of Forestry, *Corvallis, Oregon* 97331

(1) Relate density and composition of streamside vegetation to the energy budget of forest streams, (2) using the information from the first objective, relate vegetation density and species to stream temperature changes and (3) prepare a vegetative model for use by foresters to aid them in manipulating stream-side vegetation when preparing plans for logging near streams.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1678, PULP MILL EFFLUENT DISPOSAL

F.J. BURGESS, Oregon State University, School of Engineering, *Corvallis, Oregon* 97331

Research will be conducted on predicting the effects of kraft mill waste disposal in the ocean on the marine environment. A remote sensing system and aerial photography will be utilized to estimate waste concentrations, water currents, diffusion coefficients, and vertical waste concentration profiles in an ocean outfall plume. Aerial photography will be taken with a multispectral camera system of the waste field. Boat sampling will be conducted at the same time to provide 'ground truth' data. Data will be compiled and analyzed by a system of computer analysis which was developed for this purpose in 1968-69.

The investigation will include several kraft mill outfalls along the Oregon coast. Results of bioassays and chemical analyses will be related to photographic imagery. Zones of water quality influence about existing outfalls and proposed outfalls will be estimated, and diffusion coefficients will be estimated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1679, LITERATURE RESEARCH ON WATER QUALITY REQUIREMENTS AND TOXICOLOGY OF FISHES

P. DOUDOROFF, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Annotated bibliographies and copies of all obtainable materials (literature) on recent advances in fish toxicology relating to water pollution in the Soviet Union (USSR), the toxicity to freshwater and marine fishes of simple and complex cyanides, ammonia and ammonium compounds, sulfides, and carbon dioxide (world literature), and the dissolved oxygen requirements of marine fishes (world literature) are to be assembled and some of the collected materials studied and abstracted. This is to be the first phase of a proposed, continuing literature research project, being preliminary to the planned preparation of detailed, critical reviews of the literature on the above subjects, which should be useful in connection with future development or refinement of water quality criteria for the protection of fisheries and in the planning of further experimental research.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1680, HYDROLOGY OF SMALL MOUNTAIN STREAMS

J.T. KRYGIER, Oregon State University, School of Forestry, *Corvallis, Oregon* 97331 (ORE-F-00850)

OBJECTIVE: Determine the significance of logging and road building on streamflow.

APPROACH: Five watersheds under 130 acres each have been gauged since 1962 and are being calibrated to a U.S. Geological Survey Control Watershed nearby. Storm flows and other characteristics are separated from the hydrographs and compared to the control data by regression techniques for periods before and after road building and logging.

PROGRESS: Effect of clearcut logging on several watersheds in the Coast Range of Oregon has been evaluated for effects on peak discharge, volume, time-to-peak, and other flow parameters. Covariance techniques were applied to control and treated watersheds before and after logging to determine if significant

changes occurred. Peak discharge was increased significantly on two clearcut watersheds. Larger increases were noted in the fall than during winter. Quick flow, delayed flow, and total flow were increased from the larger cutover. Time-to-peak was not altered. Current analysis is emphasizing roads and cutover units on Deer Creek watershed (25% clearcut).

SUPPORTED BY Oregon State Government

2.1681, IMMEDIATE EFFECTS OF LOGGING ON THE FRESHWATER ENVIRONMENT OF SALMONIDS
R.L. LANTZ, Oregon State University, State Game Commission, *Corvallis, Oregon* 97331

Objectives: 1. To measure environmental changes in salmon spawning and rearing areas during and immediately after logging. 2. To determine the influence of any environmental changes on fish populations.

Justification: This project expands current research efforts to investigate, on a long-term intensive basis, the effects of logging on salmonids in three Alsea River tributaries. Information from a larger number of streams, studied on a less intensive basis, will provide a broader sample of the effects of timber harvesting activities, eliminate the single-area content, and make the entire study more representative of conditions along the Oregon coast.

Procedures: Trained crews measure a variety of parameters on predetermined sampling schedules one year before and one year after logging occurs. Parameters monitored include dissolved oxygen content of surface and intragravel waters, water temperature, streamflow levels, gravel compositon, pH, and fish population estimates. Specific sampling units have been established on twelve coastal streams. To date, prelogging information has been collected on all of the streams. Post- logging data has been collected on four streams.

SUPPORTED BY Oregon State Government

2.1682, MARINE FISHERIES - ESTUARINE ALGAL COMMUNITIES
C.D. MCINTIRE, Oregon State University, School of Science, *Corvallis, Oregon* 97331

The research and training is concerned with the physiological ecology of benthic algal communities and the interrelationship with animals of commercial importance.

Field data on the structure, i.e.species composition and relative abundance, and on the production of benthic diatom communities has been obtained for over a 12 month period from the Yaquina estuary. Much of this data has been analyzed relative to light intensity, salinity and desiccation resulting from tidal cycles. A manuscript will soon be submitted for publication.

The model laboratory ecosystem, located at the OSU Marine Science Center, has provided information on the structure and productivity of benthic algal communities. Experimental data concerning light intensity and desiccation has provided baseline information used for analysis of changes in community structure and productivity under the effects of reduced salinity or heated water. The results of these experiments were, briefly, productivity increased when freshwater or heated seawater were introduced into a marine environment. But, the species diversity (number and relative abundance) decreased, which often leads to a very unstable community. Generally, instability will damage the food chain structure and may place great stress on the feeding habits of commercially important animals. Barry Wulff, the trainee, has performed the laboratory experiments and his Ph.D. thesis will be completed in August, 1970.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1683, PHYSICAL FACTORS AFFECTING OREGON COASTAL POLLUTION
V.T. NEAL, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

The central aim of this research is to provide information on and understanding of the physical factors that will control the pollution of certain Oregon coastal areas. These physical factors are primarily circulation and water density distribution (therefore salinity and temperature) in the nearshore region and the tidal regime in and near the mouths of estuaries. Dissolved oxygen will also be an important factor in determining 'safe' pollution levels. Therefore these factors will be measured and their variability determined at selected places.

The time variability of these factors will be determined as a function of seasonal and meteorological conditions.

All data forthcoming from this project will be made available immediately to the Pacific Northwest Water Laboratory at Corvallis, Oregon. Since the knowledge to be gained by this project is needed by that agency, the planning and operation of this program will be arranged in close cooperation with the personnel of that agency.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1684, RELATIONSHIP OF AQUATIC FLORA TO WATER QUALITY AND POLLUTION
H.K. PHINNEY, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00275)

OBJECTIVE: Establish a continuing research program concerning the relation of aquatic flora to the quality of water supplies and water pollution. Determine by biological studies of aquatic habitats, the relation between biotic and edaphic factors that are responsible for changes in the quality of water resources. Coordinate and extend studies presently conducted in the general area of aquatic botany.

APPROACH: Study of the structure of natural aquatic communities existing under varying degrees of pollution. Field and laboratory studies of the metabolic status of these communities. Development of simplified communities under controlled laboratory condition in artificial ecosystems. By use of information obtained in approaches 1-3 the structure of communities of aquatic plants and their metabolic status can be related to variations in individual ecological factors and to human activity.

PROGRESS: Projects brought to completion: (a) The culture of planktonic algae from Yaquina Estuary and the suitability as food for larval shellfish. Two manuscripts are in preparation. (b) The effects of kraft process mill wastes on benthic algae in laboratory stream. Manuscript in preparation. (c) Ecology of benthic microalgae of estuarine intertidal sediments. Manuscript in preparation. Projects to be completed by July 1, 1970: (a) Distribution of benthic microalgae in Yaquina Estuary in relation to season, temperature and salinity. New projects undertaken: (a) The effects of kraft process mill wastes on benthic algae in controlled flow streams. (b) The control of distribution of intertidal algae by biological interactions.

SUPPORTED BY Oregon State Government

2.1685, EFFECTS OF PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH
C.E. WARREN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331

This is Phase II of an investigation directed toward determining the highest concentrations of untreated and biologically stabilized kraft mill effluents which, either by direct effects on salmon and trout or by indirect effects through their food chains, will not reduce their production in receiving waters. Research under Phase I of this investigation has established the concentrations of such effluents which just begin to affect the growth of salmon in aquaria and the concentrations which under different conditions in laboratory stream communities may begin to be deleterious to production of these fish. Phase II of this investigation is to extend the research to conditions more nearly resembling those in receiving waters. For this purpose, large experimental stream channels have been constructed at the site of a kraft mill. Here in long-term experiments, we intend to establish those concentrations of untreated and biologically stabilized kraft mill effluents, which either by direct effects on salmon and trout or by effects on their food chains, can be expected to reduce the production of these fish in nature. Phase II research initiated July 1, 1969 for a period of three years.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1686, ECOLOGICAL STUDIES OF AN EXPERIMENTAL STREAM

C.E. WARREN, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Changes in streams, whether due to natural causes or the activities of man, bring about changes in the pathways by which energy from its various sources reaches organisms of interest to man. For about twenty years, biologists have been studying the pathways of energy transfer and efficiencies with which energy is transferred through aquatic communities. Because of the complexity of most biological communities, these studies have not progressed far. Nevertheless, certain of the approaches and methods that have been used in such studies have promising application in the solution of water pollution problems. The general objectives for our studies are (1) to identify key relationships between important organisms and their environments and determine how these are affected by pollutional changes, and (2) to find or develop and test practical approaches, parameters, and methods for utilizing these relationships in the solution of water poliution problems.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1687, EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH

C.E. WARREN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00781)

OBJECTIVE: Determine the influence of biologically treated and biologically stabilized pulp mill effluents on the food habits, food comsumption, growth and production of salmonids and on biological communities in laboratory streams, experimental streams, channels and in nature.

APPROACH: Laboratory studies on the influence of these effluents on the growth of fish provided known food rations will make it possible to determine to what extent changes in growth and production of fish in laboratory streams, in controlled experimental streams, and in rivers are due to direct effects of the effluents on the fish themselves. Studies on the influence of effluents on the food consumption, growth, and production of fish and on the organisms comprising the food chain of these fish in simplified communities in laboratory streams will provide knowledge of not only the direct but the indirect effects these effluents are likely to have on fish production. Studies on a much larger scale in controlled experimental streams will provide knowledge of the effects of effluents on fish production in biological systems that are more nearly natural. Finally, studies on rivers receiving kraft mill effluents will provide necessary information for the design and interpretation of the other studies as well as information that will be necessary to define and solve actual problems concerning the influence of effluents on fish production.

PROGRESS: Kraft mill effluents, both untreated and biologically stabilized, can have a direct effect on the growth of juvenile chinook salmon fed in aquaria at final BOD levels between 0.5 and 1.0 mg/l and above. There are, however, differences being either more or less toxic than this. Both untreated and biologically stabilized kraft mill effluents can reduce the production of juvenile chinook salmon in laboratory stream communities when introduced at a rate of 1.5 percent by volume, even though this results in BOD levels of 0.3 mg/l for the treated effluent as compared to 3.0 mg/l for the untreated effluent. Some of the toxic substances present in the effluents must not be reduced by biological stabilization in proportion to BOD.

SUPPORTED BY Oregon State Government

2.1688, EFFECTS OF LOGGING ON SALMON POPULATIONS IN COASTAL STREAMS

J.D. HALL, State Fish Commission, *Portland, Oregon* 97201

This segment of research is part of the Alsea Watershed Study, designed to determine the effects of Douglas-fir logging practices on the physical and biotic resources in small coastal watersheds. The objective of the research covered in this project is to determine the effects of two patterns of timber harvest (complete clear-cut versus patch-cut) on the abundance of coho salmon in coastal streams. The work funded by this project is concerned primarily with analysis, interpretation, and publication of results of the study.

In fiscal year 1971 there exists an unusual opportunity to study factors affecting downstream migration of newly emerged fry and the effects of logging on carrying capacity of headwater streams. There was a very small adult run into the study streams in the past winter. Therefore, it will be possible to carefully monitor the distribution of these fish and contrast their migratory patterns in logged and unlogged streams.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1689, AN EXPANDED PROGRAM OF RESEARCH IN FRESHWATER ECOLOGY

UNKNOWN, Acad. of Nat. Sci. of Phila., *Philadelphia, Pennsylvania* 19103

An expanded research program is being undertaken, focused on the structure of natural aquatic communities and the flow of energy through them. This should lead to better means of determining the effects of specific pollutants and of learning how different aquatic communities can be managed so as to resist or neutralize pollutants. Moreover, it appears that qualitative comparisons may be made between aquatic communities and other types of collectivity, even human; there is thus the possibility that useful analogies regarding energy flow and psychobiological environmental quality, applicable to the urban environment, may be drawn from the results of these studies.

SUPPORTED BY Rockefeller Foundation - New York, N.Y.

2.1690, CYTOPATHOLOGY IN FISH EXPOSED TO STREAM POLLUTANTS

A. ANTHONY, Penn. State University, School of Science, *University Park, Pennsylvania* 16802

The major focus of this project is on histochemical and histophysiological consequences of acid exposure on gills, blood, liver and other organs of representative species of native Pennsylvania fish. One of the important practical objectives is the development and evaluation of short term methods of predicting what constitutes a safe level of a specified stream pollutant using quantitative histochemical bioassay procedures. Laboratory and field experiments will be conducted using subacute (1 mo) and acute (4-7 d) exposures. Comparisons will be made on hatchery-bred and native brook trout. Laboratory tests will involve the use of a gravity-flow diluter system with automated pH regulation and field tests will entail maintaining fish in enclosure pens placed in streams rated as good, marginal and poor with respect to mine acid pollution.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1691, FISH AND FOOD ORGANISMS IN MINE ACID WATERS OF PENNSYLVANIA

R.L. BUTLER, Penn. State University, State Coop. Fishery Unit, *University Park, Pennsylvania* 16802

The objectives are: (1) Determine the species of fish and their abundance in waters exposed to different concentrations of mine acids throughout Pennsylvania and relate their distribution to total alkalinity, total acidity, pH, sulfate and specific conductance. (2) Quantify one or more behavioral responses to cover in at least two species of fish which can be used for measures of chronic toxicity within the assumed chronic pH ranges of 4.5 to 6.0. (3) Carry out similar behavioral assays with treated mine water from acid treatment plant developed under FWPCA grant WPRD-34-01-68 at Hollywood, Pennsylvania.

A 2-man crew will continue to obtain fish samples from selected streams that are exposed to mine acid conditions. Measurements will include species, number and sizes of fish, pH, total alkalinity, total acidity, total sulphate and conductivity at each site of collection. A summary analysis will be made of all collections for fish species and abundance throughout the state.

Chronic toxicity bioassays of fish species will be made on 2-hour tests of response to cover within a 40-foot stream aquarium. Statistical comparisons will be made for each species under clean, mine acid and treated water conditions.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1692, ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES)

G. FIELD, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00625)

OBJECTIVE: Determine the natural food of black fly larvae. Determine the effect of eutrophication of streams on the development of black fly larvae. Determine the faunistic relationships of black fly larvae. Establish a laboratory culture of simuliids.

APPROACH: Field studies: Locate streams in which simuliids occur. Determine parameters of the ecological system. Determine water quality. Laboratory studies: Determine adequate larval diet. Determine effects of eutrophication by nitrates and phosphates on larval dietary.

PROGRESS: A number of streams in Washington County has been surveyed and the greatest concentrations of simuliid larvae have been found in streams receiving mild organic pollution. Larvae of Simulium vittatum zett. have been found to be abundant in a stream receiving discharge from a private fish hatchery. Large populations of chironomid larvae, isopods, and amphipods are also found in the same stream. Also, there is a large biomass of aquatic weeds which may be due to the increased productivity of the stream. Large numbers of black fly larvae have also been found in waters flowing from eutrophic ponds. Larvae of Simulium decorum Walk. have been found in large numbers in streams of this nature. Preparations are under way to determine chemical and physical parameters of streams supporting heavy populations of larvae. Tests for phosphate, nitrates, total solids have been worked out.

SUPPORTED BY U.S. Dept. of Agriculture

2.1693, CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS

H.P. JEFFRIES, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

The ocean is physically stable compared with land and freshwater environments, and the medium has intimate association with the life it bathes. Consequently marine organisms have developed less complex regulatory systems than their terrestrial and aquatic counterparts. But when the ocean does change -- by natural processes or as the result of pollution -- it follows that the biotic community will also change, along with the ecosystem's ability to process waste materials. Homeostatic control at the community level is, therefore, an essential element in understanding the sea's populations, especially in coastal waters where environmental oscillations are large.

The major goal of this investigation is to identify and measure quantitatively the ways marine communities respond to ecological stress. The internal responses are measured in terms of homeostasis; the external stresses result from temperature, salinity, competition, food and pollution.

The first phase of this investigation showed that the balances of free amino acids, fatty acids and blood constituents are sensitive indicators of environmental conditions. Relationships observed in nature between external stress and internal composition are now being analyzed in the laboratory. In addition, the genetic determinants of chemical specificity will be separated from environmental influences in copepods, mollusks and fishes.

When we know the minimum stress intensities and corresponding maximum internal tolerances within which normal community composition and function are maintained, we should be able to predict the fate of populations living under various conditions of water quality.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1694, CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS

H.P. JEFFRIES, Univ. of Rhode Island, School of Oceanography, *Kingston, Rhode Island* 02881

The ocean is physically stable compared with land and freshwater environments, and the medium has intimate association with the life it bathes. Consequently marine organisms have developed less complex regulatory systems than their terrestrial and aquatic counterparts. But when the ocean does change -- by natural processes or as the result of pollution -- it follows that the biotic community will also change, along with the ecosystem's ability to process waste materials. Homeostatic control at the community level is, therefore, an essential element in understanding the sea's populations, especially in coastal waters where environmental oscillations are large.

The major goal of this investigation is to identify and measure quantitatively the ways marine communities respond to ecological stress. The internal responses are measured in terms of homeostasis; the external stressors are temperature, salinity, competition, food and pollution.

The first phase of this investigation showed that the patterns of free amino acids, fatty acids and blood constituents are sensitive indicators of environmental conditions. Relationships observed in nature are now being analyzed in the laboratory. Hard clams from polluted water have persistent patterns of abnormality. A shrimp is being used as another laboratory test organism.

When we know the natural stress intensities and internal tolerances, we should be able to predict the fate of populations living under various conditions of water quality.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1695, DEPENDENCE OF FISH ON TIDAL MARSHES

S. NIXON, Univ. of Rhode Island, School of Oceanography, *Kingston, Rhode Island* 02881

As part of a continuing effort to develop a mathematical simulation model of the physical oceanography, ecology, and economics of Narragansett Bay, a preliminary computer model will be extended to include more realistic parameters of tidal flushing, river and sewage inflows, and more complex biological interactions. An attempt will also be made to further develop the interface between ecological and economic dimensions of the model so that it may become a useful tool for long- range management of the bay.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1696, CHARACTERISTICS OF ORGANIC SUBSTANCES IN TIDAL MARSHES AND BENTHIC ENVIRONMENTS

J. QUINN, Univ. of Rhode Island, School of Oceanography, *Kingston, Rhode Island* 02881

1. To measure the contribution of organic substances from tidal marshes to the organic matter found in estuarine waters and sediments.

2. To study the equilibrium between dissolved, particulate and sedimentary organic matter.

3.To establish the trophic relationships between natural organic matter and the estuarine community and the effect of pollutants on these relationships.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1697, HEALTH EFFECTS OF TOXIC CHEMICALS WITHIN THE WATER ENVIRONMENT

A.S. ZYGMUNTOWICZ, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

Real or potential threats are posed by chemical contaminants in our drinking water supplies and certain of these are recognized to have cumulative, long-term deleterious effects, including chronic and incapacitating illnesses. The variety and complexity of such chemical contaminants are rapidly increasing. During the time that the precise health effects of such materials are being investigated, while we attempt to develop or improve our capabili-

ties to qualitate and quantitate their presence, while methodology for their removal or preclusion is under design. humans are serving as filters and accumulators for many of these substances. The potential for widespread illness is in all likelihood compounded by synergistic effects as well as reinforcement by pollutants introduced from other environmental media.

Objectives: To investigate those mechanisms of concentration of toxic chemicals within the water environment, including the biochemical and physiological implications for human health that will permit the establishment of chemical standards.

Accomplishments through FY-1970: Prior to the CWSS, the cumulative effects of cadmium, chromium, copper, and zinc on whole body glycogen, glutamic-oxalacetic transaminase, malic dehydrogenase and shell growth were measured over a 20-week period. While investigation into the biochemical mechanisms of heavy metal accumulation was carried out in shellfish, the result of this type of study may be significant in the analysis of physiological effects of toxic metals in mammalin systems exposed to environmental pollutants, their competition and binding to active sites and possible mechanisms of detoxification in the system. Data to date indicates that animal (oysters) exposed to continuous levels of cadmium (0.1 and 0.2ppm) show lower glycogen levels on the higher cadmium level than do controls. Transaminase levels appear to be slightly elevated in low cadium, while malic dehydrogenase in both cadmium concentration is significantly elevated over control values. Malic dehydrogenase activity is markedly depressed on both high and low copper levels (0.25 and 0.05 ppm). High zinc (0.2 ppm) also appears to depress transaminase activity after 9-10 weeks. Carbonic anhydrase, a zinc dependent enzyme found in many animal tissues, is active in hydrating CO2 to carbonic acid.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

2.1698, EFFECTS OF ELEVATED TEMPERATURE ON SPAWNING AND DEVELOPMENT OF FISHES

C.R. ARNOLD, U.S. Dept. of the Interior, Bureau of Sport Fish. & Wlfe., *Narragansett, Rhode Island* 02882 (AT(49-7)3045)

Fish spawning appears to be triggered by critical levels of temperature and photoperiod. For inshore marine species we plan to experiment with varying temperature and photoperiod to determine the precise rate of spawning advancement to be expected with exposure to artificially heated waters. In a graded series of temperatures we will determine the relation between development, survival and production of deformities in embryos of winter flounder, scup, tautog, and striped bass. A series of thermal shock experiments is planned for embryos held in salinities from 0.5 - 36 ppt. Experimental lots of larvae, acclimated at normal temperatures, will be exposed to a thermal shock. The behavior and subsequent development of larvae will be observed during a sufficiently long post-shock period to determine latent effects. The reproduction, survival and growth of minute forage organisms important to the diet of larval finfish will also be studied under different ambient temperatures.

Results: In early phases of the study relating thermal variations to development of marine fish eggs and larvae, eggs of scup, winter flounder and cod, subjected to temperature increases up to 8C for 1/2, 1-1/2, and 2 hour periods usually had a significant mortality prior to hatching. Part 2 of 3.

SUPPORTED BY U.S. Atomic Energy Commission

2.1699, EFFECTS OF CRUDE OILS AND THEIR EMULSIONS ON MARINE ORGANISMS

R. EISLER, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

Oil discharge at sea, especially accidental discharges by super- tankers, represent a potential threat to aquatic life. Laboratory bioassays on the acute toxicity of different grades of crude to various species of marine fishes and crustaceans are now in progress. The effect on toxicity of emulsifying or complexing the oil with various chemical agents is being investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1700, PHARMACOLOGY OF METAL POISONING IN ESTUARINE FISHES

R. EISLER, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

Pilot bioassays were conducted under laboratory conditions with mummichogs, Fundulus heteroclitus, against various metals abundant in solid wastes dumped off shore. Analyses by atomic absorption, and other methods, of mummichogs that died during exposure to high concentrations demonstrate measurable changes in elementary chemical composition. Tissues from fishes surviving sublethal exposures were also significantly different from controls in levels of one or more of the 25 metals measured. The significance of these changes in terms of enviromental stress and metabolic pathways is being studied.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1701, COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES

R. EISLER, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

Disposal of solid wastes at sea is being practiced by an increasing number of municipalities. Preliminary analysis of incompletely-ashed incinerator wastes by atomic adsorption indicates that aluminum, iron, calcium, zinc, sodium, potassium, and lead--in that order--are most abundant. Short-term bioassays with inorganic salts of these and other metals to the mummichog, Fundulus heteroclitus, are being conducted under controlled environmental conditions. Relationships between mortality, physical-chemical environment, and concentration of test metal in solution is being investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1702, EFFECT OF NITRILOTRIACETIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON

S.J. ERICKSON, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

Laboratory studies will be conducted to determine the relationship of nitrilotriacetic acid (NTA), a metal chelator, to the toxicity of metals to selected species of estuarine phytoplankton. The metals employed in this study will be those which are known metabolic toxins and are of importance from the standpoint of estuarine pollution.

The toxicity of the various metals to six species of phytoplankton will be determined in the presence of several concentrations of NTA. In addition to growth rate, C14 labeled carbon dioxide will also be employed as a parameter for determining levels of metal toxicity.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1703, EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON

J.H. GENTILE, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

The effects of petroleum and petroleum wastes upon important species of estuarine phytoplankton and zooplankton will be assessed. Assays on zooplankton will employ acute toxicity to various stages in the organisms' life history as the principal parameters. Assays on phytoplankton will involve the effects of pollutants on growth, photosynthesis, and respiration as well as mechanical effects such as cell lysis. Comparative toxicity of different types of petroleum products will be investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1704, HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES

P.P. YEVICH, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

Histopathologic studies will be conducted on various species of marine fishes after exposure to pollutants. Studies presently are being conducted on mummichogs being exposed to Cd and Pd.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1705, HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES

P.P. YEVICH, U.S. Dept. of the Interior, Federal Water Quality Admin., *West Kingston, Rhode Island* 02892

Histopathologic studies will be conducted on various species of marine invertebrates: quahogs, soft shell clams, oysters, lobsters, shrimp, blue crab, etc. after exposure to various pollutants. Studies are presently being conducted in cooperation with the Northeast Marine Health Sciences Laboratory on quahogs (Mercenaria mercenaria) which have been exposed to 0.05 and 0.025 ppm of Cu, 0.2 ppm of Zn, 0.2 and 0.1 ppm of Cd and 0.05 and 0.1 ppm of Cr.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1706, THERMAL EFFECTS IN FLOWING STREAMS

R.S. HARVEY, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801 (AT(07-2)-1)

The objective is to use laboratory streams to learn the effects of heated effluents, such as those produced by power generating plants, on the biota in natural streams receiving the thermal waters.

Organisms in reactor effluent streams are exposed to nonlethal changes in temperature, and we want to know the effects of slightly elevated temperature on the biota.

Results to date: Pilot studies are in progress to determine the optimum flow and the best design for the experimental streams. The Thermal Effects Laboratory will be erected on Upper Three Runs Creek, which will serve as a source of substrate, water and organisms for the experimental streams. Factors such as current velocity, temperature, gas and nutrient concentrations, light intensity, and turbidity will be subject to varying degrees of control.

SUPPORTED BY U.S. Atomic Energy Commission

2.1707, THERMAL EFFECTS IN RESERVOIRS (LAKES)

J.S. MARSHALL, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801 (AT(07-2)-1)

The ecological effects of hypernormal temperatures in lakes due to condenser discharges from electric power plants are important considerations in reactor siting.

The initial emphasis in this program is on the short-term effects of hypernormal water temperatures on the rates of primary plankton production and plankton community respiration. Work will then move to the long-term effects of hypernormal temperatures on species diversity and population dynamics, with emphasis on zooplankton.

Studies will be made of short-and-long-term effects of hypernormal temperatures on nonplanktonic organisms in a cooling reservoir, including periphyton, macrophytes, macro- and microinvertebrates, and possibly certain vertebrates.

Field observations will be supplemented with laboratory experiments. Experiments are designed to determine the interaction of temperature with other key variables such as light intensity and nutrient concentration.

Results to date: Measurements of the effects of elevated temperatures in the cooling reservoir on photosynthetic carbon fixation by phytoplankton showed that the results obtained during the summer of 1969 confirm those reported earlier for the winter months, in that the effect of the higher temperatures are either nil or stimulatory. No short-term inhibitory effects were found even at 36 degrees C.

SUPPORTED BY U.S. Atomic Energy Commission

2.1708, THE ECOLOGICAL EFFECTS OF THERMAL STRESS ON CERTAIN NEUROENDOCRINE-PHYSIOLOGICAL SYSTEMS OF SELECTED AQUATIC ANIMALS

A.S. TOMBES, Clemson University, School of Agriculture, *Clemson, South Carolina* 29631

This study will involve laboratory and field investigations on a vertebrate (fish) and on several invertebrates (aquatic insect larvae) to determine the impact of sub-lethal thermal stress on the organisms mediated by the neuroendocrine-physiological systems.

Field aspects will involve the determination of densities, growth rates, and seasonal positioning of life cycle stages both away from the area of heat discharge and within the area of thermal effluent. Laboratory studies will monitor the organisms' responses to specific levels and durations of thermal stress and various photoperiods. Initially the histology will be described of the neuroendocrine system. This will be followed by an experimental phase where sub-lethal levels of thermal stress will be introduced to the animals. If any specific changes occur in the neuroendocrine system they will be identified and related to the duration and time of exposure to different temperature levels and, in turn, will be correlated with possible ecological effects.

Laboratory data will be related to the possible need for improved water quality and waste disposal standards of nuclear reactors, by determining the extent to which a body of water can absorb thermally enriched effluent without influencing the lake's ecosystem beyond that level which has been determined to be ecologically and economically permissible.

Hopefully the combination of organismal and ecological levels of study will provide a bioassay surveillance or predictive system for sub- lethal thermal loads.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1709, SYNERGISTIC INTERACTIONS OF ENVIRONMENTAL FLUCTUATIONS AND SUBLETHAL CONCENTRATIONS OF POLLUTANTS IN THE FIDDLER CRAB, UCA PUGILATOR

W.B. VERNBERG, Univ. of South Carolina, Graduate School, *Columbia, South Carolina* 29208

This study is concerned with the effects of sublethal concentrations of man-made pollutants under varying environmental conditions on both larvae and adults of Uca pugilator, including both laboratory reared and field animals. Three classes of response will be monitored in the laboratory: 1) growth rate and frequency of molting; 2) metabolic response; and 3) behavior, including phototaxis, circadian or tidal rhythms of activity, swimming rate, and reproduction.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

2.1710, WATER POLLUTION INVESTIGATION, BATTLE CREEK, SOUTH DAKOTA

R.D. GLOVER, State Dept. of Game Fish & Pk., *Pierre, South Dakota* 57501

Objectives: To document the benthic fauna populations.

Procedures: The benthic fauna sampling program will be the only facet of this project which will be continued. Sampling will be conducted at previously described stations and information collected will be used to supplement existing data.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1711, EFFECTS OF DEVELOPMENT ON WATER QUALITY

M.A. CHURCHILL, U.S. Tennessee Valley Auth., Div. of Environ. Res. & Dev., *Chattanooga, Tennessee* 37401

Provide a means for predicting the quality of the water to be released through low-level outlets of proposed impoundments. A regression equation has been fitted to data collected routinely for a number of years for other purposes. This equation allows the prediction of dissolved-oxygen concentrations in the releases throughout the year. As more extensive data on water quality and on movement of water into, through, and out of reservoirs are obtained, a rational prediction equation will be developed that will apply to a wider range of conditions than does the regression equation. Techniques for predicting concentrations of iron, manganese, plankton, coliform organisms, and other properties are also sought. Means of raising dissolved-oxygen concentrations by modifying the design or operation of discharge-control structures are under evaluation.

2. WATER QUALITY

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1712, EFFECTS OF TEMPERATURE ON AQUATIC LIFE

M.A. CHURCHILL, U.S. Tennessee Valley Auth., Div. of Environ. Res. & Dev., *Chattanooga, Tennessee* 37401

Research is being conducted to provide sound technical bases for development of realistic temperature control criteria for maintenance and propagation of aquatic life. The effects of temperature on the quality and quantity of economically important species and their supporting food chain will be studied. Laboratory studies have been initiated to determine lethal temperatures for nine species of locally important fish and several fish-food organisms. It is planned to construct eight large channels simulating natural waterways. In these channels, normal biotic situations will prevail except for water temperatures. Six of the channels will contain lake water heated to maintain desired elevated temperatures. Two channels will serve as biological controls and will contain water of ambient stream temperature.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1713, EFFECTS OF IMPOUNDMENT ON WATER QUALITY

M.A. CHURCHILL, U.S. Tennessee Valley Auth., Div. of Environ. Res. & Dev., *Chattanooga, Tennessee* 37401

Problem. To develop engineering methods which can be used in planning, designing, and operating river and reservoir water control structures associated with multi-purpose water resource projects for management of water quality and quantity. The water quality management problem arises from the discharge of hypolimnetic water during periods of reservoir stratification having quality problems associated with low temperatures, low dissolved oxygen, and objectionable quantities of iron and manganese. These water quality problems are associated with low level outlets in existing and proposed water control structures.

Method. The physical, chemical, and biological factors which cause objectionable changes in water quality during periods of reservoir stratification are to be qualitatively and quantitatively assessed. The resulting knowledge is to be used to develop a model which will allow temporal and spatial changes in the water quality parameters of temperatures and dissolved oxygen to be predicted within an impoundment. This model is necessary for evaluating the effectiveness and feasibility of proposed design and operational changes to improve water quality of discharged water.

The research method has involved frequent field surveys and laboratory analyses of water quality parameters of interest over several years during stratification of reservoirs in eastern Tennessee. Data produced are being studied extensively to gain insight into the relationships between physical, chemical, and biological factors and the associated water quality changes. These relationships will then be used to develop a predictive model for changes in water quality due to impoundment.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1714, EVALUATION OF FACTORS AFFECTING SPAWNING OF DALE HOLLOW WHITE BASS

B.L. RIDLEY, Tennessee Technological Univ., School of Arts, *Cookeville, Tennessee* 38501

Objectives: Determination of spawning areas; temperature and time of year at spawning; and sex ratio at the spawning areas. An attempt will be made to assess the effects of coal mine drainage on spawning. An attempt will also be made to determine if separate spawning populations exist in Dale Hollow Reservoir.

Procedures: Spawning areas will be determined along with the time of year and the temperature at spawning time. The sex ratio at the spawning areas will be recorded. It is known that the east fork of the Obey River is used some as a spawning ground and that the east fork is polluted by coal mine drainage. An attempt will be made to determine how severe this pollution affects the spawning white bass and to determine if this is a limiting factor to their spawning. Water quality data presently being collected on the east fork by another researcher. If time permits, it will be determined if there are separate spawning populations of white bass within Dale Hollow Reservoir, and if the same fish use the same spawning grounds from year to year. This will be accomplished by fin clipping fish for future recognition upon recapture.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1715, COAL STRIP MINE WATERSHED DEMONSTRATION--JACKSON COUNTY, ALABAMA

K.J. SEIGWORTH, U.S. Tennessee Valley Auth., *Knoxville, Tennessee* 37902

The demonstration-research watershed was established in June 1968 to determine how area coal strip-mining and subsequent reclamation practices will affect the water resource and aquatic life of a small 136-acre watershed in northeast Alabama. Farco Mining Company is cooperating in the study.

Hydrologic observations include precipitation, streamflow, water temperature, and sediment. Samples for complete water-quality are being secured. In addition, ecological studies of aquatic life in and adjacent to the stream are being conducted.

The project will be conducted in three phases: (1) a calibration period of approximately two years, (2) an action phase during which about 50 percent of the watershed will be mined, and (3) a recovery period following reclamation work on the stripped areas. Current reclamation provisions included in TVA coal contracts will be reviewed in the light of data obtained from the project.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1716, NORTH FORK CITICO CREEK WATERSHED RESEARCH

P.C. SPATH, U.S. Tennessee Valley Auth., *Knoxville, Tennessee* 37902

Research established in 1960 cooperatively by TVA, U. S. Forest Service, and Tennessee State Game and Fish Commission in Cherokee National Forest to determine the effect of high-standard, multiple purpose forest management on watershed hydrology and stream biology. The well-managed, completely forested Appalachian Mountain watershed has an area of 7 square miles and ranges in elevation from 2000 to 5000 feet above sea level.

Hydrologic observations include precipitation, streamflow, air and water temperatures, relative humidity, sediment and quarterly water- quality samples for mineral analysis. Forest, soil, and hydrologic condition surveys were made. Wildlife habitat surveys will be made and browse condition and trend or change in plant species composition observed. Stream biology investigations include sampling of bottom fauna, growth rate of wild rainbow trout, and determination of fish population.

The research involves two phases. The calibration phase involves the determination of the hydrologic characteristics of the watershed under existing conditions. The second phase, called the action phase, involves determining the changes in the hydrologic characteristics of the watershed caused by the construction of access roads to selected timber cutting areas and by the cutting and removal of timber in the selected areas. The calibration phase was completed in 1965. The action phase was begun in 1966 when construction was started on an access road to the first timber sales area. Construction of this access road was completed in 1967. Timber cutting began in the spring of 1968 and was completed in the first timber sale area in the fall of 1969. A system of roads is planned for additional timber harvesting operations and to provide access to proposed areas.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1717, EFFECTS OF WATER POLLUTION ON ZOOPLANKTON

D.L. BUNTING, Univ. of Tennessee, Graduate School, *Knoxville, Tennessee* 37916

Because of the lack of information dealing with the tolerances and reproductive rates of zooplankton species in polluted waters, it is planned to 1) provide estimates of the median

tolerance limits of planktonic rotifers, cladocerans, and copepods to insecticides and toxic materials found in domestic and industrial wastes, 2) to measure the effect of sublethal concentrations of toxic wastes on the reproductive rates of natural and laboratory populations of planktonic rotifers, cladocerans, and copepods, and 3) to determine the growth patterns of several important planktonic rotifers, so that immature specimens may be segregated from adults in the egg/female/day estimates of reproduction. It is expected that the median tolerance limits based on long term studies will contribute to the study of water quality criteria. And that the knowledge of tolerances and reproductive rates along with critical study of standing crops will further the understanding of changes in community structure brought about by the addition of toxic materials to natural water.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1718, HIGH ANALYSIS FERTILIZER INVESTIGATIONS - FISHERIES
B.D. JACO, U.S. Tennessee Valley Auth., *Norris, Tennessee* 37828

A comprehensive test of the effect of high-analysis plant nutrient application on fish production, particularly sport fish reproduction and survival, in limited areas of large TVA reservoirs. This project completed; results show:

Increasing sport fishing in selected coves of a deep reservoir through application of inorganic fertilizer during one growing season does not appear to be practical. The fertilizer produced little lasting increase in nutrients in the water of the coves. Most of it presumably sank into the mud or was sluiced out of the coves.

Fertilization increases the number of bottom organisms and zooplankton but there was no significant change in numbers, size, species composition, or survival of fish. Temperature and oxygen profiles coupled with the physical characteristics (directional axis of coves in relation to main creek and cove depth and length) suggest that the age of the water may be very significant in increasing production in coves.

The exact effect of fertilizer still remains unknown since the amount of fertilizer loss to sinking and sluicing could not be measured. But one thing seems clear: the measured increase in production was due to only a small fraction of the total application.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1719, COAL STRIP MINE WATERSHED STUDY
D.H. SCANLON, U.S. Tennessee Valley Auth., Div. of For. Fish. & Wlf. Dev., *Norris, Tennessee* 37828

A watershed project to determine how coal strip mining and subsequent reclamation affects water quality and stream ecology. The 136-acre watershed under study is in Jackson County, Alabama. Over half the watershed will be stripped for coal in 1970. Hydrologic data collection began in May 1968 upon completion of the weir and project instrumentation, and will continue for two years prior to mining, during the mining operation, and for ten years after reclamation. Biologists began sampling the stream and streamside flora and fauna in February 1968, and will continue periodic measurements through life of the study to identify ecological change.

SUPPORTED BY U.S. Tennessee Valley Auth.

2.1720, THERMAL ENRICHMENT STUDIES
S.F. AUERBACH, U.S. Atomic Energy Commission, Ecological Sciences Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

The objectives of these studies is to develop a capability for predicting the impact of man-made thermal modifications to freshwater ecosystems. Operation of power reactors can affect water temperatures when surface waters are used for cooling and the use of cooling towers can affect water quality through consumptive use of water for cooling purposes which may result in a concentration of chemicals, including radionuclides, in the released water. Research will include a closely integrated program of simultaneous field and laboratory investigation related to the needs of engineering design in power plant construction and siting. The behavioral responses of fish to temperature changes will be considered as they relate to predation, migration, spawning and survival of the population. Warm water species of fish, such as largemouth bass and channel catfish and associated food organisms, will be the experimental animals.

A simultaneous effort will be the development of systems models incorporating different temperature, nutrient regimes and stresses. These models would form a basis for predicting the ecological consequences of thermal additions to various aquatic habitats. The models will also serve as a guide in the experimental studies.

Preliminary results showed that the excretion rates of Cs 137 and 65 Zn were directly related to temperature within the range of 10 to 30 C. However, the Q sub 10 law does not appear to offer a good method of extrapolating to biological half-lives at the extreme temperature ranges. Similar studies of 32P metabolism showed that the biological half-life of 32P decreased from 58 days at 9.3 C to 3.7 days at 19.3 C. Assimilation of 32P from the gut was 51 per cent at 19.3 C and 30 to 38 per cent at the lower temperatures.

SUPPORTED BY U.S. Atomic Energy Commission

2.1721, ENVIRONMENTAL QUALITY STUDY PROJECT - UTILIZATION OF WASTE HEAT
S.E. BEALL, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

The conversion of energy to produce electricity in a thermal plant results in 60-70% of the energy being dispersed to the environment, usually by direct water cooling. The goal of this work is to use an energy systems approach to attempt to utilize this waste heat and simultaneously to lessen the environmental insult of the heated water. Possible uses include urban, industrial, agricultural, and aquacultural. The latter two have more immediate promise. Urban uses are very promising in the context of new or renovated cities. Our objective is to determine whether there are economically viable uses, conditions under which they may be developed, and the enviromental consequences of such developments. We utilize prior experience gained from AEC/HUD studies at ORNL and also the work of the Middle East Study Group. Experimental work, virtually absent in the past, is expected to commence in FY 71.

Results to date: We have finished design of a facility for shrimp production and an economic study of the system as a part of a major, shore-based energy center and have completed conceptual design of a greenhouse system utilizing heated water for heating and cooling and associated economic studies. We organized a working conference on prospects for beneficial use of waste heat, attended by representatives of government, industry, utilities, and universities.

SUPPORTED BY U.S. Atomic Energy Commission

2.1722, AGING AND IMMUNE COMPETENCE-EFFECT OF ENVIRONMENT ON IMMUNE COMPETENCE
T. MAKINODAN, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

Since we began our study on aging of the immune system over ten years ago, dramatic improvements were made in the operation of animal care. Thus, by today's standard, a conventional mouse farm of a decade ago would probably be rated as a substandard farm. We do not know to what extent improvement in animal care may have influenced our earlier findings. Since studies on the effect of substandard environment on life span and immunologic activity of mice have never been made, we have undertaken this problem.

Five six-weeks old, 'specific-pathogen-free' BC3 F sub1 mice purchased from Cumberland View Farm were reared in either a conventional (clean) or a substandard (dirty) farm. The diet was the same. Those in the clean farm received clean pans twice a week and chlorinated water (16 parts per million) three times a week, and those in the dirty farm received clean pans only once a week, and tap water twice a week. The water bottles in the dirty farm were purposely contaminated with viable Salmonella and Pseudomonas soon after we initiated this project. Both primary and secondary antibody-forming capacities are being assessed.

Results: The results revealed that no significant farm effect was detected immunologically and no striking difference in the life span was noted; e.g., the median life span was comparable. These results indicate that 'specific-pathogen-free', postweaning mice can adapt themselves to a substandard environment without any long term effects on their immune system and life span. These studies are being expanded to include aged mice that were bred in their respective farms.

SUPPORTED BY U.S. Atomic Energy Commission

2.1723, ENVIRONMENTAL QUALITY STUDY PROJECT - THERMAL DISCHARGES AND EFFECTS STUDIES
M.M. YAROSH, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

Objective of this work is to develop a program of work designed to provide the basis for regulation of thermal effluents, to minimize their environmental impact by careful and improved design of inlets, outfalls and cooling towers, and to develop tools for regional planning of power plants. There is much already known about thermal discharges and aquatic effects. However there are large areas of insufficient knowledge that need to be bolstered with specific research, especially in thermal effects in the biosphere, analytical models for thermal water plumes, and wet and dry cooling tower design and meteorology. Our procedure is a combination of state-of-the-art survey, identification of needed R&D, ordering of research priorities, and experimental and theoretical studies. Results: A state-of-the-art review on atmospheric effects of cooling towers was largely completed. An evaluation of thermal baseline studies by utilities on docketed reactor sites was made. A study was undertaken of the current and projected research programs in the thermal area by approximately 200 federal and state agencies, utilities, universities, and private industries. A task force was assembled to prepare a Program Plan on Thermal Discharges and Effects (first draft due July 1970).

SUPPORTED BY U.S. Atomic Energy Commission

2.1724, THE DISTRIBUTION AND DENSITY OF MACROBENTHOS IN LAKE ARLINGTON, TEXAS
T.R. HELLIER, Univ. of Texas, Graduate School, *Arlington, Texas* 76010

It is proposed in this study to determine the qualitative and quantitative distribution of benthic invertebrates in Lake Arlington, Texas with emphasis being placed upon horizontal distribution and seasonal succession, and the possible effects of heated effluent upon the aquatic community. Collections will cover a period of at least one calendar year, thus permitting an analysis of the seasonal aspect of benthic distribution. By correlation of benthic samples with analyses of temperature, oxygen concentration, bottom type and other physicochemical characteristics, it is hoped that an understanding of temperature-related influences upon the benthic community may be developed.

SUPPORTED BY Texas Electric Service Company - Texas

2.1725, LARGEMOUTH BASS REPRODUCTION STUDY
K.W. GHOLSON, State Parks & Wildlife Dept., *Austin, Texas* 78701

Objective: To identify factors concerned with sewage effluent and hydroelectric cooling which inhibit largemouth bass reproduction.

Procedures: 1. Adult bass will be dissected and sexual development recorded along with length, weight, and other pertinent data. 2. Spawning areas will be located in Calaveras Lake, spawning activity observed, and information recorded. 3. Fertilized largemouth bass eggs will be removed from nests and incubated in the laboratory and/or state fish hatchery. These eggs and eventually produced fry will be observed for hatch-ability, development and survival. 4. Adult largemouth bass will be collected from Calaveras and Braunig Lakes and taken to a state fish hatchery and observed for spawning activity and success. 5. Monthly water temperatures will be recorded at established stations throughout the lake to establish a water temperature profile for Calaveras and Braunig Lakes. 6. During the first month of this segment, top and bottom water samples will be taken throughout the two lakes to determine water quality of the two reservoirs. Following, this, periodic samples will be collected to determine any changes which might occur in the lakes. 7. Quarterly core samples will be made at established stations to identify bottom deposits and to determine rate of desposit of organic detritus and other deposits on the bottom of the two lakes. 8. Pesticide residue analyses will be conducted on the following samples: a. Four water samples per lake monthly; b. Three bottom samples quarterly; c. Gonad, liver, and muscle tissue of four largemouth bass (2 males and 2 females) from each reservoir monthly.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1726, THE EFFECTS OF ENGINEERING PROJECTS ON THE ECOLOGY OF JONES BAY
R.B. JOHNSON, State Parks & Wildlife Dept., *Austin, Texas* 78701

Objectives: To study the ecology of Jones Bay prior to alteration and to evaluate the effects of the proposed Hitchcock extension of the Texas City Hurricane Protection Levee.

Procedures: The study will include description of the area, an analysis of bottom sediments, chemical and physical water quality, and species composition and abundance. The extent and quality of nursery habitat will be evaluated.

Representative stations will be established and sampled systematically in affected areas and in control sites. Catch per unit effort records will be maintained so that all work can be duplicated and compared. Sampling procedures will compare to those used in estuarine research by the Texas Parks and Wildlife Department and the Bureau of Commercial Fisheries Laboratory at Galveston.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1727, THE EFFECTS OF ENGINEERING PROJECTS ON THE ECOLOGY OF MOSES LAKE
R.B. JOHNSON, State Parks & Wildlife Dept., *Austin, Texas* 78701

Objectives: To study the ecology of Moses Lake and compare data accrued prior to the construction of the Texas City Hurricane Protection Levee, and to evaluate the effects of levee alterations in progress.

Procedures: The study will include description of the area, an analysis of bottom sediments, chemical and physical water quality, and species composition and abundance. The extent and quality of nursery habitat will be evaluated.

Representative stations will be established and sampled systematically in affected areas and in control sites. Catch per unit effort records will be maintained so that all work can be duplicated and compared. Sampling procedures will compare to those used in estuarine research by the Texas Parks and Wildlife Department and the Bureau of Commercial Fisheries Laboratory at Galveston.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1728, THERMAL STUDY IN WILKES RESERVOIR
J.E. TOOLE, State Parks & Wildlife Dept., *Austin, Texas* 78701

P.S. Objective: To determine the effects of hydroelectric thermal effluent on aquatic life in Wilkes Reservoir.

Procedures: All field data from previous segments will be analyzed and compiled for publication or final report as findings warrant.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1729, BOTTOM SLUDGE ACCUMULATION AND OXYGEN DEMAND IN A POLLUTED ESTUARY
R.W. HANN, Texas A & M University System, Sea Grant Program Office, *College Station, Texas* 77843

Two major components in the analysis of the water quality in an estuary are the pollutant removal rate by sedimentation and the resultant oxygen demand of the bottom deposits. This project involves a study of solids balance and the oxygen balance of an

arm of the Houston Ship Channel to develop methodology for evaluating these parameters. The study includes both field evaluation of parameters and analytical computer simulation of the phenomena taking place.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1730, HEAVY METALS AND LOCOMOTION IN FISH
H. KLEEREKOPER, Texas A & M University System, School of Science, *College Station, Texas* 77843

Locomotor behavior in response to gradients of sublethal concentrations of heavy metals in an open field situation is studied. Locomotion is monitored by means of a matrix of 2000 photocells, embedded in the floor of a tank measuring 6.0 x 6.0 x 0.6 m. The matrix is part of an electronic interface with a computer or line and data- processing equipment. Gradients of temperature, flow, and chemical conditions are controlled by feedback and servo-mechanisms. Three dimensional profiles of temperature and chemical gradients are monitored with arrays of thermistors and conductivity cells.

Velocity of locomotion, frequency distribution of angles of turns, absolute directions, distances swum, areas of preference or avoidance are computed and analyzed in relation to the gradients of copper and zinc ions in various conditions of temperature and flow.

The investigation started on July 1, 1969, was continued on July 1, 1970, and is expected to be completed by June 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1731, TOXICITY OF METALS TO MARINE PHYTOPLANKTON CULTURES
W.B. WILSON, Texas A & M University System, Graduate School, *College Station, Texas* 77843

The objectives of the proposed work are as follows: (1) Determine the acute toxicity of eight metals (V, Cr, Mo, Fe, Ni, Cu, Ag, and Hg) to cultures of three typically estuarine phytoplankton species (Cyclotella nana, Gymnodinium splendens and Isochrysis galbana) in media of various salinities; (2) Determine the acute toxicity of these metals to these organisms at five temperature levels and the interaction of temperature and salinity with the toxicity of these metals; (3) To determine whether or not organisms subjected to sub-acute toxic levels of these metals in combination with various temperatures and salinities will subsequently grow at a standard rate and determine the effects of a continuously maintained non-acutely toxic concentration of each metal to one or more of these organisms. For acute toxicity tests, it is proposed that bacteria-free and unialgal cultures of these three organisms grown in batch cultures will be subjected to various concentrations of these eight metals. The effects will be evaluated after 1, 24 and 48 hours by microscopic examination and culture enumeration. The combined effects of temperature, salinity and metals will also be evaluated by determining the C14 uptake. Chronic toxicity of metals will be evaluated in a continuous flow culture device.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1732, EFFECTS OF SELECTED POLLUTANTS ON CERTAIN GAME AND ROUGH FISH
C.E. MURPHY, Texas Christian University, Graduate School, *Fort Worth, Texas* 76129

The objectives of this project are to (1) ascertain the relative toxicity (TLm) of certain local industrial wastes for selected game and rough fish, (2) determine the influence of certain concentrations of specific industrial wastes on growth and development of selected game and rough fish, (3) gain information for computing a safe rate effluent discharge for certain industrial waste effluents.

This work will be carried out along the upper part of the Trinity River which serves as the sole avenue for transporting domestic and industrial wastes from a highly industrialized region. Initial attention will be given to effluents which bypass municipal treatment systems and are discharged directly into the river. Water samples from the river will be collected and characterized to determine the nature of the water above and below the point of waste effluent will be collected and characterized and used in TLm determinations for selected species of fish. Spawn will be exposed under the same conditions as the fish to detect effects on growth and development. All testing in the laboratory will be carried out using continuous flow systems.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1733, A STUDY OF THE EFFECTS OF DESALINATION PLANT EFFLUENTS ON MARINE BENTHIC ORGANISMS
E.F. MANDELLI, Dow Chemical Company, *Freeport, Texas* 77541

The objective of this research program is to determine the effects of increased salinities, temperatures and concentration of heavy metals, particularly copper, on the growth and survival of commercially important coastal marine benthic organisms.

Such information is of fundamental importance in the design of outfall systems fot the proper disposal of waste brine from desalination operations in coastal and estuarine areas.

The program was initiated during 1969, with long-term bioassay test (seasonal) through simulated in-situ experiments on juvenile and adult specimens of the American oyster Crassostrea virginica.

The effects of the desalting brine-cooling water mixtures are also being evaluated on early stages (eggs and larvae) of C. virginica as well as the postlarval stages of the brown and white shrimp Penaeus aztecus and P. setiferus.

SUPPORTED BY U.S. Dept. of Interior - Off. Saline Water

2.1734, STUDY OF TEMPERATURE EFFECTS IN COOLING WATER BODIES
H.C. MCKEE, Southwest Research Institute, *Houston, Texas* 77006

Ecological effects of plant cooling water in a lake and in a bay - 1967, 1968, 1969.

SUPPORTED BY No Formal Support Reported

2.1735, STUDY OF EFFECTS OF MILL WASTE WATER ON FISH LIFE
L.L. HISER, Southwest Research Institute, *San Antonio, Texas* 78228

No summary has been provided to the Science Information Exchange.

SUPPORTED BY No Formal Support Reported

2.1736, THE RELATIONSHIP OF ELECTRIC POWER STATION THERMAL CIRCULATION TO BIOLOGICAL PRODUCTIVITY OF RESERVOIRS
O.T. LIND, Baylor University, Graduate School, *Waco, Texas* 76703

The Proposed Investigation will: 1. Confirm that phytoplankton photosynthesis is reduced by the circulation process, and will relate the quantity of this reduction in a new reservoir to volume circulated, number of operating generators, time of circulation, and temperature rise. 2. Determine if the process of power plant circulation has qualitative as well as quantitative (as demonstrated in a former investigation) effects upon the photosynthetic pigments of the phytoplankton. 3. Determine if reduced photosynthesis is due to altered metabolism of individual cells or reduction of total cell number, and determine if phytoplankton diversity is reduced. 4. Determine whether reduced photosynthesis is the direct effect of temperature, as suggested by the earlier study, or to inhibition or toxicity brought on by exposure to metal ions as the water is circulated through the system. 5. Determine if degradation and recycling or organic matter is accelerated by the circulation process. 6. Determine if fish growth and production is significantly increased in the heated water, with possible application of such growth increase to fish culture.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1737, BACTERIAL ADSORPTION ON SOILS
D.W. HENDRICKS, Utah State University, Utah Water Research Laboratory, *Logan, Utah* 84321

This work will focus upon the role of adsorption, as a mechanism in bacterial retention, in the flow of bacterial suspensions through soils. The project intends to be definitive in that all of the hypothesized factors that affect bacterial adsorption will be investigated. These factors include cell concentration temperature, chemical environment, and surface activity. By understanding and quantifying the fundamental removal mechanisms, predictions of bacterial movement through soils can be made. Other mechanisms of retention which will be investigated, but in a less exhaustive treatment, include sieving, gravitational sedimentation, and several other possibilities.

Such knowledge will allow rational assessments of the health hazards of groundwater recharge, shallow aquifer contamination, and proximity of septic tanks to wells.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1738, SHORELINE ENGINEERING STUDIES ON GREAT SALT LAKE
W.P. HEWITT, Univ. of Utah, State Geolog. & Min. Surv., *Salt Lake City, Utah* 84112

The object of this study is to determine the effect of currents, storm waves, and heavy brine on engineering structures that might be built on Great Salt Lake, or upon its shores. A contour-map of the brine-lake bed contact is to be built, currents are to be studied and reefs are to be plotted.

Status: Lakewide survey involving current measurements, water depths, water temperatures and water densities are under way. Photography of lake, obtained cooperatively in 1965 and in 1966 with U.S. Geological Survey, has been studied for reef distribution and shoreline features.

Study of Kennecott Copper Corporation's tailings dike in the lake has been completed.

Isolated current measurements have been made but the major lakewide current survey has not yet commenced.

Water temperatures and density measurements are presently in progress in conjunction with our water sampling program.

Reef morphology is also currently being studied as part of the over-all continuing investigation of bottom sediments.

SUPPORTED BY Utah State Government

2.1739, A MATHEMATICAL ANAYSIS OF THERMAL POLLUTION OF LAKES A'ID ESTUARIES
R.W. MCLAY, Univ. of Vermont, School of Technology, *Burlington, Vermont* 05401 (AT)

A digital program will be written to analyze the thermal effects of the proposed nuclear reactor at Charlotte, Vermont. The program will simulate three regimes: 1) Inlet Regime, 2) Mixing Regime, 3) Extended Plume Regime.

SUPPORTED BY U.S. Atomic Energy Commission

2.1740, PROBLEMS RELATED TO THE EFFECTS OF HEATED DISCHARGES FROM THERMAL POWER PLANTS
R.C. TUCKER, U.S. Natl. Water Commission, *Arlington, Virginia* 22203

The objective of the research is to: 1. Assess the magnitude of the thermal effects problem and cooling water requirements for thermal power generation. 2. Consider what impact changing life styles may have on the problem. 3. Assess the environmental effects of heated discharges, this is to include both the effects on aquatic biota as well as stream uses. 4. Assess what significance beneficial uses of waste heat may have on reducing the thermal pollution problem. 5. Study the effects of alternative methods of heat dissipation. 6. Consider possible technological developments in power generation and condenser cooling and their possible impact on the problem. 7. Consider the present status of the art in thermal effects and recommend further study in the form of priorities for study in those areas where knowledge appears most deficient. 8. Consider the present institutional arrangements and policies dealing with thermal effects and to recommend improvements where felt necessary. 9. Propose methods for bringing the expertise of ecologists and environmentalists to the siting of power plants. 10. Propose methods for power plant siting.

The plan of study includes individual efforts by the principal investigator as well as input from a number of staff and contract studies being carried out for the NWC. The study will also include meeting with a panel of consultants. This project was initiated in FY 1970 and will terminate FY 1972.

SUPPORTED BY U.S. National Wtr. Comm. - Arlington, Va

2.1741, IDENTIFYING ENVIRONMENTAL QUALITY ATTRIBUTES IN WATER RESOURCES
R.E. VINCENT, U.S. Natl. Water Commission, *Arlington, Virginia* 22203

The overall objective of the study is to provide information on the effects--both adverse and favorable--of water resource development upon the environment, including its impact upon scenic beauty, historic and wild areas, fish and wildlife resources and recreational opportunities, and to develop means for weighing such effects against possible material gains. The study has been divided into four parts: (a) the role of environmental quality in maintaining a balance of values in water development; (b) the role and aesthetic value of water in landscape design; (c) the classification and designation of water for specific uses; and (d) recycling and ecosystem response to water manipulation. Each of these parts represents a discrete research task to be accomplished separately under contract. The overall study will evaluate and synthesize the results of the contract studies.

SUPPORTED BY U.S. National Wtr. Comm. - Arlington, Va

2.1742, EFFECTS OF DEICING COMPOUNDS ON VEGETATION AND WATER SUPPLIES
R.E. BLASER, Virginia Polytechnic Institute, School of Agriculture, *Blacksburg, Virginia* 24061

The objectives are to determine the actual effects of salts (deicing compounds), used in winter maintenance operations, on vegetation along the highway; to determine means of counteracting any detrimental effects resulting from the use of salts (deicing compounds); to make recommendations for implementation of the research findings; and to establish the state-of-the-knowledge concerning the effects of salts (deicing compounds) on water supplies.

SUPPORTED BY U.S. Dept. of Transportation - Public Rds.

2.1743, THE EFFECTS OF HEATED WASTE WATERS UPON MICROBIAL COMMUNITIES
J. CAIRNS, Virginia Polytechnic Institute, Graduate School, *Blacksburg, Virginia* 24061

One of the major water management problems is created by the discharge of heated waste waters from steam electric generating plants. Singer estimates that one quarter of all surface waters in continental United States will be used for cooling in 1985. Clearly, some basic decisions regarding the management of discharge waters should be made as soon as possible. Unfortunately, very little information concerning effects of heated discharge waters is now available, particularly where fresh-water protozoan communities are concerned. The specific aim of this project is to extend and expand the information regarding effects of heated discharge waters upon microbial communities, particularly protozoans, with some emphasis upon aquaria fungi and algal relationships. This study will initially be divided into two broad areas. 1. Simulation of the passage of water through a condensing system to determine the effect of this exposure upon unicellular organisms 2. The effect of simulated passage through the condenser upon the microbial system below the discharge point.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1744, EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS
J. CAIRNS, Virginia Polytechnic Institute, Graduate School, *Blacksburg, Virginia* 24061

The purpose of this research is to develop a rapid means of assessing non-lethal effects of toxicants upon fishes, using changes in movement patterns during exposure to toxicants and to relate the 'safe' or 'no response' concentrations so estimated to longer term functions such as growth and reproductive success. The apparatus which will be used to measure the movement patterns of the test species is measured by light beam interruption. The long range goals include the establishment of a pilot study in which the movement detecting apparatus will be incorporated into an industry's effluent to be used as a biological monitoring device.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1745, TOXICANTS AND THE EKG AND RESPIRATION OF FISH
J. CAIRNS, Virginia Polytechnic Institute, Graduate School, *Blacksburg, Virginia* 24061

One of the most critical needs for industrial pollution control is a biological monitoring technique that can provide continual information feedback on the toxicity of the waste. Most biological assessment techniques either estimate how much waste can be tolerated on the basis of bioassays (usually involving a few samples of waste, and using death of the test organisms as indication of response) or how much damage, if any, has occurred after the waste has been placed in the receiving stream (biological surveys, etc.). These are worthwhile assessments but they do not provide rapid and continual information on waste quality.

The purpose of this research is to develop a rapid means of assessing the nonlethal effects of toxicants upon fishes using changes in the electrical signals from the heart and breathing muscles during exposure. The apparatus consists of plexiglas tubes in which individual fish are confined. A continuous flow of synthetic dilution water containing various concentrations of toxicants can be passed through the tubes. The tubes are designed so that the heart and breathing signals are recorded on a Grass Polygraph.

The 'safe' or 'no response' concentrations determined by this echnique will be related to longer term functions such as growth ind reproductive success.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1746, STREAM FAUNAL RECOVERY AFTER MANGANESE STRIP-MINE RECLAMATION
K.B. CUMMING, Virginia Polytechnic Institute, School of Agriculture, *Blacksburg, Virginia* 24061

The objectives of this proposed research are to monitor water quality in four tributaries which represent various stages of recovery from strip-mine pollution and to conduct studies on the chronic physiological action of mine effluent on fishes of these waters. The change in water quality following different stages of reclamation work on National Forest lands will be used to measure the rate of stream recovery as well as to document the continuing damage caused by unreclaimed mines. The sublethal action of suspended matter and manganese metal will be described as they affect growth rate and condition index of two representative species, rainbow trout and white sucker, in this watershed. The growth studies will be carried out at the Buller Fish Cultural Station near Marion, Virginia.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1747, SOME EFFECTS OF THE RECENT INTRODUCTION OF HARD WATER INTO THE WATER SUPPLY RESERVOIR OF CARVIN COVE, VIRGINIA
K.B. CUMMING, Virginia Polytechnic Institute, School of Agriculture, *Blacksburg, Virginia* 24061

The relationship between fish production and the physical and chemical factors in lake environments have been of considerable interest to limnologists for some years. Recent introductions of hard water into Carvin Cove Reservoir have affected the overall physical and chemical properties of the reservoir. The objectives of the present study are: 1. To document the change that has taken place over the last four years in chemical quality of the water. 2. To examine the effects of this change upon distribution of bottom fauna. 3. To study the effect of the hard water upon productivity, distributions, species composition, and relative abundance of fish population from the reservoir.

SUPPORTED BY Virginia State Government

2.1748, BIOLOGY OF ANADROMOUS ALOSIDS
J. DAVIS, Virginia Inst. of Marine Sci., *Gloucester, Virginia*

Objectives: 1. Obtain a collection of data on which to base estimates of the composition of the spawning run of alosids in 1969 and the mortality rates of the species. 2. Estimate the catch of each species of Alosa in each river system. 3. Find the spawning sites and nurseries of alosid fishes in the James River system. 4. Investigate tolerance to domestic and industrial wastes in the James River.

Procedures: 1. Age and spawning history will be determined by counting rings and spawning checks on scales. 2. Catch records will be obtained from a sample of each type of gear in each river and the total number of gears of each type will be counted monthly. Total catch will be estimated by multiplying the average catch of the sample gears by the total number of units of gear. 3. The mainstream and its tributaries will be sampled for eggs, ripe fish, and newly hatched larvae. Presence of any of these will indicate a spawning area. Areas in which young fish are caught will be considered to be nurseries. 4. Tolerance will be measured both by standard laboratory techniques and by monitoring the environment before, during, and after fish kills which are expected to occur.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.1749, EFFECTS OF POLLUTANTS ON SUBMARINE PLANT SYNECOLOGY
M.A. DUBE, Western Wash. State College, Graduate School, *Bellingham, Washington* 98225

The purpose of this study is to gain an understanding of the dynamics of subtidal marine plant communities which are exposed to industrial waste outfall as compared to the dynamics of communities located in waters carrying less industrial areas before and after the development of the industrial installation. Communities closer to the source of industrial waste will be contrasted with those farther away to determine basic differences in (a) plant community structure, (b) productivity of the plant community, (c) the reproductive output of the plants, and (d) plant successional pattern. For example, it may be found that a community which is affected by pollution is arrested in a condition resembling an early stage in the successional development of an undisturbed community.

An attempt will be made to interpret differences in community dynamics in terms of differences in environmental factors by comparing at each site (a) the degree of chemical enrichment and concentration of suspended particles in the water, (b) the degree of siltation of the plants and substrate, and (c) the role of primary consumers. Controlled experiments will be run when possible to determine the separate effects of these factors.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1750, METABOLIC ROLE OF INORGANIC ELEMENTS IN SALMONIDS - 15 - EFFECT OF TOXIC LEVELS OF COPPER OR ENZYME ACTIVITIES
W.S. ZAUGG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Cook, Washington*

Determine various enzyme activities in organs which accumulate copper when fish are subjected to toxic levels of this element in their aquatic environment and/or diet. Activities to be tested include ATP phosphohydrolase and oxidative phosphorylation.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1751, ENERGY-DEPENDENT ION MOVEMENTS AND ACCUMULATION IN MEMBRANES OF SALMONID TISSUES

W.S. ZAUGG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Cook, Washington*

Mitochondria will be isolated from gill, liver and kidney tissues of salmonids and examined for their ability to accumulate ions (Ca plus plus, K plus etc,) by energy-dependent mechanisms. Energy will be generated by mitochondrial oxidative reactions or by addition of ATP. ATP dependent accumulation of ions by microsomes from these tissues will also be studied. Samples will be taken from fish maintained in fresh water and compared to fish subjected to varying times of exposure to sea water. The effect of a number of stream pollutants on these activities will be studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1752, ECOLOGICAL CHARACTERISTICS OF THE COLUMBIA RIVER

C.E. CUSHING, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The objective of this study is the acquisition of data on biological, chemical, and physical factors for the Columbia River and the determination of their inter-relationships. Basic parameters are being determined to obtain estimates of energy transfer within the ecosystem. These include the determination of species compostion, biomass, and stable element composition of the dominant species of plankton, benthos, and fish. Concurrent with the biological sampling program, physical measurements will be made of current speed, water temperature, and characterization of the bottom substrata. Hanford reactor effluent water contains all the fission products plus activation products produced by neutron irradiation of river water constituents. The river ecosystem is, therefore, excellent for defining the relative and absolute behavior of the radionuclides and stable counterparts, basic chemical and radiochemical measurements made are fundamental to studies of the biogeochemical interactions with the sediments and biota of the river.

Results: Methods were developed which involve the concentration of river water particulates suspended, their isolation and the determination of particle size distribution in small quantities of samples. About 20 elements were measured at five ecologically significant times of the year by neutron diffraction, and six additional elements measured at monthly intervals by flame photometry, atomic absorption, and colorimetry. Over 85% of the total intact strontium sorption measured in the spring was attributable to the 2.0 mu fraction, whereas approximately 40% of the strontium sorption was attributed to particulates 0.5 mu in diameter (e.g., soluble).

SUPPORTED BY U.S. Atomic Energy Commission

2.1753, FINE STRUCTURAL EFFECTS OF TEMPERATURE IN FISH

J.C. HAMPTON, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

Previous work temperature effects in this laboratory demonstrated a shift in metabolism during acclimation to changes in water temperature. Liver and muscle were used as model organs and some fine structural changes in liver were correlated with the biochemical data. The sensing mechanism, or pathway, which mediates temperature acclimation in fish is unknown but certain organs, the hypothalamus, lateral line system, swim bladder and gills, are suspect because they function in sensing and initiating responses to environmental changes. These organs in the trout are studied for possible fine structural changes at temperatures ranging from 7.5 degrees-30 degrees C. Autoradiographic studies on cell turnover and protein synthesis in the organs listed and in liver during acclimation are made. Changes in the relative abundance of glycogen and mitochondria in muscle as well as in the actin and myosin filaments are evaluated at temperatures between 7.5 degrees C and 30 degrees C.

Results to date: A comparative study of red and white muscle fine structure was completed on tissues from trout acclimated to 7.5 degrees C. The results show only minor differences, if any in sarcomere length, and dimensions of filaments, but a significant increase in the number of mitochondria and the amount of glycogen in red muscle as compared with white muscle.

SUPPORTED BY U.S. Atomic Energy Commission

2.1754, SIMULATION MODELING OF THERMAL EFFECTS ON SELECTED RIVER SYSTEMS

R.T. JASKE, Battelle Memorial Institute, *Richland, Washington* 99352

This program consists of the application of digital simulation program originally developed for the investigation and prediction of Columbia River water quality, primarily temperature, both above and below the Hanford plant, to perform water quality predictions associated with the erection or planning for nuclear electrical generating facilities in critical major river basin areas. These critical areas, or marketing regions would be selected by the Div. of RD&T in response to current licensing needs and other predictions.

During FY 1968 it is proposed to complete simulation tests of the Illinois and Deerfield Rivers where major facilities are currently in operation. In addition, reports of the estimated effects of the Dresden 2 and 3 plants currently under construction down to river mile 80 are planned. A major regional system, such as the entire upper Mississippi or the Ohio River Basin will be selected by RD&T for simulation prediction through the foreseeable future. This program was initiated in FY 1967 and is expected to be continued through FY 1971 on the basis of current planning.

SUPPORTED BY U.S. Atomic Energy Commisaion

2.1755, EXTENDED STUDIES RELATED TO CONSTRUCTION OF A POWER REACTOR NEAR KALAMA, WASHINGTON

R.T. JASKE, Battelle Memorial Institute, *Richland, Washington* 99352

This program is designed to supplement previous work performed for the PUD by Battelle-Northwest. The original study centered on predicting the dispersion of heated effluent from a power reactor using once through cooling. The primary objectives of this proposed research program are: 1) Examine the effect of direct dilution on the ecological community 2) Study the possible conflict of interest over the use of water by both hydro and thermal power facilities 3) Install meteorological equipment which will provide the substance for the safety analysis report necessary for the preparation of required construction permits.

Period 6/70 to Present: Because of the unsettled situation regarding the interpretation of standards, further research on the site has been reduced to the routine collection of temperature information at five stations on the Lower Columbia. A progress report dated September 1970 is available summarizing all information collected during the past 12 months.

Significant findings include 1) That a greater temperature differential exists laterally in the affected reach than would be caused by fully mixed effluent from a 1000 MW reactor cooled on a once through basis and 2) The temperature regimen of the Kalama River, a valuable tributary of the Columbia located just below the plant site, has a diurnal temperature range and order of magnitude greater than that of the Columbia during the months of June, July and early August.

Continuation of the temperature measurements is under consideration. Further action to develop a power reactor site at Kalama for once through cooling is not certain.

SUPPORTED BY Clark County Government - Washington

2.1756, EFFECT OF REACTOR EFFLUENT OF QUALITY OF COLUMBIA RIVER WATER

R.T. JASKE, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)1830)

The study concerns the dispersion of Hanford effluent in the Columbia from point of discharge to the estuary at River Mile 20, a reach of 375 miles. The primary objective is the identification of thermal release and interrelated effects including the develop-

ment of models for transport of heat and radionuclides within the system.

A simulation model of the three hydroelectric plants (Wanapum, Priest Rapids and McNary) and the Hanford Reach was developed in a cost analysis of improved regulation of the river to increase minimum flow in the vicinity of the Hanford reactors. The model was solved with the UMPIRE code. The constraints were: the total and partial power demand, rates of change of the nearest upstream pool, minimum flow rates, water balance on the reservoirs, generating capability, and pool heights.

Dispersion characteristics of the river between R. Miles 383 and 355 were analyzed by both remote sensing and physical contact sampling systems using dye as a tracer. The effect of effluent buoyancy on the lateral dispersion coefficient was studied empirically; the coefficient depends upon density differentials. Values for the longitudinal diffusion coefficient were 500 - 3000 sq.ft./sec for flow rates 80,000 - 130,000 cu.ft./sec.

Early summer and fall transects (1969) at the Oregon-Washington border were used to check the accuracy of the COL-HEAT simulation model and the extent of stratification and mixing in the reservoir under maximum solar thermal input. The model was then used to estimate the persistence to the border (M.308) of Hanford heat additions (M.382). Sixty-five percent or more of the river temperature increment between Priest Rapids Dam and Richland is dissipated in that reach; the remainder is weakly related to the weather in terms of yearly variations.

SUPPORTED BY U.S. Atomic Energy Commission

2.1757, HYDRO-ENVIRONMENTAL EVALUATION OF NUCLEAR POWER PLANTS
R.E. NAKATANI, Battelle Memorial Institute, *Richland, Washington* 99352

The purpose of this work is to identify and describe the critical hydro-environmental problems facing the nuclear power industry. The work is essentially a survey of existing conditions. Thirteen nuclear power and two fossil fuel plants having distinctive heat release conditions or methods were visited. A report of findings and recommended research and development has been prepared.

SUPPORTED BY U.S. Atomic Energy Commission

2.1758, EFFECTS OF MODIFICATIONS ON THE COLUMBIA RIVER
D.G. WATSON, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The objective of this work is to develop an understanding of the impact of man-made modifications on freshwater ecosystems. The need for realistic information in the field of thermal effects is essential for location of nuclear power plants with a minimum of damage to environmental quality. Determination of the basic thermal requirements of aquatic organisms is necessary for formulating sound water quality standards for the nation's waters in the face of a wide variety of environmental alterations. Existing knowledge does not allow an estimate of the biological cost of radionuclides in the environment to be determined. Communities and populations under natural conditions are of interest in this work. Rainbow trout and chinook salmon will be examined because of their commercial importance.

RESULTS: In behavioral studies, thermally shocked fish were found to be selectively preyed upon, above certain minimum thermal doses. Artificial laboratory channels, maintained above ambient river temperature, were used to measure the effects of thermal increments on productivity and species composition. Biomass turnover, as output and standing crop, provided estimates of relative productivities. Measurement of radiation dose to the benthic river communities was continued. Dose rates to the underside of the river substrate were about 25 percent less than to the upper surface.

SUPPORTED BY U.S. Atomic Energy Commission

2.1759, SIMULATION MODELING OF ENVIRONMENTAL EFFECTS OF THERMAL GENERATION
P. HOFMANN, Westinghouse Electric Corp., *Richland, Washington* 99352

The purpose of this work is to apply the digital simulation capability developed in connection with the use of Columbia River water for cooling the Hanford plutonium production reactors to other water bodies.

Reports entitled 'A Test Simulation of the Temperatures of the Deerfield River', BNWL-628; 'A Test Simulation of the Temperature of the Illinois River and a Prediction of the Effects of Dresden II and Dresden III Reactors, BNWL-728'; and 'Simulation Modeling of Thermal Effluents in an Irrigation System, BNWL-1277', have been published and are available from the Clearinghouse for Federal Scientific and Technical Information.

A lake temperature prediction model has been developed. This model will be tested using field data from the Great Lakes during FY 1972.

SUPPORTED BY U.S. Atomic Energy Commission

2.1760, REGIONAL MODELING OF SURFACE WATER TEMPERATURES FROM PROJECTED POWER GROWTH
D.E. PETERSON, Westinghouse Electric Corp., *Richland, Washington* 99352

Digital simulation programs developed at the Pacific Northwest Laboratory applicable to the Columbia River have been used to predict the impact of nuclear facility operation in major river-basin areas. Program outputs have included modifications based on plant operational experience for both normal and abnormal weather and flow conditions. Ultimate capabilities of given stream systems to support thermal generation concentrations have been and will be estimated.

Reports entitled 'A Test Simulation of Potential Effects of Thermal Power Plants on Streams in the Upper Mississippi River Basin, BNWL-999' and 'Potential Thermal Effects of an Expanding Power Industry: Ohio River Basin I, BNWL-1299' have been published and are available from the Clearinghouse for Federal Scientific and Technical Information. A complete assessment of the cooling capacity of the entire Mississippi River system is presently underway. Surveys of the cooling capacity of Atlantic and Gulf coast systems are planned.

SUPPORTED BY U.S. Atomic Energy Commission

2.1761, FISH BEHAVIOR AND PHYSIOLOGY
A.B. GROVES, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Seattle, Washington* 98102

The essential purpose of this work is to acquire a knowledge of intrinsic physical and sensory abilities of fish which relate to specific environmental factors encountered in migration and fish passage situations. A broader purpose is to assess the adaptive ranges of these capacities in different migratory fish stocks. This information will be applied to help predict or anticipate the effects on migrant fish of various river and estuarine development programs which are creating numerous changes in the environments of native stocks of commercially valuable species.

Specifically the work is with salmonids and involves measurements of fish capacities against selected environmental variables. This includes measurements of swimming performance abilities of juvenile and adult fish and activity patterns and responses of salmonid species. Studies also are made of sensory responses which may relate to migration and homing behavior, of physical and hydraulic factors that can injure fish in power turbines, of responses that may aid in diverting fish away from dangerous areas in turbines, and of effects on migrants of thermal shock such as that encountered by passing through heated effluents from thermal power plants.

The work is now in the laboratory but is directed to the idea that the derived information can be applied directly to field problems.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1762, COASTAL AND ESTUARINE RESOURCE DEVELOPMENT
T. JOYNER, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Seattle, Washington* 98102

Waters of estuaries and bays of Puget Sound offer attractive sites for water-cooled thermal-electric plants. Several large plants (1000 plus MGW) are already under consideration and more will undoubtedly follow in the near future. Uncontrolled discharge of effluents from these plants could produce environmental changes unfavorable to certain marine species. In contrast, when properly controlled and directed to produce changes calculated to optimize production and growth of desired marine organisms, effluents may be regarded as beneficial additives for aquacultural systems.

The purpose of these studies will be to: (1) Determine response and tolerance to thermal change of commercially significant marine organisms and their food sources. (2) Assess potentials for use of heated effluents for aquacultural systems.

A mobile field laboratory will be used to carry out on-site thermal tolerance experiments with organisms native to the area. Closed-system designs using thermal effluents for culture of oysters, clams, crustaceans, and other commercially important marine organisms will be explored.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1763, EFFECTS OF INDUSTRIAL EXPANSION ON THE AQUATIC ENVIRONMENT OF ESTUARINE AREAS
G.R. SNYDER, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Seattle, Washington* 98102

The Lower Columbia River and its estuary plays a critical role in the life cycle of anadromous salmonids. Each year millions of young fish move downstream from native rearing areas and artificial propagation facilities. These fish all pass through the lower river and estuary where they undergo physiological transformations in preparation for their movement from fresh to salt water. The estuary also is an important nursery area and the transition zone for marine species of fish.

Industrial expansion in this area by the thermal electric power, aluminum, and pulp and paper industries can drastically modify the environment. Forecasts indicate that over 2000 MW. of electricity (possibly 4000MW.) could be produced in the Columbia estuary by 1985. The effects of waste heat discharged from these plants could be detrimental to the overall aquatic ecology and specifically to the production of commercial species of fish. Limnological studies are planned to determine the existing ecology at sites known to have potential for industrial expansion. The effects of increases in water temperature on aquatic organisms at specific sites will be studied. Predictions of physical and biological changes will be made. The effects of the environmental changes on fish and on secondary organisms necessary for their survival and growth will receive initial emphasis.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1764, EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES
G. WEDEMEYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle, Washington* 98115

Anadromous fishes may be forced to swim through areas of thermal pollution during their fluvial migration. The effect of such heat stress on the host-defense mechanisms against infectious diseases will be studied using the juvenile coho salmon and steelhead trout.

Fish acclimated to 50F will be subjected to selected heat-stress regimens and changes in those physiological parameters involved in non- immunological disease resistance will be measured. These will include inter-renal vitamin C, the 17-hydroxycorticosteroid hormones, plasma proteins, glucose, oxygen levels, and blood buffering capacity.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1765, COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC - A) BIOLOGICAL; B) CHEMICAL AND GEOLOGICAL; AND C) PHYSICAL OCEANOGRAPHY
C.A. BARNES, Univ. of Washington, School of Arts, *Seattle, Washington* 98105 (AT(45-1))

The planned research extends that initiated in 1961 and directed towards determining the properties, distributions and movement of Columbia river water and its transported load including radionuclides in the Northeast Pacific, and establishing a base for predicting the general behavior of river water at sea. Past measurements have provided a general description of water mass properties, currents, nutrients, dissolved oxygen, selected radionuclides, phytoplankton, primary productivity, selected zooplankton and benthos, bathymetry, sub-bottom structure, and characteristics of sediments in the river and on the adjacent sea floor. The continued studies are subdivided into three separate subproject and subject areas: A) Biological, B) Chemical and Geological, and C) Physical Oceanography, and will investigate in greater depth selected properties and processes as follows: A) Phytoplankton including the subsurface chlorophyll maximum layer, excretion of organic matter, annual production and theoretical model studies of production; distributions of zooplankton and biomass, zooplankton-phytoplankton relationships, oxygen consumption in the seabed, DNA in marine sediment, benthic communities and taxonomy of polychaetes; B) Determination of mercury concentrations in waters and sediments of the Columbia River and adjacent marine environment, associated processes and rates of interchange; identification and budgets of Columbia River sedimentary and contributing dissolved materials in the deep waters and bottom sediment over the continental shelf, slope and border land; and construction of a computer model pertinent to effluent movement and sediment distribution; C) Direct measurement of currents and winds with buoyed arrays at fixed locations off the Washington coast stressing the basic dynamics; theoretical study of the three-dimensional circulation near the river mouth; numerical modelling of the coastal area from 42 degrees to 48 degrees N; completion of bottom drifter studies and hydrographic atlas.

SUPPORTED BY U.S. Atomic Energy Commission

2.1766, WATER RESOURCES SCIENTIFIC INFORMATION CENTER, WATER QUALITY REQUIREMENTS AND EFFECT OF WATER POLLUTION ON FRESHWATER MARINE ORGANISMS
M. KATZ, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105

The establishment of a Water Resources Scientific Information Center to collect and abstract the current pertinent world literature on the water quality requirements of freshwater and marine organisms is proposed. It is further proposed to collect and abstract the world literature on the effects of water pollution on freshwater and marine organisms.

The Principal Investigator has the resources of the Fisheries--Oceanography as well as the other libraries of the University of Washington, besides an extensive personal exchange with leading water quality workers of the world. It is expected that over 500 titles will be collected and abstracted during the first year of the project.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1767, PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS
J. LEWIN, Univ. of Washington, School of Arts, *Seattle, Washington* 98105

Funds from this grant continue NSF support of investigations concerned with the physiology, nutrition and systematics of marine diatoms. Specifically the projects are (1) comparative morphology and physiology of species belonging to the genus Chaetoceros, especially with regard to morphological structure of

the silica shell and setae as revealed by electron microscopy; and of salinity tolerances as revealed by laboratory cultures; (2) field and laboratory investigations of surfzone diatoms of the Olympic Peninsula with respect to their responses to nutrients and their growth responses to various nutrient concentrations; (3) studies of heterotrophic nutrition of marine pennate diatoms as related to growth promoting substrates; (4) exploratory studies to determine the nature of available and unavailable iron in sea water from various localities; (5) isolation and culture of certain species of algae from the deep phytoplankton layer which exists below the 1 percent light level and which makes a considerable contribution to primary production; and (6) investigations of the response to boron of various species of centric diatoms particularly to test the possible role of boron in cell metabolism. Marine diatoms in temperate neritic ocean waters are the major plant contributors to primary production. These investigations provide information which will be useful in considering the effects of organic, inorganic and thermal pollutants on the behavior of various species of marine organisms.

SUPPORTED BY U.S. National Science Foundation

2.1768, THE RESPONSE OF LAKE SAMMAMISH LIMNOPLANKTON TO SEWAGE WASTE DIVERSION

E.B. WELCH, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

A study to determane the recovery characteristics of eutrophic Lake Sammamish following sewage waste diversion is proposed. Changes in primary and secondary productivity nutrient budgets and physical characteristics will be monitored for a two year period to establish rate and trends of recovery. Responses of limnoplankton productivity, as well as chemical and physical factors, in Lake Sammamish will be compared with similar responses occurring in Lake Washington following sewage diversion. These comparisons will be made statistically so that significant results can be used to develop prediction models for lake productivity responses to sewage diversion. In addition, particular attention will be given to the effects of yellow organic acids on algal productivity since Lake Sammamish apparently receives yellow organic acids from bogs and lakes located to the east. The complete findings of this study should provide tentative means for estimating the response of lakes physically similar to Sammamish to diversions of sewage carrying large quantities of algal nutrients.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1769, INFLUENCE OF INDUSTRIAL AND MUNICIPAL WASTES ON ESTUARINE AND OFF SHORE WATER QUALITY

J.F. SANTOS, U.S. Dept. of the Interior, Geological Survey, *Tacoma, Washington* 98402

This project is being carried on in cooperation with the Municipality of Metropolitan Seattle.

A major objective is to study the influence of industrial and municipal waste disposal on all phases of water quality, chemical, physical, ecological, and sanitary in fresh, brackish, and saline environments. Measurements made with multiple parameter water quality recorders at four sites on the Duamish River estuary are the basis for the attempted correlations. Parameters recorded include dissolved oxygen, specific conductance, water temperature, pH, turbidity and solar radiation index. Computer programs will be written to analyze these data and to detect significant relations.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1770, IMPACT OF CORPS OF ENGINEERS CONSTRUCTION ACTIVITIES ON THE ECOLOGICAL ENVIRONMENT

H. MILLS, Marshall University, School of Arts, *Huntington, West Virginia* 25701 (DACA)

Technical Objective: The objective of this work unit is to provide consultant services and to define areas and capabilities for environmental research as related to the U. S. Army Engineer Waterways Experiment Station in particular and the U. S. Army Corps of Engineers in general, with emphasis on the extreme importance of developing an in- house capability for a coordinated systems approach to meet military as well as civic needs. Army interests in ecology include but are not limited to the conduct of military and construction activities so that the ecological environment will not be adversely affected. Military reservations together with theaters of operations encompass all aspects of ecology such as water resources, land and forests which together contain all species of fish and wildlife.

SUPPORTED BY U.S. Dept. of Defense - Army

2.1771, GROWTH OF THE BROWN BULLHEAD, ICTALURUS NEBULOSUS (LE SUEUR), IN MINE ACID POLLUTED WATER

A. BENSON, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

The study is an evaluation of the environmental effects of acid mine water on growth rates of the brown bullhead, Ictalurus nebulosus (Le Sueur). The investigation is based on evident tolerance of this species to acid conditions and its possible management potential in acid water.

The procedural research plan includes: (1) comparative sampling of brown bullhead populations in acid and non-acid bodies of water; (2) collecting data on environmental conditions; (3) determining growth rates; and (4) collecting supplemental data on food habits and on food availability.

The results are expected to be useful in management planning for sport fisheries, in establishing water-quality criteria, and in planning future research.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1772, MICRO-ECOSYSTEMS SIMULATION OF PRIMARY PRODUCTION IN THERMAL AND ACID MINE WATER LOADINGS RELATED TO WATER USE OF THE MONONGAHELA RIVER

E.C. KELLER, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

This project is concerned with the empirical systems simulation of sets of micro-ecosystems in regard to the joint, interacting effects of thermal loading and variable levels of acid mine water. Following the systems analysis of the empirical stimulation results, preliminary mathematical modeling will be developed for predictive purposes. Some field work will evaluate the modeling attempts.

The general approach of the project will consist of three distinct phases: 1. Examination by sampling of the phytoplankton of natural waters of selected segments of the Monongahela River, including two thermal outfalls. 2. Laboratory controlled experiments concerning specific conditions in simulated microecosystems and construction of empirical models (or model) consistent with the findings of No. 1. 3. Construction of mathematical models in a systems context from the empirical data and models from Nos. 1 and 2 above.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1773, PHYSIOLOGICAL EFFECTS OF SUBLETHAL LEVELS OF ACID WATER ON FISH

W.J. PEGG, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

The project proposes to determine metabolic rates by indirect calorimetric methods; eg, measurement of oxygen consumption of sunfish and bullheads which have been subjected to different laboratory controlled aquatic environments. The environment will consist of acid waters with pH ranges about 6.0 to 3.0 and cold total acidities varying from 3 to 70 mg/l $CaCO_3$. The environmental waters will be composed of combinations of acid coal mine drainage water and solutions of sulfuric acid diluted with natural river water and constituted river water. Calcium levels are to be varied in the test waters to determine whether or not increased levels of environmental calcium can reduce the effect of acid water. If oxygen consumption is a valid measure of energy utilization in fish, then increased metabolic rate under acid water conditions would indicate that the fish must expend energy to compensate for the stress induced by the environment.

2. WATER QUALITY

This research proposes to add metabolic rate data relative to the acid environment typically found in the Monongahela River basin. It also proposes to evaluate the relative tolerances of native river fish to the acid environment. The study may also be considered as an effort to gain more appropriate water quality criteria applicable to the problems of reclamation and maintenance of a sport fishery in the Monongahela River basin.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1774, EVALUATE PERFORMANCE OF POULTRY AS AFFECTED BY WATER QUALITY
R.A. PETERSON, West Va. University, Agricultural Experiment Sta., *Morgantown, West Virginia* 26506 (WVA00148)

OBJECTIVE: To determine and evaluate the effect of various water quality factors on biological performance of poultry as they exist in West Virginia.

APPROACH: Field trials will be conducted to determine water quality conditions and their effect upon biological performance, both before and after treatment in broilers and laying hens.

PROGRESS: Two field studies are being conducted to determine the effects of water treatment in (1) a 10,000 cage-layer operation and (2) a 52,000 capacity broiler operation. Caged hens are receiving well water that is untreated, superchlorinated, dechlorinated and dechlorinated-demineralized. The broiler study treatments are as such: pond water that is untreated, superchlorinated, filtered super- chlorinated and filtered dechlorinated. Productive performance data, being collected monthly and by the brood, as yet has not been analyzed as the tests will not be completed for another year. Water Quality Study. Work done at the Kite Farm, a poultry layer operation, has principally been concerned with the collection of temperature data both inside and out, and the treatment of water and its measurement for layers in cages. The effects of water treatment and temperatures on egg quality and production at this point are inconclusive. Difficulty with equipment to accurately measure water consumption has been experienced and work is continuing to improve water measuring methods and equipment. Water treating equipment is working satisfactorily. The water treatment and measuring equipment installed at the Funkhouser broiler houses near Moorefield is working well but again at this time results of this study are not conclusive.

SUPPORTED BY West Virginia State Government

2.1775, INFLUENCE OF ACID MINE WATER UPON ACID TOLERANCE AND SYNTHETIC ABILITY OF SEWAGE MICROORGANISMS
H.A. WILSON, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

The research proposes to study differences between acid-tolerant and acid-intolerant bacteria isolated from polluted streams containing sewage and acid mine water, and to determine whether the environment created by the acid mine water interferes with the synthetic ability of certain bacteria, thereby causing them to be acid intolerant. Particular regard is to be given RNA, DNA, and amino-acid cell leakage. Radioisotopes of Na, K, and H are to be used to study cell leakage and internal pH. Results of the research may aid in water-quality management or treatment-plant and treatment-procedures design. Standard microbiological and analytic-chemical procedures and gas chromatographic, liquid-scintillation, and amino-acid-analyzer methods will be used. Minimum-growth pH will be determined for acid-tolerant and acid-intolerant isolates.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1776, MICROBIOLOGY OF FARM PONDS
H.A. WILSON, West Va. University, Agricultural Experiment Sta., *Morgantown, West Virginia* 26506 (WVA00132)

OBJECTIVE: Study qualitatively and quantitatively, the microbiological population of fresh water systems and the factors influencing this population; whether certain special bacterial groups such as cellulose decomposers, nitrifiers, nitrogen fixers, etc., are present: the effect that pesticide and herbicide residues have upon the microbial population of such waters and whether any members of the water microflora are capable of degrading either the active or inert constituents of such materials; the potential danger to livestock drinking from ponds and stagnant pools when heavy algal growths appear; the probable pollution hazards to ponds and streams from garbage dumps, sanitary landfills and domestic sewage from private residences.

APPROACH: Standard microbiological procedures will be the general basis of study.

PROGRESS: Coliform and enterococci densities were greater in ponds receiving run-off water from livestock areas. No psychrophilic bacteria, optimum growth below 20 C, were found although some isolates grew slowly at temperatures near O C. The relative stability of the farm pond waters studied was about 99% as determined by the methylene blue test. This was substantiated by the biochemical oxygen demand (BOD), which ranged from 1.1 to 315 mg oxygen consumed per liter. Rivers with BOD values between 1 and 4 ppm have been considered clean. Sediment BOD values ranged from 20 to 45 ppm per gram on an oven dry basis. This indicates the considerable amount of organic matter in pond sediment. The bacterial flora of ponds apparently is predominantly small gram negative rods with gram positive rods and cocci in considerable lesser numbers. This corresponds to findings of fresh water lakes. Microscopic examination of slides submerged in pond water revealed considerable numbers of algae as well as bacteria. Most of the algae were diatoms belonging to the genera Fragilaria, Diatoma, Synedra, Surirella, Stauroneis, and Navicula.

SUPPORTED BY U.S. Dept. of Agriculture

2.1777, IMPACT OF LAGOONS AND SAND BLANKETS ON FISH, AQUATIC LIFE AND WATER EQUALITY
D.A. BRATLEY, State Dept. of Nat. Resources, *Delafield, Wisconsin* 53018

Phase one, involved assembling Public Service Commission records on characteristics and extensiveness of lagoons and sand blankets in inland Wisconsin lands. Phase two, involved field research on Lake Winnebago and southeastern Wisconsin lakes to determine the effects of encroachments upon species composition, density, and dominance of aquatic vegetation, fish, bottom organisms and plankton. Water Quality Stations were also monitored in connection with this work. A completion report is being prepared.

SUPPORTED BY Wisconsin State Government - Madison

2.1778, EFFECTS OF DREDGING ON THE ECOLOGY OF SPRING PONDS
R.F. CARLINE, State Dept. of Nat. Resources, *Madison, Wisconsin* 53701

Objectives: Determine the effect of dredging on the important physical, chemical and biological characteristics of spring ponds, with particular reference to trout populations and the sport fishery.

Procedure: Determine: (1) the standing crops, growth and survival of trout populations in spring ponds, (2) growth rate and age structure of trout populations in outlet streams of spring ponds,(3) timing and magnitude of movement of trout between spring ponds and their outlet streams, (4) extent, location, timing, of spawning by trout in spring ponds and the hatching success of eggs spawned, (5) yield of trout from spring ponds,(6) food habits of trout in spring ponds,(7) standing crops and generic composition of the benthic invertebrate and planktonic populations in spring ponds, (8) important limnological characteristics of spring ponds, (9) hydrologic characteristics of spring ponds, and (10) cost effectiveness of spring dredging.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1779, BIOLOGICAL NITROGEN FIXATION IN LAKES, PHASE II
R.H. BURRIS, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

A mobile laboratory has been equipped for routine analytical work including gas chromatography. This laboratory will be used

to study biological N2 fixation in lakes and on the fringes of lakes. Samples of aquatic flora and of root nodules of higher plants will be exposed in the field to acetylene under a close approximation of natural conditions. Reduction of acetylene to ethylene will be determined by gas chromatography and will be used as an index of the activity of the N2-fixing system. The data will be evaluated in terms of the role of biological N2-fixing agents, particularly the blue-green algae, in eutrophication of fresh water lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1780, ECOLOGICAL RESPONSES OF FISHES AND FISH-FOOD ORGANISMS TO HEATED EFFLUENT - CASE STUDY OF LAKE MONONA, WISCONSIN
J.J. MAGNUSON, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The major objective of the research program is to evaluate the effects of steam-electric plant operation on the ecology of lake fishes and their food organisms. In the present project, certain ecological responses of fishes and invertebrates living in the littoral zone of Lake Monona will be assessed with respect to uptake, heating, and discharge of condenser-cooling water from Madison Gas & Electric Co.

Field investigation will consist of the following phases: 1. Diurnal and seasonal distribution patterns of fishes in relation to littoral temperature gradients produced by cooling-water discharge. 2. Growth rates of young fishes in the outfall area as compared to other littoral areas. 3. Food habits of bluegills and longnose gar in outfall and other littoral areas. 4. Movements of fishes within the outfall area and among outfall and extra-outfall areas. 5. Distribution and abundance of invertebrate fish-food organisms in the outfall area as compared to other littoral areas. 6. Uptake and discharge of fish-food organisms in the condenser-cooling water.

The following laboratory investigations will be conducted to complement the field research: 1. Temperature selection by representative fish- and invertebrate-eating fishes of Lake Monona in the absence of other major variables. 2. Effects of food distribution and predators on temperature selection in fishes. 3. Effects of differences in temperature acclimation of predator and prey fishes on predation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1781, THE AQUATIC ENVIRONMENT AND ELECTRICAL POWER GENERATION
R.A. RAGOTZKIE, Univ. of Wisconsin, School of Letters, *Madison, Wisconsin* 53706

The environmental effects of electrical power generation, using the Great Lakes for cooling purposes, will be studied along with socio economic considerations.

The first project includes the alteration of the physical environment by the discharge of heated effluence and the prediction of plume behavior. The behavior of migrating coho salmon, as modified by these discharges, is under investigation along with the influence of the heated discharge on the already stressed Alewife.

Future projects will include studies of (1) radioactive uptake by organisms gathered in the heated discharges, (2) contrast of the potential detrimental effects of fossil vs. nuclear power, (3) an analysis of the uses of electricity which could be considered essential, unessential or wasteful, and (4) a study of the human perception of pollution caused by nuclear generation of the Great Lakes.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1782, PHYSIOLOGICAL RESPONSES TO THERMAL POLLUTION
A.H. HOUSTON, Marquette University, Graduate School, *Milwaukee, Wisconsin* 53233

An attempt will be made to assess the physiological status of animals maintained under conditions of thermal pollution in terms of the systemic responses invoked to meet basic vegetative requirements, and the secondary effects which such adaptations may induce. For purposes of the present study emphasis will be placed upon cardiovascular- respiratory adjustment associated with the satisfaction of temperature- elevated oxygen demand in a desirable game fish species, the brook trout, and a frequently potential competitor, the common carp. Experimentally, the study will involve determinations of routine levels of oxygen consumption, cardiac and ventilation rates, and the oxygen tensions of inspired and expired water, and arterial and venous blood. The effects of cardiovascular respiratory adaptation upon water- - electrolyte regulation, a critical factor in systemic and metabolic control, will be evaluated through determination of blood and tissue levels of the major electrolytes and water, phase distribution analysis, and estimations of cellular ionic composition. In conjunction with this renal responses will be investigated through determinations of glomerular filtration rates, urine flows, urinary water-electrolyte levels and tubular recovery rates of th elements considered.

SUPPORTED BY U.S. National Science Foundation

2.1783, PHYSIOLOGICAL AND BIOCHEMICAL TECHNIQUES TO ASSESS THE EFFECTS OF SUBLETHAL CONCENTRATIONS OF CHEMICAL WATER POLLUTION ON FISH
H.M. MILES, Marquette University, Graduate School, *Milwaukee, Wisconsin* 53233

The ultimate objective is to develop techniques that will yield new information on the effects of heavy metal pollutants on the metabolism and physiology of fishes.

The rate of uptake of mercury from water by fish and its distribution in the various tissues will be determined by radiotracer studies. Physiological parameters in wild populations of fish living in mercury contaminated areas will be compared to those living in control areas.

The effects of mercury on the kidney function of adult fish will be determined along with a general sublethal bioassay method.

Observation of physiological parameters will be expanded to include fish exposed to other heavy metals.

SUPPORTED BY Wisconsin State Government - Madison

2.1784, PHYSIOLOGICAL EFFECTS OF THERMAL POLLUTION ON TROUT
E.M LONSDALE, Univ. of Wyoming, School of Engineering, *Laramie, Wyoming* 82070

Efforts are being made to remotely monitor physiological data from fish and wildlife with the main interest being the telemetry of EKG potentials from free swimming trout. Heart action of fish is very sensitive to water temperature.

SUPPORTED BY University of Wyoming

G. SOCIETAL IMPLICATIONS, MANAGEMENT, AND OTHER ASPECTS OF WATER POLLUTION

Legislation, Administration, Standards, Socio-economic Studies, Government Relations, Planning, Protection and Miscellaneous Environmental Pollution Studies.

2.1785, GEOLOGIC AND HYDROLOGIC STUDIES RELATED TO SPECIFIC POLLUTION PROBLEMS
R.M. ALVERSON, State Geol. Survey, *University, Alabama* 35486

The purpose of the project is to conduct geologic and hydraulic studies, research, and investigations in connection with specific ground and surface water pollution problems under consideration by the supporting agency. A report is in preparation documenting the growth of such activities through the years, relating specific pollution problems to geology and hydrology, and making recommendations as to areas and fields into which this cooperative approach to specific pollution problems can be expanded.

2. WATER QUALITY

SUPPORTED BY Alabama State Government

2.1786, WATER RESERVOIR SYSTEMS
J.J. KALVINSKAS, North Amer. Rockwell Corp., *Anaheim, California* 92803 (C-1187)

A program is proposed to investigate a reservoir system network in an urban area to alleviate problems of storm water runoff, eliminate costly and cumbersome sewer networks for storm drainage, and simultaneously provide for rainfall conservation. The study would be accomplished by conducting a systematic analysis of water runoff in an urban area, evaluating the location of a multiplicity of reservoirs throughout the area, and investigating both surface and subterranean reservoirs for rainfall storage.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1787, A SYSTEM APPROACH FOR INTEGRATING GROUNDWATER AND SURFACE-WATER USE
R.E. MITCHELL, Aerojet General Corporation, *Azusa, California* 91702 (C-1136)

This program will produce an analytical technique by which the most efficient utilization of water resources may be determined. The influence factors of potential surface supplies, quantity and quality needs of the users, waste-water treatment, groundwater pollution, community growth characteristics, economics, and legal/organizational needs will be included.

This research program is undertaken to present a systems approach to the preservation of the quality and quantity of the groundwater resource.

The research program will evaluate the projected needs of a typical expanding urban/rural community currently using groundwater supply and evaluate the steps to be taken to best provide the future water supply. The various sources of surface water and groundwater and their quality management will be considered. In addition, all the system constraints will be included so that a useful approach will be defined. To validate the approach, the study will be related to an existing groundwater problem area. The program will relate all the factors, both direct and indirect, to provide a master plan for this area.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1788, MANAGEMENT GUIDES UNDER ACCELERATED RECREATION DEMANDS AND INTENSIVE LAND USE
R.H. TWISS, U.S. Dept. of Agriculture, Pac. Sw. For. & Rg. Expt. Sta., *Berkeley, California* (PSW1901)

OBJECTIVE: Clarify and study the problems of planning and managing forest lands where there are accelerating land-use pressures and intensive recreation demands.

APPROACH: Study will be made of the principles of analyzing scenic aspects of resources, campground ecology, trends in the use of campgrounds and other intensively used sites, what forest recreation visitors seek and how they are affected by crowding or land management changes, improvement in plantings and horticultural treatments on forest recreation areas and integration of forest recreation with general resource or economic development. (3 to 7 my.)

PROGRESS: A comprehensive study of a 36 square mile watershed in urbanizing Marin Co. in California was completed. It considered major environmental factors which might affect future development, including geologic hazards, vegetation, soil, wildlife resources and climate, especially as it relates to problems of air pollution and also visual impact of future development. The study documents the critical need for locally based decisions on resource alterations, resource management, and design control. This approach should be a basic step in land management, as a guide to regional environmental quality planning, project review, and plan formulation. The techniques developed are being extended to other areas having similar development problems. Changes in conditions that may have been caused by recreational use, from 1961-1966, at five campgrounds were studied. The increase in vegetation after 5 years was attributed to barriers placed in campgrounds and to greater precipitation. The over-all improvement in campground conditions is interpreted as an 'adjustment' to recreational use. Ski resort simulation model was field tested on several proposed developments. The resultant predictions added objective support to actual planning decisions made by NFS. Original model has been improved through additional data collection during the past winter sports season.

SUPPORTED BY U.S. Dept. of Agriculture

2.1789, EVALUATION OF GROUNDWATER RESOURCES, LIVERMORE VALLEY, CALIFORNIA
P.A. WITHERSPOON, Univ. of California, School of Engineering, *Berkeley, California* 94720

A predicted rapid increase in the population of Livermore Valley, California over the next few decades points to the need for a master plan of water management. The main objective of this investigation is to provide quantitative data on the hydrologic characteristics of the groundwater basin of this valley that can be used in formulating this plan. An improved mathematical model has recently been developed at the University of California and will be the principal analytical tool.

A three year program of investigation is proposed. The first year will be spent in collecting basic hydrologic data. The geology has recently been worked out by the California Department of Water Resources. The second year will be spent in setting up two-dimensional and three-dimensional models of the basin. With this approach, it will be possible to investigate: (1) subsurface rates and directions of flow, (2) effectiveness of existing hydrologic barriers (vertical and horizontal), and (3) effect on subsurface flow patterns of current and future rates of recharge and discharge. The third year will be devoted to an analysis of the probable impact on subsurface hydrologic conditions over the basin of anticipated rates of water withdrawal and waste water disposal.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1790, ENVIRONMENTAL DECISION-MAKING IN THE LAKE TAHOE BASIN
L.D. MUSOLF, Univ. of California, Graduate School, *Davis, California* 95616

Lake Tahoe, the largest alpine lake in North America, is situated at an altitude of 6,200 feet in a 500-square mile basin astride the California-Nevada border. The combined effect of lake, shores, streams, and surrounding mountains is one of the outstanding natural and scenic resources of the world. For the very reason that the Tahoe Basin is so attractive, its unique qualities are threatened by the activities of man. Development of the area to date has been controlled largely by market demand. Problems of urbanization are developing, the most notable of which is the increasing eutrophication of the lake.

A newly formed group of faculty members representing a variety of separate disciplines, including the social sciences, humanities, law, engineering, and ecology will undertake the development of an interdisciplinary approach to long term research on the interrelationships of human decision making and environmental conditions in the Tahoe Basin. The use of the findings of such research will be utilized in the development of a predictive model which can anticipate the environmental consequences of different decision strategies. It is hoped that the model may be used as a tool in assisting public agencies to plan their future actions in the Tahoe Basin. The initial stages will be concerned with the development of a systems model concerned with environmental decision making.

SUPPORTED BY U.S. National Science Foundation

2.1791, THE ECONOMICS OF WATER TRANSFER - AN APPRAISAL OF INSTITUTIONS
J.H. SNYDER, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D-AEC-2210-RR)

OBJECTIVE: Collect, assemble and analyze primary and secondary data relating to vegetable crop production and water use and nonagricultural water use. Analytical techniques include linear programming, variate difference analysis, and Markov chain techniques. Evaluation of institutional arrangements influencing water use and water use transfer. Case study of such in-

stitutions as the Monterey County Flood Control and Water Conservation District will be supplemented by regional input-output analysis and may involve some river systems analysis.

PROGRESS: The total environment of the water economy of the Salinas Valley, including the institutional framework of a flood control and water conservancy district provided the focal point for analyzing water development, use, and transfer problems of the area. This study inquired directly into operationally feasible adjustments that could be implemented within the existing political and institutional environment. It emphasized the evaluation of political-institutional structures, legal structures, and administrative techniques. Optimal water management rationale for the water district was defined within the composite structure of the water economy. Analysis indicates that inefficiency costs associated with an absence of direct control of water withdrawal may or may not be large relative to those under a control scheme. It is concluded that economic incentives for aggregate water use are not vastly different with or without pumping controls when relatively low-cost, supplementary water supplies are available. Availability of such supplies places the principal emphasis on equity rather than efficiency factors. Further analysis of the salt-water intrusion problems found that the threat of court action by the injured parties caused a shift from the present status quo solution to one where pumpers in the uncontaminated area would be as well off if they contributed to the cost of a fresh water canal rather than suffer the consequences of having the courts adjudicate the basin. The aggregate profit level of the entire pressure area would be maximized under this solution as well.

SUPPORTED BY U.S. Dept. of Agriculture

2.1792, AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA
L.A. SCHINAZI, Aerojet General Corporation, *El Monte, California* 91734

This study has as its primary objective the establishment of a scientific basis from which meaningful recreational water quality criteria can be formulated. Ultimately, such criteria would be used as guidelines for setting recreational water quality standards. The health hazards faced by aquatic recreationists during primary contact activities (swimming, skindiving, etc.) in polluted water are being reviewed, analyzed, and mathematically related, with a view toward the construction of mathematical models which will correlate the variables involved in this epidemiological situation.

A secondary objective is the delineation of information gaps in our knowledge with respect to certain parameters needed to develop a rational basis for criteria formulation, and to suggest areas of needed research. The present investigation is restricted to a consideration of nine factors that represent the types of problems and parameters of importance in the development of recreational water quality criteria, namely, (1) total coliforms; (2) fecal coliforms, (3) salmonella, (4) viruses. (5) pesticides, (6) oils, (7) temperature, (8) pH, and (9) clarity.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1793, MEASUREMENT AND MANAGEMENT ASPECTS OF WATER TOXICOLOGY
E.S. FLOWERS, Univ. of California, School of Public Health, *Los Angeles, California* 90024

In this project, it is proposed to train students in laboratory skills and technical considerations necessary to evaluate, review, define, and manage water quality problems. Both laboratory and field studies will be conducted in four areas of interest. These are biomagnification of water contaminants in the food web, the effects of thermal additions to water on aquatic biota, airborne contamination of watersheds, and threshold effects of stressor agents. Contaminants to be considered include heavy metals, pesticides, radionuclides, and temperature changes.

Laboratory studies will involve analytical chemistry of contaminants and aquarium or light box studies of environmental factors affecting the numbers diversity, reproductive capacity, or behavior of aquatic species. Field studies using a material balance approach will be conducted on residential and wilderness areas of the Malibu Creek watershed in the Los Angeles area.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1794, SUPPORT OF RESEARCH VESSEL OPERATIONS
J.M. SAVAGE, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

This grant provides funds for the operational expenses of the research vessel VELERO IV of the University of Southern California. During the grant year the vessel supports an intensive program of study on the physical, geological and biological characteristics of the ocean off shore of central and southern California with special emphasis on the Santa Barbara Island basins. Specifically these investigations include studies of the relationship between the characteristics of water mass and the distribution and ecology of the midwater animals of the area; a study of bacterial populations in the areas where wastes are discharged into coastal waters; a study leading to the development of a system using the light absorption characteristics of coastal waters to define areas of pollution; studies on the biological effects of the oil spillage in the Santa Barbara channel; as well as a study of potential economic mineral concentrations on the coastal shelf off Southern California.

SUPPORTED BY U.S. National Science Foundation

2.1795, MARKETS TO 1980 FOR WASTE WATER TREATMENT AND RENOVATION FACILITIES
R.E. DELARUE, Stanford Research Institute, *Menlo Park, California* 94025

The overall objectives of the study are (1) to identify markets whose growth will offer business opportunities to suppliers of equipment, chemicals, materials, and services for waste water treatment; (2) to establish a timetable for the growth rates of these markets; and (3) to identify business strategies through which companies can successfully penetrate the markets. Specifically, the objectives are to:

1. Forecast the markets of 1980 for both municipal and industrial waste water treatment facilities that will be required for treatment of waste water either for release or reuse; including cooling towers.

2. Forecast the markets to 1980 for equipment (including instrumentation) and services for both municipal and industrial facilities.

3. Forecast the markets to 1980 for chemicals, materials, and supplies that will be consumed in the operation of municipal and industrial facilities.

4. Evaluate the effects of anticipated government legislation, policies, and expenditures on the markets for waste treatment and renovation.

5. Identify and analyze the criteria necessary for sponsors to compete successfully and profitably for these markets.

SUPPORTED BY No Formal Support Reported

2.1796, ASSESSMENT OF THE MARKET FOR WATER AND WASTE WATER INSTRUMENTATION AND CONTROLS, AND WATER QUALITY MONITORING SYSTEMS
R. MIKULA, Stanford Research Institute, *Menlo Park, California* 94025

The objectives of the research are to: (1) Forecast the market for instrumentation and controls in water treatment applications, (2) Forecast the market for water quality monitoring systems used by government agencies, (3) Assess the expected change in technology, user requirements, and competitive environment in these markets, (4) identify and evaluate the factors and business strategies that allow a company to compete profitably and successfully for these markets. Project initiated in 1968 and is continuing.

2. WATER QUALITY

SUPPORTED BY No Formal Support Reported

2.1797, PALO ALTO, SAN MATEO, AND MONTARA MOUNTAIN 7.5-MIN. QUADRANGLES AND VICINITY, CALIFORNIA
E.H. PAMPEYAN, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

States to which project pertains: California.

Objectives of the project are: (1) To prepare detailed geologic maps of bedrock and surficial deposits of the Palo Alto, San Mateo, and Montara Mountain Quadrangles, and adjacent parts of the Redwood Point and Woodside quadrangles that will establish the geologic framework and supply basic engineering geologic data needed by planners, engineers, and contractors for proper development of urban expansion and engineering structures in this area. (2) To add to the scientific knowledge of the geologic features. (3) To study the earth materials, including their physical properties and engineering behavior relative to foundation stability and use as construction materials.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1798, FORMULATION OF A GENERAL MATHEMATICAL MODEL FOR THE PREDICTION OF THERMAL ENERGY CHANGES IN IMPOUNDMENTS
G.T. ORLOB, Water Resources Engineers Inc., *Walnut Creek, California* 94529

The development of a generalized mathematical model which will represent, within the practical and reasonable limits of accuracy, the thermal changes which may be expected under alternative hydrologic, hydraulic, and climatologic conditions for operating reservoirs. It is intended that the work support and complement that already completed or underway by the Study Team in its investigation of the Columbia River System.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1799, NATIONAL AND ENVIRONMENTAL HAZARDS, DISORDERS, ENVIRONMENTAL QUALITY
I. BURTON, Univ. of Toronto, *Toronto, Ontario, Canada*

Several projects on various agents of human response to environment, forestry, and environmental quality and stressful elements in the environment studies on the following topics: Snow hazard in urban areas. Perception of hazards. The hazardousness of a place. Pollution and outdoor recreation, including beach use on the Great Lakes, and water pollution as a hazard to health of swimmers.

Selected work on floods, droughts, earthquakes, tornadoes is being performed at Clark University, Worcester, Mass. (R. W. Kates), University of Chicago (G. F. White) and Southern Illinois University, Carbondale, Illinois (Duane Bauman).

SUPPORTED BY U.S. National Science Foundation

2.1800, WORKSHOP ON RESEARCH PROBLEMS IN AIR AND WATER POLLUTION
W.E. BRITTIN, Univ. of Colorado, School of Arts, *Boulder, Colorado* 80304

It is proposed to hold a workshop of one week's duration on fundamental research problems in water pollution, followed by a similar program for air pollution. The contents of the workshops would be addressed to physical and biological, basic and applied research scientists. Highlighting the workshops will be addresses by outstanding authorities in such subject areas as effects of long term, low level exposure to pollutants, eutrophication, thermal pollution, fate of pollutants in the hydrosphere, micrometeorology, tropiospheric chemistry, and others. Specific emphasis will be placed on unanswered basic and applied research questions as contrasted to purely technological and legal questions. Although the workshops will be divided into sessions on air and water pollution, its major thrust will be directed toward the planning of overall environmental research programs. The need for such a workshop is based on the recognition that many fundamental scientific questions remain unanswered with the result that many regulatory programs already enacted or being conceived do not have sufficient scientific basis. Accordingly there is wide disagreement among scientists as to the relative biological risks of pollutants. A monograph containing the lectures of the distinguished speakers will be published. It is expected that the research identified will involve interdisciplinary problem-oriented efforts. The organizers of the workshop will be in close contact with personnel headed by Dr. Gilbert White. Thus the proposed workshop has a far broader significance than the mere discussion of air and water pollution problems.

SUPPORTED BY U.S. National Science Foundation

2.1801, GREATER ANCHORAGE AREA BOROUGH, ALASKA
E. DOBROVOLNY, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: Alaska.

In consequence of the geologic effects of the Alaska earthquake of 1964 and its impact on land development, local government officials asked the U.S. Geological Survey for additional geologic work deemed necessary for Borough-wide planning. To meet this request, a general geologic map on a scale of 1:63,360 has been prepared and is now in the final stages of compilation for the Greater Anchorage Area Borough, which encompasses about 1,750 square miles. Study of Quaternary deposits is emphasized because most land-use development is concentrated on them. Special-purpose maps, such as slope stability, construction materials, and foundation and excavation conditions are being prepared from the general geologic map for use by planners and developers. The geologic work is closely coordinated with hydrologic investigations being conducted by the USGS Water Resources Division. Data developed by these combined studies are adequate to establish patterns of geologic and hydrologic relationships applicable to regional planning. For specific site development, however, more detailed and intensive investigation is required.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1802, PLANNING AND SPECIAL STUDIES
D.A. HOFFMAN, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

A general, long-range approach is necessary for developing a coherent and purposeful water quality program. As one of the necessary steps in developing such a program, new studies of particular phases of the overall program will be explored and, where applicable, developed into individual programs. Proper integration with the work of other groups will be required, and an overall program will be coordinated with all of the Bureau programs and with related studies of Federal, State, and Local agencies. In order to fully accomplish these objectives two programs have been set up under this program: 1. Coordination and Planning - Division of Research personnel will attend meetings, conferences, and symposiums which pertain to the Bureau's water quality and ecology research program. Coordination meetings with other Denver personnel will continue. A meeting with regional personnel will be held in order to maintain awareness of regional problems. The research program will be evaluated to determine if it is meeting the Bureau's needs and responsibilities. Planning meetings will be held to develop a seminar concerning water resource projects and ecology, to be co- sponsored with the American Institute of Biological Sciences: 2.Special Studies - A review of the literature concerning the state of the art and research needs of reaeration was conducted in-house. A seminar will be held for Denver Office engineers and scientists by Dr. Krenkel of Vanderbilt University and Dr. Tsivoglou of Georgia Institute of Technology. The results of the literature review and seminar will be used to develop future applications of this technique for water quality enhancement. Research will be conducted in improving the techniques for collecting and analyzing unique water quality parameters with emphasis on heavy metals associated with mine drainage.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.1803, GEOLOGY OF URBAN DEVELOPMENT
H.E. MALDE, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: New Mexico.

Objectives: 1. Calibrate existing geologic factors in large unspoiled tracts vulnerable to development and thereby begin long-term appraisal of effects of urban impact. 2. Prevent future urban problems by making geologic data available for immediate designs in land use. 3. Interpret geologic data for use by planners in adding strength to zoning standards, grading specifications, and building codes. 4. Assemble information on the geologic methods adopted and their application and results as an example of work to be considered in other areas subject to urban impact.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1804, VALUE OF DESALTED WATER FOR IRRIGATION
H.L. PARKINSON, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Three irrigated study areas, located near Yuma, Arizona, Phoenix, Arizona, and Thermal, California, are being studied at reconnaissance level to determine the value of various water quality levels for irrigation. Improved water quality would be achieved by desalting brackish water in the 2000-5000 ppm range. Water quality levels of 50, 400, 900, and 1500 ppm are being studied. Desalting costs are being developed for both electrodialysis and multistage flash methods. Efforts are being made to maximize the possible benefits. Soil salinity is being held at optimal ranges for maximum production of selected crops by utilizing an adequate amount of deep percolation. Crop enterprise budgets are being used to evaluate potential direct benefits. Crop selection is carefully done to assure the best net income at each water quality level. Crops vary some between study areas. Yield levels are projected to 1990 for benefit evaluations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.1805, ECONOMIC AND INSTITUTIONAL ANALYSIS OF WATER QUALITY STANDARDS AND MANAGEMENT
K.C. NOBE, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00010)

OBJECTIVE: Review, describe and analyze the legal and institutional settings within which the present Colorado Water Pollution Control Program developed, and appraise for efficiency and effectiveness the standards created. Develop an economic model for analyzing the efficiency of alternative methods and levels of water quality management. Determine optimum methods and levels of water quality management for selected areas in Colorado and the nature, incidence and magnitude of benefits and costs with agriculture as the source or recipient of pollutants. Assess the economic efficiency of state and federal water quality standards as related to situations studied and suggest guidelines for revision where appropriate.

APPROACH: Collect information on state and federal laws, regulations and standards on water quality management and data on institutional structures in use. Collect data on pollution and control from selected areas. Evaluate the legal and economic data collected. Analyze alternatives for modifying water quality standards over time, subject to data constraints, so as to take into account economic efficiency as a decision making criterion. Prepare project report.

PROGRESS: A compilation of federal and state water quality standards, laws, and regulations. A review of the related literature and research. Hydrological data on this area will be obtained from Gaylord Skogerboe, Agricultural Engineering, Colorado State University, who has done extensive research in that geographic area and is willing to cooperate in our research effort. Conferred with researchers of various disciplines at Colorado State University and other institutions who are working with this subject to discern the available technical data collected. Discussed this subject with the Colorado Water Pollution Control Commission and the Federal Water Pollution Control Agency, Denver Office, to discern institutional conditions, relationships, and possible constraints preventing more effective water quality control, and to obtain information regarding data and problem areas needing emphasis.

SUPPORTED BY Colorado State Government

2.1806, A STUDY OF LEGAL AND ADMINISTRATIVE PRACTICES RELATING TO LAKE POLLUTION IN THE NORTHEAST
W.C. KENNARD, Univ. of Connecticut, School of Agriculture, *Storrs, Connecticut* 06268

To identify major legal problems relative to lake pollution in the Northeast United States, generally, and Connecticut, in particular. To establish basic criteria for consideration in the formulation of policies and methodologies for the enactment of legislation in the area. To fulfill the objectives cited, it will be necessary to: Engage in a detailed and exhaustive review of judicial decisions applicable to the water quality of inland lakes, with particular reference to Connecticut water jurisprudence. Engage in a detailed and exhaustive review of existing legislation applicable directly or indirectly to inland water quality, with particular reference to legislative developments in Connecticut. Resources will include: state and federal reporter systems; state and federal statutes; federal proposals and committee reports; relevant literature including, but not limited to, federal research studies, state and local research, reports of land planning agencies, reports of conservationist organizations; technological journals, texts. Solicitation of information from state agencies which have been concerned with these problems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1807, EFFICIENT PRICING FOR URBAN WASTE WATER RENOVATION - PHASE I
R.L. LEONARD, Univ. of Connecticut, School of Agriculture, *Storrs, Connecticut* 06268

The proposed research will identify for selected urban waste water renovation plants the impact of each major industrial waste component on the effectiveness of the treatment process and on operation and maintenance costs. Additional objectives include: identification of process changes and additions needed to produce a satisfactory final effluent, estimation of added costs resulting from treating various amounts of each major industrial waste, and development of pricing systems which will promote an effective and efficient combination of industrial waste control at the source and final treatment at the municipal plant.

Known methods of pricing based on allocating costs to volume, biochemical oxygen demand, and suspended solids are not applicable in urban areas producing complex wastes which impede the treatment process.

Two activated sludge plants receiving plating wastes have been selected for detailed analysis. The operation of these plants will be simulated through the use of a digital computer program. A simulation model developed for a conventional activated sludge plant will be modified to include the effect of plating wastes. The unit process characteristics will be determined by measuring 'as built' dimensions of equipment and by measuring flow, temperature and concentration of material between unit processes. Current prices in the area will be used in estimating cost relationships.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1808, WATER RESOURCES MANAGEMENT IN DELAWARE
F.X. TANNIAN, Univ. of Delaware, Division of Urban Affairs, *Newark, Delaware* 19711

The proposed research aims to evaluate the direct and indirect costs and benefits of water management agencies in Delaware. 1. The Delaware Water and Air Resources Commission. 2. The Delaware Public Service Commission. 3. The Delaware Department of Public Health.

A second and related objective is specification of small town voting rules for sewer and water investment decisions in Delaware.

2. WATER QUALITY

The model or approach of the state agency review calls for identification and analysis of the following water market features: 1. Legal and informal agency objectives. 2. Regulations relating to water and sewer service operating decisions. 3. Regulations relating to water and sewer service investment decisions. 4. Implications of these regulations for water quantity, water quality, direct costs, direct benefits, indirect costs and benefits, pricing-taxing, inter- agency impacts.

Voting rule analysis will be accomplished through interviews and questionnaires in Delaware small towns.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1809, WATER CYCLES, WATER RESOURCES PLANNING, AND URBAN DEVELOPMENT AT ROOKERY BAY, FLORIDA

R.F. DASMANN, Conservation Foundation Inc., *Washington, District of Columbia* (C-1817)

Centering on a watershed, estuary and bay located near Naples, Florida, the project is intended to study means of reconciling the pressures of urban development with the necessity for preserving the quality of environment. There are two aspects of the study. One, under the direction of the Institute of Marine Science will investigate the hydrology, oceanography, water quality and ecology of the Rookery Bay system as it is subjected to the urban development. Hopefully the development will proceed in accordance with a plan previously designed by the Foundation and the Institute. This plan is intended to protect the natural environment of the Rookery Bay system while permitting urban development to take place. Even in the event that this plan is not followed and development proceeds along other lines, the project will provide measures of the changes that take place. The second aspect of the project is intended to study the politics, economics, and social attitudes involved in the decision-making process in the Rookery Bay region in order to develop information useful to other areas where urban development takes place in a similar water-oriented environment. This aspect of the study will be conducted by The Conservation Foundation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1810, ENVIRONMENTAL QUALITY

UNKNOWN, Resources for the Future Inc., *Washington, District of Columbia* 20036

About six years ago, Resources for the Future began research on environmental quality, particularly on water pollution problems. From these initial studies has developed the beginning of a conceptual framework for analysis of pollution problems.

Results of the studies point to two central concepts. The first states that wastes are simply residuals from the variety of extraction, production, and consumption processes in which man engages. Residuals occur as gases, liquids, or energy and are discharged into or onto the air, water, and land. So long as the amounts of the residuals do not exceed the capabilities of these natural systems for absorption and regeneration, no serious harm is done. When they do, pollution is the result.

The second concept states that since matter cannot be destroyed, a major objective of residuals management must be a reduction in the total amount of wastes that is generated, through a reduction in the total input of material in the system.

Scientists of Resources for the Future are now seeking to complete and refine the conceptual framework. One approach will be a series of individual studies, including such topics as how the decision-making structures in a democratic society are related to efficient environmental quality management and how reasonably accurate projections of residuals can be made on a regional and national basis. Another project will be to construct a computer model capable of examining a variety of management strategies in terms of their costs, benefits, and distributional implications. A third approach will be to make case studies of certain defined geographic areas. In the latter approach, Resources for the Future plans to involve itself with local groups; in that manner, local capabilities, and perhaps a regional laboratory, would be developed that could continue an analysis of the environmental problems of the region.

SUPPORTED BY Rockefeller Foundation - New York, N.Y.

2.1811, URBAN INFRASTRUCTURE INVESTMENT IN DEVELOPING COUNTRIES

L. WINGO, Resources for the Future Inc., *Washington, District of Columbia* 20036

The identities are being sought of the determinants of investment in urban public facilities in developing countries with special attention to the Latin American experience. The principal areas considered are housing, school facilities, transportation facilities, public buildings, public health facilities, and water and sewerage. A crucial part of the study involves statistical analysis of the economic characteristics of the urban areas of Chile as they relate to the country's existing stock of urban public facilities.

Document provided by Highway Research Information Service.

SUPPORTED BY Resources for Future Inc. - Wash., D.C.

2.1812, ENVIRONMENT AND TECHNOLOGY ASSESSMENT

J.L. LIVERMAN, U.S. Atomic Energy Commission, *Washington, District of Columbia*

The program attempts to evaluate the impacts that technology has had on the environment and to explore ways to reverse or prevent such impacts in the future. The program is concerned with environmental assessments of electrical energy, its generation and use, materials (i.e., toxic substances) and of waste management techniques. It also focuses on the development of research methods and analytical techniques relevant to achieving these assessments. These include an environmental information system, regional modeling, environmental indices, and education and communication. The problem assessment activity relies heavily on case studies and on continuous problem monitoring and evaluation. It is also related directly to analytical and laboratory research efforts which include: (1) total social cost of electrical energy, (2) trace element profiles through coal fueled plant; (3) econometric demand-supply model; (4) convergence of social and market equilibria; (5) analysis of abatement costs; (6) waste heat utilization; (7) alternative patterns in energy use; (8) rapid, high- sensitivity x- ray fluorescence for analysis of toxic heavy elements; (9) ecology of toxic metals; (10) toxic metals and lake and river sediments; (11) substitution technology for toxic and critical materials; (12) materials in aqueous streams; (13) environmental mutagenesis studies; and (14) techniques for measuring the mutation rate in man. The goal of the program is to understand the options (both technological and social) for societal choice in environmental problem solving. Crucial to this goal is the distillation of information necessary to produce clearly stated alternatives and their associated consequences.

SUPPORTED BY U.S. National Science Foundation

2.1813, LEGAL ASPECTS OF WATER RIGHTS IN THE EAST

H. ELLIS, U.S. Dept. of Agriculture, Natural Resource Econ. Div., *Washington, District of Columbia* 20250 (NRE3-2-54-00)

OBJECTIVE: Review, analyze, and compare the development and current status of laws applicable to water rights and regulation in the 31 Eastern States. This includes the States lying east of the Mississippi River and along its western border.

APPROACH: Analyses are made of state and federal statutes, constitutional provisions, court decisions and other factors applicable to water rights and regulation such as administrative regulations and contractual agreements, problems in acquiring or exercising private or public rights to use various sources of water for agricultural and other purposes, relationships to economic and physical factors, interstate and international considerations, and possible improvements in the applicable laws or their operation. The findings may be published separately for individual states or in reports that cover and compare all or several of the states.

PROGRESS: A paper was published discussing developments and issues concerning water rights regulation in the 31 Eastern States, including a discussion of court-made private and public water rights; contractual arrangements; permit systems and other regulations of water use, development or pollution and lake levels; and emerging issues. A summary and detailed report published on Indiana water law includes analyses of relevant court decisions, legislation, administration of water-use laws in Indiana, and suggestions for legislative action. A report on institutional arrangements for supplying and distributing irrigation water in North Dakota in the Garrison Diversion Unit, Missouri River Basin project, was also published including contractual arrangements between the Bureau of Reclamation, the Garrison Diversion Conservancy District, and irrigation districts. A manuscript on water- use law and administration in Wisconsin, in final publication stage, discusses the development of court decisions and the role of different levels of government concerning water use in Wisconsin, including an examination of the actual administration of a number of statutory laws. Other work in progress includes a supplemental national bibliography on water-law publications and a bibliography on federal-state jurisdictional questions.

SUPPORTED BY U.S. Dept. of Agriculture

2.1814, AIDS FOR WASTEWATER SYSTEM PERSONNEL SAFETY AND ADVANCEMENT
G.W. BURKE, U.S. Dept. of the Interior, Federal Water Quality Admin., *Washington, District of Columbia*

In this project expert consultants will prepare informational materials describing the use of recommended practices in maintaining safety and in testing certifying qualified personnel in water pollution control facilities. The consultants will study selected programs and evaluate the pros and cons on each program.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1815, WATER LAW OF SOUTHEASTERN ESTUARIES
M.W. COLLINS, Univ. of Georgia, Inst. of Government, *Athens, Georgia* 30602

This will be a comprehensive survey of the estuarine water law of Louisiana, Mississippi, Alabama, Florida, Georgia, and South Carolina. The resulting monograph of approximately 300 pages would draw conclusions as to the extent to which the law of these jurisdictions (1) protects commercial fishing and public recreational uses against deleterious competing uses such as pollution, land-fill, and dredging, (2) is related in this respect to the law of bordering states and to the federal regulatory power in marginal and territorial seas. Conclusions will be drawn as to overlaps, gaps, and conflicts of the present law. These can provide bases for remedial state and federal action to restore and preserve the estuaries of Southern states. The study can assist similar research in other regions of the United States.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1816, EVALUATION OF BENEFIT-COST ESTIMATION OF THE ECOLOGIC AND ECONOMIC IMPACTS FROM WATER RESOURCES CONSERVATION AND DEVELOPMENT
R.M. NORTH, Univ. of Georgia, Inst. of Natural Resources, *Athens, Georgia* 30601

The purposes of this research are to evaluate the effectiveness of the benefit-cost estimation of water resources conservation and development projects and to identify values and procedures which will more fully account for positive and negative changes in the ecology and economy of areas affected by project development.

The specific objectives of this research are: (1) To compare the actual and estimated benefits and costs accruing to project design purposes; (2) to estimate certain associated ecologic and economic changes induced by projects which were not enumerated in project formulation and planning; and (3) to suggest methods and values for expanding benefit-cost considerations to additional ecologic and economic impacts expected from future projects.

Data collection and analyses will be concentrated on a selection of representative projects in several physiographic regimes of the Southeast. Emphases will be placed on the selection of completed small watershed projects. The analyses will consider (1) investment costs, (2) OMR costs, (3) alternative costs for achieving similar project purposes, and (4) associated costs such as the loss of wildlife habitat and product. Comparative analyses of these costs will be made with (1) direct benefits from each purpose, (2) benefits from alternative methods of achieving project purposes, and (3) associated benefits such as improved wildlife habitat or product.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1817, ANALYSIS OF LAND USE PATTERNS - DOCTORAL DISSERTATION RESEARCH
G.L. PLUMMER, Univ. of Georgia, Graduate School, *Athens, Georgia* 30601

This dissertation research is on analysis of land use patterns in Georgia. The study will determine the applicability of phytosociological concepts at the community-ecosystem level and will include human as well as natural communities. Reference points will be established that might be used for predicting changes in the ecosystem composition.

SUPPORTED BY U.S. National Science Foundation

2.1818, A STUDY OF PUBLIC ATTITUDES AND MULTIPLE OBJECTIVE DECISION CRITERIA FOR WATER POLLUTION CONTROL PROJECTS
G.J. THUESEN, Georgia Inst. of Technology, Environmental Resources Center, *Atlanta, Georgia* 30332

The objective of the proposed research is an investigation of quantitative methods for translating public attitudes and conceptions about water pollution into criteria that will be useful in planning pollution control projects. These methods will include various analytical techniques including mathematical programming, Bayesian statistics, decision theory, Markov chains, and simulation. In addition, the decision criteria developed will be evaluated in order to determine its effectiveness as decision aids in the planning process. The evaluation of these criteria will be accomplished by comparison of its effectiveness when applied to simulated decision problems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1819, ILLINOIS AND ITS INTERSTATE COMPACTS
M.E. RIDGEWAY, Southern Illinois University, Graduate School, *Carbondale, Illinois* 62901

Examination of the interstate compacts to which Illinois is a party, their legal status, agency and institutional arrangements, administrative powers and problems. Within determined limits, comparisons of Illinois' arrangements with those of other states to ascertain areas of possible improvements in control, direction, and achievement of compact proposals and goals. This study includes three interstate water compacts: The Ohio River Valley Sanitation Compact, the Wabash Valley Interstate Compact, and the Great Lakes Interstate Compact. Auxiliary to the water question is the Bi-State Development Compact of Illinois and Missouri. This latter compact also embraces metropolitan area problems, including water and air pollution.

SUPPORTED BY Southern Illinois University

2.1820, NETWORK EVALUATION OF WASTEWATER COLLECTION ECONOMICS
R.S. GEMMELL, Northwestern University, School of Technology, *Evanston, Illinois* 60201

Using a digital computer, a network model will be developed to represent the economics of wastewater collection as a function of urban form and structure. The basic objectives of the project are: (1) to test the hypothesis that waste-water collection network costs are a function of urban form and structure: city size, shape, pattern and the spatial distribution of people and activities; (2) to explore the cost behavior of sewer networks under different conditions of urban form and structure; (3) to explore the cost impli-

cations of simultaneous variations of urban size and density distribution of the population; (4) to develop a predictive model for wastewater collection network costs; and (5) to develop a methodology for evaluating the impact of planning decisions on sewer system costs. The research procedure is: (1) develop cost functions for network link components (pipes, etc.), (2) select network design criteria, (3) determine cost functions of network nodal components (manholes, pumping stations, private collection costs within buildings, etc.), (4) develop cost-sensitive measures of urban form and structure, (5) examine aggregate network cost functions and their correlation with the urban attributes previously developed, and (6) extract conclusions regarding costs and benefits of planning decisions relating to wastewater collection.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1821, PERFORMANCE OF REGIONALLY RELATED TREATMENT PLANTS

R.S. GEMMELL, Northwestern University, School of Technology *Evanston, Illinois* 60201

In planning for wastewater treatment facilities within a regional system, the question of the optimal degree of centralization of treatment facilities is of interest. There are two major considerations to be made in the answering of this question of the optimal degree of centralization. One is, how does centralization affect the economics of interceptor and outfall piping systems and plant construction and operation in the case of (a) centralized and (b) spatially separated treatment facilities? The other consideration is, what are the corresponding effects of many spatially separated effluent streams and a few centralized effluent streams on the receiving waters with regard to (a) the areal distribution of effluent streams and (b) independently fluctuating qualities of effluent streams?

To study the performance of regionally-related wastewater treatment plants, a performance model based on findings of an analysis of actual plant operations data is to be developed. The basic objectives are: (1) study and develop mathematical representations of the stochastic nature of individual wastewater treatment plant input and output parameters, (2) study and develop mathematical representations of the dependence of relative operating efficiencies among treatment facilities of a multiple plant regional system through developing a methodology for testing dependence and conducting tests on actual data, (3) apply the mathematical functions derived above to existing performance models of regional treatment plant systems, or (4) develop a performance model for a multiple plant regional treatment system based on the above findings, in the event that the models applied in (3) are inadequate. The model capabilities would include the determination of resulting water qualities and the economic impact of achieving those water qualities from alternative systems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1822, CITIZEN WORKSHOPS ON CLEAN WATER FOR AMERICA

J.W. PENFOLD, Izaak Walton League of America, *Glenview, Illinois* 60025

The purpose of the project is, by means of national and regional workshops, to equip a substantial number of citizen organization leaders to organize and conduct citizen workshops on water quality criteria at state and community levels. At these workshops, the opportunities for clean water progress, made available by the Water Quality Act of 1965, will be comprehensively discussed under the guidance of technical experts.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1823, ENVIRONMENTAL GEOLOGY OF BOONE AND DEKALB COUNTIES, ILLINOIS

J.P. KEMPTON, State Geol. Survey, *Urbana, Illinois* 61801

A report on the sand-and-gravel and dolomite resources of counties has been published and is available; the remainder of the information will be available when published. The rapid growth and development of Boone County and the northern half of DeKalb County have indicated a need to develop information on the geologic conditions related to land- use planning. This study will relate knowledge of the geologic conditions related to land-use planning. This study will relate knowledge of the geology, including occurrence of water and mineral resources (sand and gravel, dolomite, clay, borrow material, etc.) to urban and industrial growth, waste-disposal needs, open-space development, flooding, storm drainage, surface reservoirs, and general engineering conditions.

Published information on the bedrock geology and bedrock topography has been modified to present information on the area of occurrence and depth of the major bedrock aquifers and on dolomite resources. Subsurface and surface mapping have proceeded to outline the stratigraphy, distribution and character of the glacier deposits. Information on the glacial drift will be applied to evaluation of the occurrence of sand and gravel as a material resource and as aquifers and to the drift in general in terms of construction conditions and waste disposal.

Illinois State Geological Survey review, June 1970: Discontinued. DeKalb County published as Environmental Geology Note 33.

SUPPORTED BY Illinois State Government - Springfield

2.1824, DEVELOPMENT OF COST CRITERIA FOR WATER SUPPLY

J.H. DAWES, State Water Survey, *Urbana, Illinois* 61801

An effort is being made to develop cost data criteria to be applied in comparisons of alternative water resources developments. These criteria will be extracted from actual cost data collected from federal, state, municipal, and private agencies. The study encompasses impoundments, well supplies, and transmission facilities. Although the study is being made for Illinois, the purpose and format of its results should be of general interest.

Completed as of August 1969 were the following technical letters: No. 7, Water Transmission Costs; No. 8, Cost of Reservoirs in Illinois; No. 9, Cost of Pumping Water; No. 10, Costs of Wells and Pumps; No. 11, Cost of Water Treatment in Illinois; and No. 12, Sewage Treatment Costs.

Cost studies are continuing for the development of working tools in our water resources development model that involves the capture, storage, treatment, distribution, reconditioning and recovery of water supplies.

SUPPORTED BY Illinois State Government - Springfield

2.1825, LAKE MICHIGAN WATER QUALITY MODEL

R.L. EVANS, State Water Survey, *Urbana, Illinois* 61801

The specific objective of the project is to develop a mathematical water quality model for Lake Michigan. Model formulation will be primarily based upon information regarding dissolved conservative mineral substances. The data will be from records that are available and will pertain to the chemical quality of rainfall, natural and man- made discharges, and waters of the lake. Changes in content as expressed by the model in relationship to economic growth, population shifts, etc., will serve as an instrument for water quality management.

SUPPORTED BY Illinois State Government - Springfield

2.1826, WATER QUALITY MODEL DERIVED FROM SYSTEM ANALYSES

R.L. EVANS, State Water Survey, *Urbana, Illinois* 61801

As a subsystem for an overall endeavor to develop a water management program for the Kaskaskia River Basin, the elements and their interrelations and interactions for a water quality model are being defined; once defined these elements will be used for developing a water quality model. The objective of the model will be to determine the degree of treatment required for each waste discharger in order to achieve a desired water quality objective at the minimum cost to all dischargers.

SUPPORTED BY Illinois State Government - Springfield

2.1827, WATER QUALITY CRITERIA FOR SELECTED RECREATION USES
D.W. BISHOP, Univ. of Illinois, Graduate School, *Urbana, Illinois* 61801

The proposed research plan involves laboratory and field investigations directed at the determination of water quality criteria for selected recreation uses. The objectives of the project are: I. To survey the types and extents of water pollution which are, or are considered to be, detrimental to selected water-oriented recreation activities of the residents of a six county area in East Central Illinois. A. To determine the beliefs and attitudes toward different types and extents of pollution for different activities (questions about what types and extents of pollution bother the respondents). B. To determine if choice of location for particular activities is related to physical measures of water quality. C. To determine types of pollution that users believe to affect their choices of sites for particular activities, and how the users conceptualize those pollutants. These problems are to be investigated for both on-site and off-site users. II. Water quality criteria for water oriented recreation, based on a combination of information from the survey and from existing quality standards; and to develop a rating scale, for selected recreation uses of water, based on the quality criteria.

The research will be conducted by survey questionnaires and interviews of users at recreation sites and at off-site locations. Statistical analysis may include Kendall's coefficient of concordance, differences in the mean or the number of cases, bivariate frequency tables, chi square analysis, and multiple regression techniques. Both chemical and biological tests of water quality will be made.

The survey method and methods for developing the water quality criteria and rating scale, if successful, will provide states, regions, other agencies and the nation with a tool to survey their residents, test their waters and develop comprehensive water qualiy criteria for recreation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1828, ECONOMIC EVALUATION OF THE EFFECT OF SELECTED CROP PRACTICES ON NON-AGRICULTURAL USES OF WATER
G.R. SWANSON, Univ. of Illinois, School of Agriculture, *Urbana, Illinois* 61801

A watershed in Illinois will be selected for an economic analysis of the effect of crop production practices on the quality of receiving waters. The concept of a watershed firm will be used. The criteria for choice of crops and management practices will be maximization of net farm income subject to constraints of resources available on farms in the watershed, allowable limits of silt accumulation in reservoirs, and acceptable levels of pollution by chemicals originating from crop production practices. In the event that these constraints effectively limit otherwise economically optimal levels of crop production practices, estimates will be made of the cost of altering each of the effective constraints.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1829, A QUANTITATIVE ANALYSIS OF LANDSCAPE ESTHETICS, WITH SPECIAL REFERENCE TO STREAM AND VALLEY SYSTEMS AND RELATED WATER AND LAND RESOURCES
W.N. MELHORN, Purdue University, School of Science, *Lafayette, Indiana* 47907

Development of the National Objectives Accounts has placed importance on environments and human well-being, supplementing the former emphasis on economic activity and growth in productivity. To assist the decision-making process regarding disposition and handling of water and related land resource projects, numerical data concerning the environment must be obtained for input into accounting procedures as conventionally done with technical and economic parameters.

Leopold has proposed a method designed to quantify esthetic features of environment. Using 46 field-evaluated descriptive categories of physical, biologic and water quality, and human use and interest factors, a 'uniqueness ratio' is determined for each stream segment, valley, or site. The system subdues or eliminates personal subjectivity and produces an objective numerical description for each stream or valley studied. The numerical value can be related directly to the environmental and human-well being factors of the objectives accounts.

Indiana basins and streams will be studied by the Leopold method, and additions, deletions or modifications made as appropriate to a mid- latitude temperate climate as opposed to the 'wild rivers' studied originally by Leopold. The results will provide quantitative data either supporting need for technical development of undeveloped water resources, or conversely provide numerical arguments favoring environmental protection.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1830, ECONOMIC ANALYSIS OF OPTIMAL WATER QUALITY MANAGEMENT
A. WHINSTON, Purdue University, Graduate School, *Lafayette, Indiana* 47907

The overall objective of the research proposal is the further development of the methodology and techniques of economic analysis as applied to water pollution. In particular, a substantial part of the work will attempt to apply these techniques to the White River.

The specific parts of the project may be listed as follows: 1) The development of steady state transfer functions for parts of the White River. 2) The formulation of water quality management models. 3) The development of mathematical techniques to solve the water management problems. 4) A study of the economics of a regional treatment system. 5) An extension of the model to the time variable case.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1831, TECHNOLOGY AND ECONOMICS OF CONSERVATION
P.E. ROSENBERRY, Iowa State University, U.S.D.A. Nat. Resour. Ec. Div., *Ames, Iowa* 50010 (NRE2-8-16-01)

OBJECTIVE: Determine and evaluate the economic aspects of current and developing technology of water management. This will include evaluating the effectiveness of alternative terrace systems and other land treatment measures in managing the flow of surface water to more effectively utilize precipitation in crop production through control of runoff, reduce soil fertility losses from sheet erosion, control gully growth, and reduce downstream sediment and flood damages. Associated effects which will be analyzed include the maintenance or improvement of soil productivity, pollution abatement, efficiency of machinery use, and the land area removed from production as a result of the water management measures adopted.

APPROACH: The first step will be a comparative cost study of alternative types of terraces as applied in the North Central Region. The analysis will consider slope, soils and methods of construction. The large, parallel, grassed-backslope terraces currently receiving widespread acceptance will receive particular attention. Additional studies will evaluate the effectiveness of representative terrace systems and other measures in producing various on-site benefits.

PROGRESS: Data on the construction cost per foot of grass backslope (GBS) terraces have been collected cooperatively with SCS in North Central Iowa since 1964. Initial analysis of the data indicated that the number of cubic yards of earth moved per linear foot of terrace was an important variable. Since hand computation of this variable was impractical, a model was designed with sufficient equations and interrelationships to handle the various terrace site situations and applied in computing cubic yards of earth needed per linear foot of terrace and the cubic feet of water storage for various terrace designs and ground slopes. Work related to the Treynor experimental watershed of ARS in southwest Iowa was reviewed in an oral presentation at the Mid-central meetings of the American Society of Agricultural Engineers in St. Joseph, Mo. The paper discusses the economic factors involved in a comparison of a terraced and unterraced watershed, in addition to topography, climatology and hydrology data.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Agriculture

2.1832, WATER RESOURCE DEVELOPMENT
J.F. TIMMONS, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01445)

OBJECTIVE: Develop an economic basis for allocating water among competing uses and users, investigate possibilites of structural means for developing water resources and sharing costs and benefits.

APPROACH: Uses of water from particular supply sources, i.e., aquifers or impoundments, will be identified. Productivities of water in various uses will be determined. Competitive and complementary ranges of uses will be identified. Effects on water quality by uses will be investigated with the costs of maintaining quality of water for re-use.

PROGRESS: Work proceeded on water quality management with particular reference to agriculture based upon sedimentation. Studies means were developed for tracing the causes and effects of various effluents arising within agriculture. Alternative means for assigning values to various qualities of water for purposes of allocation were identified and appraised. Methods for identifying and approximating demands and supplies of water of various qualities were developed.

SUPPORTED BY U.S. Dept. of Agriculture

2.1833, BALANCED STORM DRAINAGE
J.S. MCNOWN, Univ. of Kansas, School of Engineering, *Lawrence, Kansas* 66044

Rainwater flows on roadways, in gutters and through storm drains on its way to storm sewers. Selection of a design storm and analysis of consequent run off provide a value for the flow to be handled successively by the surface and underground systems. Despite resultant uncertainties in the quantity of flow to be handled, the system still should handle the expected flow efficiently, be economically designed, be free from hazards caused either by ponding in traffic lanes or irregularities on the surface, and satisfy such diverse requirements as safety to pedestrians and self cleaning from brush, silt and leaves. Finally, the system should not unduly restrict traffic for storms which exceed the design value.

Present practice is well defined only for the series of inlets tested at Johns Hopkins with flush and depressed horizontal gratings. Additional study is required for curb-inlet openings and various combinations of Froude number, slope, alignment curvature, grating arrangement and approach flow. For example, small indentations upstream from the opening can significantly increase the effective length simply by allowing flow curvature to begin before the opening itself is reached. Such factors will be analyzed and tested in the laboratory after study of current practice and laboratory investigations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1834, THE POLITICAL AND ADMINISTRATIVE PROBLEMS OF INSURING APPROPRIATE RESIDENTIAL SERVICES IN THE PERRY AND CLINTON RESERVOIR AREAS
S.M. WYMAN, Univ. of Kansas, Graduate School, *Lawrence, Kansas* 66044

This study is focused on political and administrative problems facing local governments responsible for controlling the impact of residential development on water quality in the Perry and Clinton reservoir areas in Kansas. Significant constraints on both the local governments and other parties involved in development will be identified and described. These descriptions will be based on attitude surveys of developers, small parcel owners, and state and local government officials regarding improvement costs, tax burdens, and changes in governmental policies, structures and powers. A review of the limitations and opportunities for reform existent in current statutes will also be conducted as will a comparative study to identify governmental patterns and procedures which have been effective at other Midwest reservoirs. A report will be written containing problem descriptions and recommendations for their resolution. This report will be designed for use by developers, governmental officials and interested citizens.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1835, A DETAILED INVESTIGATION OF THE SOCIOLOGICAL, ECONOMIC, & ECOLOGICAL ASPECTS OF PROPOSED RESERVOIR SITES IN THE SALT RIVER BASIN, KENTUCKY
L.A. KRUMHOLZ, Univ. of Louisville, Water Resources Laboratory, *Louisville, Kentucky* 40208

The impoundment of the Salt River to form Taylorsville Reservoir has been authorized and the advanced engineering and design underway. Construction of the dam three miles upstream from Taylorsville, Kentucky, is scheduled to begin early in 1971. This is the first of a series of three impoundments proposed for the Salt River Basin.

The overall project will include detailed studies of the impact of such impoundments on the biological, sociological, agricultural, and economic characteristics of the areas to be impounded and their environs. The biological phases of the project will include detailed ecological studies of the aquatic environment and the contiguous terrestrial areas. Sampling the biota and collection of physical and chemical data have been underway for more than a year and will continue at biweekly intervals at 20 stations throughout construction of the dam, clearing the reservoir site, impounding the water, and for at least 5 years after impoundment. Changes in water quality and in the biota will be documented as they take place.

This project extends and broadens the biological, physical, and chemical phase of the investigation into its third and fourth year. The sociological phase of the study is underway under the direction of Drs. Henry F. Dobyns and Rabel Burdge of the University of Kentucky. Economic studies of the area will continue under the supervision of Dr. John P. Nelson of the School of Business, University of Louisville.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1836, STUDY OF A RIVER SYSTEM AS A CHEMICAL REACTOR (PHASE II)
E.C. BOALEK, Univ. of Maine, School of Technology, *Orono, Maine* 04473

Phases I and II involved an experimental plan, grounded in a base of chemical reactor control theory. This plan guided design, construction, and field testing of necessary hardware systems for continuous monitoring, transmission and processing of data necessary to implement a new concept for programming pollution inputs in balance with the variable capability of the river to purge itself by oxidation reactions. Phase III projects an intensive program of data collection and analysis for the Penobscot River to provide an empirical base for decisions on: 1. The value to the control scheme of the presently projected river model compared to alternative models which can be developed using the same experimental data; and 2. Reconciliation of technical feasibility with economic consequences in implementing controls for a quality spectrum of attainable water specifications.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1837, ECONOMIC ANALYSIS OF ENVIRONMENTAL QUALITY EFFECTS ASSOCIATED WITH SEASONAL HOMES
D.M. TOBEY, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473

OBJECTIVES: Determine the environmental situations (positive and negative) associated with seasonal homes and analyze the attitudes, interests, and goals of people for a quality seasonal home environment. Evaluate the social and private costs and benefits of identified environmental situations at both the regional and national level. Determine the total potential market for seasonal homes in the Northeast and delineate the effects of environmental factors upon this market.

Approach. Case study method will be used in five selected areas: (1) Lake in organized township in Central Maine (2) Lake in densely populated area in Southern Maine (3) Lake in unor-

ganized township in Northern Maine (4) Community in densely populated coastal area in Southern Maine (5) Community in sparsely populated coastal area in Eastern Maine. For each selected area major factors analyzed will be air, water and scenic pollution. Causes will be related to methods of waste and sewage disposal and effects of unplanned land use. Systems analysis will be used to estimate social costs and benefits generated by environment effects. Benefit: cost ratio will be computed wherever possible.

Progress, 7/69 - 6/70: Investigators compiled taxation data from five seasonal home areas in Maine, a mixture of coastal and inland (lakeshore) communities. These data are being used for the construction of a sample of seasonal homes from which financial and attitudinal data will be collected.

Two communities were selected as study areas to be included in the regional research effort. Questionnaires, standardized for use throughout the Northeast region, were prepared to elicit attitudinal responses from officials, permanent residents, and seasonal residents of these communities.

SUPPORTED BY U.S. Dept. of Agriculture

2.1838, LEGAL ASPECTS OF WATER POLLUTION CONTROL THROUGH IMPLEMENTATION OF THE EFFLUENT CHARGE CONCEPT

O.E. DELOGU, Univ. of Maine, School of Law, *Portland, Maine* 04101

The three initial objectives of the study are: (1) to determine what legal constraints (if any) would burden or preclude the adoption of an effluent charge in Maine. (2) to design a suitable agency structure for imposing an effluent charge, administering the funds realized from such a charge, and adjusting the size of the charge to both quantity and quality of waste discharges and the costs over time of construction and maintaining the waste treatment facilities made necessary by the discharge of pollutant material into the state's waters. (3) to draft and submit to the legislature alternative legislative proposals for actual implementation of the effluent charge concept.

It is clear that the translation of the concept of effluent charge into a working program in any particular jurisdiction involves reducing abstract broad brush principles to detailed step-by-step implementing mechanisms, which must be consonant with the constitution, statutes, and administrative practices of the jurisdiction involved. The mechanics of handling the fund must be thought through and decisions as between state level construction of treatment facilities, regional (special district) construction of such facilities, or the local construction of such facilities must be made. Finally, the legislature must be presented with a series of alternatives each of which must be suitable to the jurisdiction and each of which must be supported by a commentary outlining the strengths and weaknesses of that particular approach.

This project will be completed during FY 1971.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1839, NORTHEAST VIRGINIA

L. PAVLIDES, U.S. Dept. of the Interior, Geological Survey, *Beltsville, Maryland* 20705

Major research objective is to study the geology of the outer Piedmont of northeast Virginia, and includes studies of the Coastal Plain and Triassic deposits where the quadrangle boundaries overlap into these two provinces. Closer dating of the Glenarm Series by determining the relationship of the Quantico Slate to the Arvonia Slate (mid-Ord.) is a prime topical objective. Supplemental objectives will include studies on distribution, thickness, and composition of saprolite; reconnaissance stream sediment sampling; evaluation of clay, sand, and gravel resources; and other general studies related to environmental problems. These will include complementing data obtained from geologic studies with analysis of existing soil maps to possibly evaluate factors such as suitability of land for urbanization with respect to sanitary waste disposal problems. It is hoped the environmental-oriented studies of this project will be of use to planners prior to the anticipated massive urbanization predicted for this general area (Washington-Richmond corridor).

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.1840, RESEARCH AND STUDY OF THE CHESAPEAKE BAY

R.W. KRAUSE, Univ. of Maryland, School of Arts, *College Park, Maryland* 20740

The research to be conducted under this project involves the initial implementation of a comprehensive research plan and research management methodology outlined in a report entitled 'The Chesapeake Bay: Report of a Research Planning Study', submitted to the National Science Foundation by the Johns Hopkins University, the University of Maryland and the Virginia Institute of Marine Science.

In the research program major attention will be directed toward the construction of a data bank for storage and retrieval of information classified according to an inventory methodology designed to identify all the significant entity interactions of the Chesapeake Bay, their respective processes and characteristics. Such information will assist in the management of the Bay and in delineating those areas of inadequate knowledge for which research is necessary.

A second objective is the application of systems analysis to the Bay and its components for a comprehension of its dynamics, its characteristics and its probable fate according to the choices made in the management process.

A third objective is initiation of an integrated research program in biology, physics and chemistry, economics, and sociology, behavioral sciences and institutions, including government and law.

In addition, specific problem areas and case studies will be the subject of intensive interdisciplinary research.

SUPPORTED BY U.S. National Science Foundation

2.1841, A METHODOLOGY FOR PLANNING OPTIMAL REGIONAL WASTE MANAGEMENT SYSTEMS

D.D. ADRIAN, Univ. of Massachusetts, School of Engineering, *Amherst, Massachusetts* 01002

A regional system of waste management encompasses several communities lying on the watershed of a stream which is used for effluent disposal. These communities may at present have various types of treatment plants. Regional planning is an attempt to maintain or to upgrade stream quality by expanding or adding new facilities while considering the region as whole rather than on a piecemeal, community by community basis. The expected outcome of this type of planning is the pooling or sharing of some facilities thereby significantly lowering the cost of meeting stream standards.

The overall objective of this research is to develop a practicable methodology for regional waste water management planning employing economic optimization techniques. It is proposed that this be done as follows:

A. Form a research team drawing personnel from several disciplines. B. Develop for each sub-system of the regional plan quantitative expressions defining and describing: 1. Physical relationships among variables. 2. Significant constraints on the subsystems 3. Cost functions. C. Construct over-all mathematical model integrating the above relationships. D. Adapt and develop techniques for model analysis and optimization. Code these techniques for a computer. E. Devise methods for testing the model in the absence of existing regional waste management plans and test the model in accordance with these methods.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1842, FORMATION OF PUBLIC POLICY ON OUT-OF-BASIN DIVERSION OF CONNECTICUT RIVER FLOOD WATERS TO BOSTON METROPOLITAN AREA

B.B. BERGER, Univ. of Massachusetts, Water Resources Research Ctr., *Amherst, Massachusetts* 01002 (C-2169)

The study will seek to answer two sets of questions: (1) How does public policy evolve in respect to this inter-basin transfer of water? Subordinate questions are: (a) How did the various in-

terested public groups form their opinions on this controversial issue? (b) How did the attitudes of these public groups change in time and what factors accounted for these changes? (c) How effective were public hearings in providing an opportunity for expression of public opinion? (d) What factors most strongly influenced the attitudes of the members of the special task force assigned by the General Court to the study of the proposed legislation? (2) What consequences in the Connecticut River Basin may reasonably be associated with diversions out of the basin? Subordinate questions are: (a) What is the role of flood flows in scouring bottom deposits? (b) What is the role of spring and autumnal flood flows in triggering movements of anadromous fish? (c) What is the role of flood flows in nutrient supply and removal? (d) What is the role of flood flows in the pollution of the river and its amelioration? (e) What is the influence of flood flows on the ecology of tidal and estuarial water? (f) What are the long-term water supply requirements of the basin region? (g) What is the role of Connecticut River flood flows in recharging regional groundwater aquifers important to the region?

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1843, EVOLUTION OF PUBLIC POLICY ALTERNATIVES IN MAXIMIZING PUBLIC BENEFITS RESULTING FROM WATER QUALITY IMPROVEMENT

J.H. MARTIN, Univ. of Massachusetts, Graduate School, *Amherst, Massachusetts* 01002

The objective of this proposed research will be to produce a model by means of which: 1. Increased values of water-related lands may be estimated as a result of water quality improvements. 2. The beneficiaries of these increased values with prevailing public policies on land use may be identified. 3. Alternative strategies may be described, by means of which these increased values may produce maximum public benefit. 4. A basis for prudent public policy may be recommended.

The study will be an attempt to show how the massive commitment of public funds may be best employed to serve certain varying-term objectives. How over the long-term the expenditures of funds may be realised as a massive capital investment in one of the nation's most valuable natural resources: its natural rivers, lakes and riparian lands.

Study area: The lower pioneer valley regional planning district of the Connecticut River in Massachusetts.

Work includes: 1. Examining public, private and commercial attitudes towards water, water pollution, and water pollution abatement. 2. Inventory and analysis techniques for water-lands. 3. Governmental structures and attitudes. 4. Models for water-land use planning: policies and strategies. 5. Case studies of application of models to selected water-land situations 6. Aesthetic factors.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1844, ECONOMIC ANALYSIS OF COORDINATED WATERSHED PLANNING

J.B. WYCKOFF, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01002 (MAS00281)

OBJECTIVE: Determine the private costs of meeting water quality standards in a selected watershed. Synthesize the cost of meeting water quality standards through coordinated planning of a watershed. Examine the institutional setting affecting coordinated watershed planning. Examine the social costs and benefits associated with alternative water quality levels.

APPROACH: A watershed within the state ordered to improve its water quality will be studied in detail. Each individual firm and community is essentially solving their own problem. The private costs involved will be determined. Public health records will be utilized to determine the quantity and quality of effluent discharge by each in the watershed and aggregated for the stream total. An optimum treatment system, planned on a coordinated watershed basis, will be programmed considering alternatives. The legal, political, social, and economic institutions affecting coordinated planning will be determined and evaluated. Implications of the existing institutions relative to the efficiency of coordinated planning will be studied. The social costs and benefits of water quality will be determined. The framework provided by welfare economics will be used to determine the net effects upon society.

PROGRESS: A recent legal decision has freed access to the remainder of the data needed for the project. This is now being collected and analysis is being completed. Although the analysis is not complete, preliminary indications are that the existing Federal regulations which must be met in order to qualify for Federal grants and aid may be resulting in the 'wrong' pollution control systems being built.

SUPPORTED BY U.S. Dept. of Agriculture

2.1845, DATA COLLECTION ECONOMICS FOR WATER POLLUTION CONTROL STUDIES

A.S. GOODMAN, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

Specific Aims - Water pollution control agencies have programs for collecting data and processing them in accordance with procedures that have evolved over the years. Due to the very large number of projects, it is desirable to make these programs more efficient and therefore less costly. It would be expedient for these agencies to know the relative importance of various field and laboratory data in making water and wastewater studies.

The proposed research expects to be able to indicate: (1) for portions of such programs, where field and laboratory techniques are well developed, the extent of sampling needed for useful results and (2) for portions of such programs where field and laboratory techniques are not well developed, the relative importance that ought to be placed on researching and developing such techniques.

Methods - Data used for predictive formulas and for program examination and enforcement would be classified. The intent would be to focus on data which are needed for mathematical analysis. Electronic computer studies would vary data within expected ranges and determine resulting river water qualities and economic effects. Other statistical and economic analyses would also be employed.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1846, WATER AND THE CITIES

E. MILLER, A B T Associates, *Cambridge, Massachusetts* (C-1469)

The proposed research is to: 1. investigate the question of the costs and the benefits of investment in pollution abatement aimed at expanding water recreation facilities, 2. to examine the potentialities of new directions in urban design that are made possible by the availability of waterfront land for other than transportation-oriented activity, 3. to conduct a reconnaissance into the technology of water supply and its alternatives to predict developing patterns of feasibility and highlight important trade-off margins among competing techniques and 5. to examine the industrial, aesthetic, residential, commercial and recreational interaction of an urban estuarial environment. Interim reports are available from: Edward Miller, ABT Associates, 55 Wheeler Street, Cambridge, Mass. 02138.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1847, THE ECONOMICS OF WATER SUPPLY AND QUALITY

R. DORFMAN, Harvard University, Graduate School, *Cambridge, Massachusetts* 02138

The objective of this research is to develop improved methods of planning water resource developments in situations where municipal and industrial water supply and pollution problems are significant.

This work is comprised of three essential parts. First is the study of the economics of water pollution abatement at the waste source and the construction of functions which reflect the losses and benefits associated with alternative abatement measures such as low flow augmentation, long-distance waste transport and in-stream treatment. Second is the study of the economics of municipal and industrial water supply and the development of improved benefit and loss functions for water system performance.

Finally these economic functions will be incorporated into simulation models of the Delaware River basin and estuary with the objective of developing improved methods for planning water supply and pollution abatement policy.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1848, INPUT-OUTPUT ANALYSIS OF GENERATION AND ELIMINATION OF POLLUTION IN THE UNITED STATES ECONOMY

W.W. LEONTIEF, Harvard University, School of Arts, *Cambridge, Massachusetts* 02138

The proposed exploratory research involves approach to empirical implementation of a model described in a paper, Environmental Repercussions and the Economic Structure: An Input/Output Approach, in the Review of Economics and Statistics. The objectives of the proposal are: 1) an extension of the present input/output matrices for the American economy, by the addition of appropriate numbers of rows representing sector-by-sector emission of different types of pollutants and columns representing anti- pollution processes; 2) projection of these pollution and anti- pollution coefficients in 1980 or 1985; 3) analytical use of the new data base thus created in a quantitative assessment of principal types of pollution and in the analysis of changes and activity levels of various sectors of the economy that will result from alternative combinations of anti-pollution methods.

A specific agenda for further analytical and empirical work on pollution will be a primary output of this exploratory research effort.

SUPPORTED BY U.S. National Science Foundation

2.1849, MANAGEMENT ASPECTS OF THERMAL POLLUTION CONTROL

D.H. MARKS, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

The effect of environmental constraints such as stream temperature standards on thermal power investment and location decisions is investigated. A location model is developed which shows optimal location of plants and equipment choice from an efficiency point of view while meeting environmental constraints. Thus, the model may be used to show how costs and decisions change as environmental standards change. Additional work on the type of temperature models needed for precise evaluation under different conditions, the effects of stream geometry on outfall design, and the trade-off between location and additional investment in different types of heat abatement equipment is also to be carried out.

SUPPORTED BY Massachusetts Inst. of Tech. - Cambridge

2.1850, MATHEMATICAL WATER QUALITY PLANNING MODELS

J.C. SCHAAKE, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Three mathematical models are being developed and applied to determine optimal schemes for investing in facilities to control water quality in the Boston Harbor. Feasible facilities include storage space for storing combined sewer overflows, treatment facilities for treating municipal and industrial wastes, and diversion facilities for distributing wastes (treated, untreated, and combined overflows) throughout the harbor. The models include: a mathematical programming model for determining optimal investment schemes; a waste transport model for estimating coefficients for the mathematical programming model, and a tidal current model for estimating currents for the waste transport model.

SUPPORTED BY Massachusetts Inst. of Tech. - Cambridge

2.1851, SUPPORT OF TWO RESEARCH VESSELS

D.C. CHANDLER, Univ. of Michigan, Great Lakes Research Division, *Ann Arbor, Michigan* 48104

This project provides operating support for two vessels belonging to University of Michigan and utilized by the staff from that institution and others located around the Great Lakes. They are employed for regional Sea Grants programs being carried out by U. of Michigan and U. of Wisconsin.

These vessels will be used for biological, physical and chemical monitoring of Lake Michigan, deep water current studies, river plume studies, thermal pollution studies, and sediment coring.

SUPPORTED BY U.S. National Science Foundation

2.1852, COLLABORATIVE PROGRAMS WITH GOVERNMENT AND PRIVATE AGENCIES FOR SOLUTION OF ENVIRONMENTAL PROBLEMS

UNKNOWN, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan* 48104

No summary has been provided to the Science Information Exchange.

SUPPORTED BY W.K. Kellogg Foundation

2.1853, DEVELOPING BROADLY COHERENT MULTIDISCIPLINARY RESEARCH AND GRADUATE TRAINING PROGRAMS IN ENVIRONMENTAL QUALITY

UNNOWN, Univ. of Michigan, Graduate School, *Ann Arbor, Michigan* 48104

The quality of the human environment is deteriorating rapidly. Simplistic solutions, dealing with only one or a limited number of factors, are no longer effective: the need now is for a holistic approach. The University of Michigan, long a leader in environmental studies, is developing problem-oriented, multidisciplinary research and training programs focused on the totality of man's environment and on its preservation and improvement.

A center for environmental quality is planned, to be responsible for all programs of research and training. Activities within specific departments and schools will continue, but the center will initiate, encourage, and support multidisciplinary efforts.

Graduate programs in pertinent fields, such as forestry, waste disposal research, hydrology, and ecology, will continue. In addition, emphasis will be placed on devleoping broad undergraduate courses on man and his environment.

SUPPORTED BY Rockefeller Foundation - New York, N.Y.

2.1854, AN ENGINEERING ECONOMIC STUDY OF RECLAMATION AND MULTIPLE REUSE AS A WATER SUPPLY ALTERNATIVE

W.J. WEBER, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

The research will consider the engineering economics of total water usage through water reclamation and recycle. The feasibility and economic boundaries of recycle will be examined using idealized water- use models for municipalities and firms. The effects of available water quality and pollution control standards will be investigated as factors that directly influence decisions to use water reuse as a distinct water supply alternative. Pollution and quality constraints typical of various water use settings will be used in the model.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rcn.

2.1855, IMPACT OF WATER QUALITY CONTROLS

C.R. HUMPHRYS, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00914)

OBJECTIVE: Analyze the impact of water quality standards on uses of water in agriculture and the impact of agriculture practices on the quality of the waters available for use by others.

APPROACH: Study of impact of use of waters of varying quality on agriculture. Study of impact of agriculture practices on the quality of the water supplies available for other uses.

PROGRESS: Basic information concerning the physical character, water use, water problems (including legal and economic) and water management of Michigan's watersheds is being collected for a comprehensive reference report. The proposed report will provide background data for current and developing watershed programs in Michigan.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Agriculture

2.1856, A SURVEY OF ATTITUDES TOWARDS THE MISSISSIPPI RIVER AS A TOTAL RESOURCE IN MINNESOTA
J.P. LUDWIG, Bemidji State College, Undergraduate School, *Bemidji, Minnesota* 56601

This project will concentrate specifically on the upper Mississippi River from the Iowa border to its source in northern Minnesota. It is a joint project of natural scientists and social and behavioral scientists at the three Minnesota State Colleges--Bemidji, St. Cloud, and Winona- which are located in the river's valley. Researchers in the various involved disciplines will gather, evaluate, and collate existing data using modern tools, such as the computer, to provide a basic framework concerning the present state of man's attitudes toward and knowledge of one immediate natural resource, the Mississippi River. The proposed project will foster a cooperative inter-institutional, inter-agency, and inter-disciplinary study, providing a sound basis for future planning in such areas as additional scientific study of river ecology if necessary, and possible recovery programs. The project will also work toward much needed public information and education programs. Relevant findings will be disseminated through the news media, workshops, seminars, educational programs, and publication in appropriate journals.

Base line data will be collected on population, land use, statutes and ordinances. An attitudinal survey will be conducted which will gather information relating to attitudes toward use of the Mississippi River and regultory anti-pollution programs.

Findings will be used as a basis for educational programs designed to raise the general educational level and promote more positive attitudes toward intelligent use of water resources.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1857, SOCIAL ECONOMIC FACTORS IN THE ADOPTION BY INDUSTRY OF WATER POLLUTION CONTROL MEASURES
R.E. RICKSON, Univ. of Minnesota, School of Liberal Arts, *Minneapolis, Minnesota* 55455

This research will consider certain sociological variables involved in the adoption by industry of the technology associated with water pollution control in Minnesota. The variance in compliance with innovations in water pollution control between and within categories of industries will be studied. Managers of heavy water using industries and governmental officials will be interviewed; appropriate statistical tests will be made to analyze the interview data. The increased use of water in Minnesota has resulted in increased pollution. Some changes in the behavior of users toward water pollution control is, therefore, an urgent necessity. The results of this research control should improve the understanding of the social dimensions of the problem and provide valuable information concerning the process by which change occurs or is resisted.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1858, METHODOLOGY FOR INTEGRATING WATER QUALITY MANAGEMENT WITH THE MANAGEMENT OF THE TOTAL WATER RESOURCES IN MINNESOTA
C.P. STRAUB, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

This research is aimed at studying the water quality problems associated with the many existing and possible uses of the water resources of Minnesota and proposing methodology for integrating water quality management with the management of the other aspects of the resource. The investigations will include: collection of data on water quality for the total resource, both surface and groundwater, in Minnesota; and a study of these data: a) to determine water quality parameters to be incorporated in future programs of data collection and analysis and b) to propose methodology for integrating quality management with that of the total resource, bearing in mind likely uses of the resource.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1859, PUBLIC INVESTMENTS IN NATURAL RESOURCES
L.R. MARTIN, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-14-087)

OBJECTIVE: Improve investments in natural resources in Minnesota for such purposes as parks, recreation and wildlife, water developments, land improvements, drainage, flood control, waste disposal, and forestry.

APPROACH: The first part will involve an inventory and categorization of natural resource expenditures by various resource districts and other governmental units from secondary sources. The second part of the project will involve an evaluation of organizational and operational characteristics of selected existing and proposed districts. The third part, will develop suggestions for decision making by districts.

PROGRESS: The analytical work in Phases II and III is complete and that in Phase IV is largely complete. Most of the descriptions and analyses in Phases II and III are in first draft, including the in-depth analysis of three small watersheds and the over-all analysis of ten other small watersheds. What remains to be done is to complete the analyses in Phase IV, work out their economic interpretations, and write up the results. All of these efforts are now in process.

SUPPORTED BY Minnesota State Government - Saint Paul

2.1860, ECONOMICS OF WATER QUALITY CONTROL IN THE UPPER MISSISSIPPI RIVER (MINNESOTA)
J.J. WAELTI, Univ. of Minnesota, School of Agriculture, *Saint Paul, Minnesota* 55101

Objectives: The overall objective of the project is to formulate an economic optimizing model for water quality control and sewage disposal on selected stretches of the upper Mississippi River. The model will be designed to serve as a useful basis for public policy decisions in Minnesota with respect to both the water quality standards adopted on particular segments of the River and for least-cost-methods of attaining given standards. The methodology developed would be expected to be adaptable to water quality problems elsewhere.

Specifically, the model would be useful in answering such questions as: 1. What is the least-cost strategy of attaining given water quality parameters, taking into account: a. Natural assimilative capacity of the river; b. Variations in flow; c. Alternative levels of treatment; d. Alternative locations of treatment; 2. What are the economic benefits associated with alternative standards, taking into account the above? 3. What are the costs and benefits associated with raising or lowering water quality standards on particular stretches of the river? 4. What are the policy implications for stream standards versus uniform effluent standards for all waste dischargers?

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1861, ECONOMICS OF SEDIMENT CONTROL ON A MIXED WATERSHED IN NORTH MISSISSIPPI
H.P. COSPER, U.S. Dept. of Agriculture, Sedimentation Laboratory, *Oxford, Mississippi* 38655 (NRE2-25-25-04)

OBJECTIVE: Analyze costs and benefits of alternative means for reducing sediment yields by combinations of land treatment and structures.

APPROACH: Estimate economic effects of different levels of sediment management, based upon physical relationships for predicting sediment yields associated with alternative land use and watershed management schemes as developed by or in association with the Agricultural Research Service.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

2.1862, MISSISSIPPI'S WATER LAWS AND POTENTIAL DEVELOPMENT PROBLEMS
J.E. WALDROP, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39752 (MIS-3-206-0258)

OBJECTIVE: Describe Mississippi's water laws, its ownership, use rights, the procedures for obtaining legal rights to use water, the adequacy of the current statutes under shortage situations. Evaluate some of the economic implications of Mississippi's water laws.

APPROACH: The statutes of Mississippi will be searched. Problems that might be posed to test the adequacy of these laws in terms of economic implications include agricultural vs. industrial use of water, polution from erosion, irrigation, industrial effluent and garbage disposal.

PROGRESS. Very little progress has been made on this project for two major reasons. First, the project leader with primary responsibility for legal aspects of this project at the University of Mississippi resigned from the institute and has not been replaced and secondly, the death of Walter Christ hampered the efforts of the institute during 1969. Hopefully, these problems are partially solved at this time, and it is anticipated that revision of a rough draft of Mississippi's water laws will be continued and a report published during 1970.

SUPPORTED BY U.S Dept. of Agriculture

2.1863, ENVIRONMENTAL PLANNING ALONG MONTANA'S 'BLUE-RIBBON' TROUT STREAMS
S.S. FRISSELL, Univ. of Montana, School of Forestry, *Missoula, Montana* 59801

To insure maintenance of a quality environment along outstanding waterways, study is needed of: 1) the current land use practices adjacent to the streams, 2) the impact of these practices on the stream environment, 3) the ability of the state to protect these streams under existing policies, and 4) the need for new guidelines and authority to insure protection.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1864, ECONOMIC IMPACTS OF WATER POLLUTION CONTROL PROGRAMS ON CATTLE FEEDLOTS
M. BAKER, Nebraska Agric. Expt. Station, *Lincoln, Nebraska* 68503 (NRE8-2-28-01-X1)

OBJECTIVE: Assess the economic effects of water pollution from feedlots; evaluate alternative means of pollution abatement; estimate potential economic impacts on the feedlot enterprise, local community, and beef feeding industry from implementation of water quality regulations.

APPROACH: Select a case study watershed with feedlots. Define water pollution from feedlots. Determine existence and severity of damages to water users. Estimate costs to feedlot firms of alternative means of controlling water pollution for various types of feedlots. Estimate the potential economic costs and benefits from water quality regulations for the case study area in terms of the feedlot firms, local community, and the beef feeding industry.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

2.1865, COORDINATING THE EFFORTS OF PARTICIPATING AGENCIES IN A STUDY OF ENVIRONMENTAL EFFECTS OF WARM-WATER DISCHARGES INTO THE MISSOURI RIVER
E.R. KENDLE, State Game & Parks Commission, *Lincoln, Nebraska* 68509

Objective: To provide overall coordination for all (fishery, chemistry and physics and fish-food organisms) portions of the comprehensive study to be carried out by the various agencies involved: Bureau of Sport Fisheries and Wildlife, Federal Water Quality Administration, Iowa Conservation Commission, Nebraska Department of Health, Nebraska Game and Parks Commission, U. S. Army Corps of Engineers, U.S. Geological Survey, University of Nebraska.

Procedures: 1. Establish a schedule of operation for the field and laboratory work. 2. Insure that all agencies learn of any changes in the schedule of operation. 3. Act as a coordinator among personnel doing fishery, chemistry and physics and fish-food organism portions. 4. Insure that sufficient personnel and equipment are scheduled at the proper time to accomplish the field and laboratory work. 5. Preside at all meetings. 6. Preparation of study reports and distribution to all involved agencies.

SUPPORTED BY U.S. Dept of Interior - Bu. Sport Fish.

2.1866, EFFECT OF WATER MANAGEMENT ON QUALITY OF GROUND WATER AND SURFACE RECHARGE IN LAS VEGAS VALLEY
A.E. PECKHAM, Univ. of Nevada, Desert Research Institute, *Las Vegas, Nevada* 89109

A description of project objectives and proposed work are as follows: 1) To identify the effects on water quality of current water and waste water management. 2) To develop a comprehensive set of alternative solutions to the water quality problems which now exist as a result of the discharge of poor quality ground water in Las Vegas Wash and elsewhere in the lower portions of the Las Vegas Valley. 3) To demonstrate which of the possible solutions can most effectively be implemented to correct the pollutional aspects of Las Vegas Valley ground water and aid in general environmental quality improvement. 4) To demonstrate how waste water can be managed in such a manner as to improve the quality of the water which discharges into Lake Mead. 5) To develop a model of the system utilizing information developed from the Bureau of Reclamation project 13030 EII.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1867, USER ATTITUDES TOWARD WATER QUALITY AND PRICE
D.D. FOWLER, Univ. of Nevada, Desert Research Institute, *Reno, Nevada* 89507

This research will determine the feasibility of a large-scale survey of user attitudes toward water quality in the Las Vegas Valley and Reno-Sparks, Nevada by means of a pilot project to develop and pretest the questionnaire to be used in a subsequent survey.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1868, NEW HAMPSHIRE-TOMORROW - A COOPERATIVE EFFORT TO INITIATE ENVIRONMENTAL DEMONSTRATION PROJECTS & CREATE AWARENESS OF PROBLEM
R.D. SHEAFF, New Hampshire Charitable Fund, *Concord, New Hampshire*

Five Action Teams, each consisting of representatives of business, labor, civic groups, state agencies and local governments, have been established: Economic Growth and the Environment, Pollution Control, Scenery Preservation, Acquisition and Access, Environmental Education. Over 40 specific projects are being carried out under these categories, including: establishment of a local community recreational park, introduction of environmental topics into elementary and college curricula; study of sedimentation problems accompanying land sub- division; establishment of a multi-community open pit incinerator for solid waste disposal; testing of dye kits to identify water pollution; control of eutrophication through stratification; spray irrigation; design of industrial parks; junk car removal; visual inventory of New Hampshire's seacoast; scenic rehabilitation and preservation of a highway; establishment of the legal ownership of the state's islands; creation of a regional environmental study area in conjunction with public and private school programs; mobile homes park design; establishment of land trusts; securing of easements; establishment of community conservations; creation of lake association.

Prior to the termination of the program in the Spring of 1971, 'How-To-Do-It' booklets developed as a result of these specific field experiences will be printed and made available to existing agencies. These can serve as guidelines for future efforts.

2. WATER QUALITY

SUPPORTED BY Ford Foundation - New York, N.Y.

2.1869, A COMPENDIUM OF WATER LAW AND ECONOMICS IN NEW HAMPSHIRE
R.H. FORSTE, Univ. of New Hampshire, School of Agriculture, *Durham, New Hampshire* 03824

The considerable body of statutory and common law relating to water rights in New Hampshire exists in a diffused form throughout state statutes and in court decisions over a period of more than 150 years. Some of these statutes and decisions have relevance to wate law and use today; other statutes and laws that have been in effect for over a century may impose adverse effects on the economic efficiency of water use and the distribution of income associated with particular water users. The objectives of this study, therefore, are: (1) to describe relevant existing statutory and common law as it relates to water resources in New Hampshire; and (2) to assess the economic effects of these laws on water users and use patterns in qualitative terms, in areas of water quality, diversion, accessibility, multiple -use, and so forth.

Legal research is being performed mainly at the law offices of Alexander J. Kalinski, 51 High Street, Manchester, New Hampshire.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1870, SURFACE AND GROUND WATER POTENTIALITIES OF THE MULLICA RIVER BASIN
M.L. GRANSTROM, Rutgers the State University, School of Engineering, *New Brunswick, New Jersey* 08903

The proposed research p oject involves a systems analysis study and an ecological field investigation of aqueduct water transfer from the Mullica River Basin (containing a large state water reserve) to several New Jersey cities. This study will determine the: 1) cities which will have future demands for Mullica River water 2) optimum conjunctive surface and ground water development 3) economic effects of water withdrawal on shellfish, other biota, recreation, and waste assimilation capacity of the river and estuary.

The systems analysis approach will involve applications of extremal mathematics, such as linear programming, or simulation and stochastic processes. Fish spawning and nursery grounds studies and plankton dredging surveys will determine the distribution of these biota with respect to the existing and projected hydrography of the river-estuary system. Dissolved oxygen, salinity, and other water quality parameters will also be measured for the mathematical model. Project results will be applicable to other river basins which have conjunctive surface and ground water potentialities which affect the estuarine ecology.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1871, GOVERNMENTAL AND PRIVATE SERVICES
A.J. KAPLOVSKY, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00530)

OBJECTIVE: Provide services to governmental agencies, industries and individuals to help solve water supply, waste disposal, stream pollution and air pollution problems in cases where such services are not available from other sources, provide opportunity for faculty and students to experience practical problems and to determine research needs.

APPROACH: Study and make recommendations on problems brought to our attention and to make routine visits to state institutions to assess water supply, waste disposal or pollution situations which may lead to problems. Design assistance will be provided for systems as requested.

PROGRESS: 22 of 34 state institutions and agencies were given service. Watershed surveys and efficiency analyses were made with general assistance and operational maintenance problems consultation. Special added attention was required for 4 areas namely Leesburg, Trenton State Farm, Greystone Park and Annandale. Cooperative program of sampling of surface and ground waters for phenol was continued with U.S. Geological Survey. Phenolic concentrations in excess of 1.0 mg/l were found. A more sensitive procedure showed more phenol in 25.4% of 307 samples taken than by less sensitive method. Separation of CO(2) from water and ammonia in wastewater investigated by hollow fiber membranes. Effects of pH, concentration, pressure, and temperature on the ammonia separation was studied. Study was made to determine fundamental mechanisms by which non-electrotype solutes are rejected by reverse osmosis membranes. The overall approach used was to compare rejection of various selected compounds in dilute aqueous solution under typical operating conditions.

SUPPORTED BY New Jersey State Government - Trenton

2.1872, ADAPTIVE CONTROL THEORY APPLIED IN A CLASS OF DYNAMIC POLLUTION PROBLEMS
H.J. PERLIS, Found. for Adv. of Grad. Study, *Newark, New Jersey* 07103

This research program is concerned with the application of the techniques of passive and active adaptation to a specific class of distributed parameter systems found in the area of water pollution. The overall objective is to provide a self-adjusting pollution control system which responds to effluent inputs and parameter variations. Specifically, the specialties of automatic control theory and measurement theory will be fully utilized in the course of the research. It is anticipated that the results of this work would be sufficiently general to find application in other environmental systems and in such distributed systems as biosystems and process control systems.

SUPPORTED BY U.S. National Science Foundation

2.1873, DELAWARE ESTUARY AND BAY WATER QUALITY SAMPLING AND MATHEMATICAL MODELING PROJECT
R.C. TORTORIELLO, Delaware River Basin Comm., *Trenton, New Jersey*

The objectives of the demonstration grant project are to establish a definitive sampling program to measure estuarine water quality to provide a baseline against which water quality improvement, as a result of a pollution abatement program, could be compared. In addition, the dissolved oxygen steady-state mathematical model of the Delaware Estuary would be verified against 1967 and 1968 observed boat run data. Comparisons would be made between compiled and historical data for trends or significant changes.

SUPPORTED BY Delaware River Basin Comm. - Washington

2.1874, ESTIMATION OF CAPITAL-WATER ELASTICITIES OF SUBSTITUTION IN U.S. MANUFACTURING
F.L. BROWN, Univ. of New Mexico, Graduate School, *Albuquerque, New Mexico* 87106

Five major determinants of the future levels of manufacturing water utilization are: 1) industrial output levels, 2) the degree of substitutability between capital investment and water, 3) technological change that influences water requirement per unit of product, 4) institutional controls and changes in the cost of water compared to cost of water substitutes, and 5) the proportions of industrial water intake utilized for cooling, and for processing.

Thus far, projections of the future industrial water requirements have been based almost solely on considerations of industrial output, with recognition, but little analysis, of the impact of substitution, technological change, or changes in relative costs. Without explicit analyses of the degree of substitution between capital and water loss, it seems likely that all forecasts of the future water needs for manufacturing are bound to contain significant errors.

The objective of this proposed project is the estimation and analysis of the degree of substitutability between capital and water in manufacturing. The procedural steps to be followed may be broadly categorized as: 1) the development from the available data of reliable estimates of capital investment, water losses, water recirculation rates, and output classified according to water resource region, state (when possible) and SIC industry; 2)

econometric analysis of alternative mathematical formulations of manufacturing productions functions leading to statistically reliable estimates of the elasticities of substitution in manufacturing between water and capital in the various regions and industries; 3) the interpretation of the results of 2) with respect to the formulation of suggested policy implications for such problems as deriving efficient pollution abatement and water transfer policies.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1875, UNITED STATES INDIA EXCHANGE OF SCIENTISTS AND ENGINEERS PROGRAMME
F. COULSTON, Unknown Inst. Or Indiv. Grant, *New York*

Dr. Frederick Coulston, Professor and Director, Institute of Experimental Pathology and Toxicology at the Albany Medical College of Union University in Albany, New York, has been selected to participate in the United States India exchange of scientists and engineers program.

Dr. Coulston will spend about one month visiting several medical institutes to give a series of lectures and seminars which outline and present the kind of basic research that is needed in Toxicology and Pathology for the protection of the community from unwarranted risk with chemicals and drugs taken voluntarily or involuntarily in air, water and food.

SUPPORTED BY U.S. National Science Foundation

2.1876, LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN
T.M. JOLLIFF, State Dept. of Env. Conserv., *Cape Vincent, New York*

Objectives: To continue development of an interim comprehensive fisheries management plan for Lake Ontario, to serve as a baseline or guideline for research and management activities.

Procedures: Planning will continue the work of the period January 1, 1971 thru March 31, 1971. The comprehensive plan will encompass historical factors such as the former abundance of fisheries, their decline, the deterioration of the environment, present problems, and managerial and research methods needed to meet present and future challenges.

The comprehensive plan will serve as a tool for the enhancement of both commercial and sport fisheries and related or associated activities. Factors which will be included in the overall plan are as follows: Development and management of previously abundant species of fish, management of present species, and introduction and management of new species. Environmental control involving pollution, water levels, etc., together with associated limnological studies all aimed at the preservation of fisheries and related activities. Compilation of catch and fishing effort statistics. Research on fish stocks, population dynamics and regulation of catch. Coordination of multi-agency activities, and computerization of inventory data. The place of fish culture in future fishery management in Lake Ontario. Special pesticide studies to permit utilization of fish flesh. Planning in terms of lake areas, geographical, estuarine, tributary, inshore and deep water factors, and population center locations.

Information will be taken from historical writings and the literature in general, available data on the lake, and previously written plans for Lake Ontario. Plans will be made in collaboration with other agencies, governmental and private, state, provincial and federal, educational and institutional.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1877, EVALUATION OF RECREATIONAL AND CULTURAL BENEFITS OF ESTUARINE USE IN AN URBAN SETTING
A.J. VANTASSEL, Hofstra University, Center for Bus. & Urban Res., *Hemstead, New York* 11550 (C-1818)

The proposed research plan involves field investigations to determine the extent of use of estuarine waters of the Town of Hempstead (located in an intensively urbanized area) as a basis for evaluating the benefits from such use. These surveys of use will be supplemented by studies of expenditures with local businesses by users. Data from both types of surveys will be subjected to economic and statistical analysis by investigators from the Hofstra University Center for Business and Urban Research.

Surveys of use will consider four phases: (1) Fishing, (2) Boating, (3) Clamming, (4) Nature Study. On the first of these, the Town of Hempstead has collected extensive data in considerable detail since 1966, and these data will be supplemented by similar data for 1969-1971. In addition, state and local governmental records will be supplemented by field investigations on other uses of Hempstead estuarine waters.

The data collected in these surveys will be subjected to economic analysis by the Hofstra investigators for the purpose of estimating the dollar value of benefits from use of the estuarine waters by type of activity and in total. This has importance in establishing the value of maintaining the estuarine waters in relatively unpolluted conditions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1878, A STUDY OF POTENTIAL INSTITUTIONAL ARRANGEMENTS FOR WATER POLLUTION CONTROL IN THE HUDSON-MOHAWK RIVER BASIN
L.B. DWORSKY, Cornell University, School of Engineering, *Ithaca, New York* 14850 (C-1196)

Basin or sub-basin wide solutions to water pollution problems are technologically feasible considering existing technology and are possible conceptually using new and developing technology. Such solutions are expected to result in economies of scale, operational efficiency and the establishment of an improved priority basis for scheduling and pollutional control efforts.

A major obstacle to the development of basin or sub basin wide solutions has been the lack of modernization of governmental institutional arrangements to stimulate and encourage the early and efficient utilization of existing and newly developing technology for the public benefit.

The research proposes to develop alternative institutional arrangements for the Hudson-Mohawk River Basin, or appropriate sub-- basin units, to achieve a substantially improved water pollution control program for the study basin.

The plan of research will consider basin history, geography and culture; current water pollution control programs of state, federal, compact and local agencies; government organization affecting water pollution control; water pollution control plans; preliminary type engineering-economic studies of alternative pollution control measures; formulation of criteria to consider in the development of regional institutional arrangements for pollution control; the relation of alternative institutional arrangements for water pollution control to local water and waste water utility services, and to multi-basin and multi-purpose water and related land resources development programs in the northeastern United States. The research will conclude with a synthesis, recommendations and supporting references.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1879, STOCHASTIC MODELS FOR WATER RESOURCES MANAGEMENT
D.P. LOUCKS, Cornell University, School of Engineering, *Ithaca, New York* 14850 (C-1034)

Analytical methods are to be developed which incorporate the complex stochastic nature of streamflow and runoff into models for defining alternative policies for managing both the quantity and quality of water within a developed river system. The solutions of these stochastic programming models will indicate the daily reservoir releases and the quantities of water that should be allocated to each water use, so as to best achieve some physical or economic management objective and at the same time, satisfy all the requirements that are imposed upon the system. The study will begin in Fiscal Year 1968 and span a two-year period.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1880, CONSERVATION AND DEVELOPMENT PLANNING FOR THE ESTUARINE ZONE (A CASE STUDY IN THE TOWN OF SOUTHOLD, LONG ISLAND)
L.S. HAMILTON, State University of New York, School of Agriculture, *Ithaca, New York* 14850

2. WATER QUALITY

The estuarine zone, where fresh and salt water meet, is probably as rich in situations where one man's actions can inadvertently affect another man's welfare as any in the world of natural resources. Dredging, waste disposal, filling and bulkheading, silt and the like, can lay waste to the spawning grounds for fin fish, shellfish beds and areas of unique ecological significance. Important commercial, recreational and esthetic values can be quickly lost. Planning, controls and public investment decision processes have been developed to specifically solve these types of problems in other environments, but little has been done here. New institutions and approaches are required.

This project proposes to study the estuarine zone of an important part of Long Island in an attempt to identify the mechanisms by which problems arise, to determine the existing and potential roles of public agencies, and to develop an approach -- essentially a planning methodology -- suited to the evaluation of the public interest in the estuarine zone in meaningful policy and program terms. This project will seek positive means whereby local governments can both promote new economic development and still enjoy the fruits of this rich marine resource.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1881, MULTIPLE PURPOSE WATER RESOURCE INVESTIGATIONS

L.S. HAMILTON, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00126)

OBJECTIVE: Investigate critical multiple-use problems with respect to New York's surface waters, so that information is made available on which to base both private and public policy with respect to use and development of this vital resource.

APPROACH: Water-use conflicts are becoming increasingly severe even in the humid East. New York State already is experiencing conflict between irrigation, navigation, recreation, power production, pollution, municipal water supply, industrial use and flood control. Some of these conflicts will be examined as case studies with a goal of criteria for water allocation and policy formulation.

PROGRESS: Estuarine study has continued, with many of the portions of related projects completed, or nearing completion. Work on the Fall Creek Watershed has continued, and has served as background for interim reports. Three Ph.D. theses have been completed or drafted. Research in the Town of Southold has been completed. Research materials are being analyzed and prepared for thesis presentation for the Missouri River portion of the study and the small watershed planning study by Mr. Stern and Mr. Burgess. Field investigation and interviewing continues on the phase of the work concerning environmental planning and northeastern water resources institutions being carried out by Mr. Shelton.

SUPPORTED BY U.S. Dept. of Agriculture

2.1882, TELEVISION PROGRAMMING RELATED TO PROBLEMS OF THE ENVIRONMENT

R.D. HEFFNER, Columbia University, School of Education, *New York, New York* 10027

The Teachers College television study will include an analysis of the environmental implications of a representative slice of commercial broadcasting, an audience analysis, and an audience response study to determine what values have been transmitted by the programming. A panel of environmentalists will aid in the study.

Environmentalists believe that television is an important influence, for good or ill, on individual behavior toward the environment. However, they feel that much of the current programming is superficial, misleading, or self-serving and fails to draw implications between environmental pollution and individual behavior. For example, no connections are usually made between broad social problems, such as the effect of electric power production on the environment, and the individual behavior at the root of the problem, i.e., the demand for more and more power.

The study will be directed by Dr. Richard D. Heffner, an historian and communications analyst. The research design will be prepared by Dr. Robert Merton, Columbia sociologist. Results of the study will be made available to television producers and writers to help them in designing more positive programming.

SUPPORTED BY Ford Foundation - New York, N.Y.

2.1883, STOCHASTIC BASIS FOR COMPREHENSIVE RIVER BASIN PLANNING, PHASE II

F.G. HAAG, Union College & University, School of Engineering, *Schenectady, New York* 12308 (C-1702)

Systems analysis and stochastic methods will be utilized to model river basins. Wherever possible known probability frequency distributions wil be used with Monte Carlo methods. If probability frequency distributions do not exist they will be developed analytically and correlated with available data, as for example, in operational hydrology. The overall mathematical model for the physical variables of a river basin will be developed and programmed for the Union College digital computer. The results obtained when the model is applied to the Hudson River Basin will be compared against data that is available from New York State and the U. S. Geological Survey.

Economic data will be developed to permit relating the cost of alternate water development plans (e.g., waste treatment plants, flow augmentation, and water transmission facilities) to the relative economic benefits to alternate users (e.g., domestics, industrial, recreational, commercial fishing, and transportation).

The physical and economic models will be coupled and optimization techniques will be applied. The use of stochastic methods will permit more realistic decision making because the degree of chance taking will be described quantitatively in terms of confidence levels.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1884, STUDY OF INSTITUTIONAL ARRANGEMENTS FOR MANAGEMENT OF REGIONAL SEWERAGE PLANS FOR THE TOCKS ISLAND REGION OF THE DELAWARE

G.S. BIRKHEAD, Syracuse University, School of Public Affairs, *Syracuse, New York* 13210

Water Resources Planning (Institution Problems): This will be a study of alternative organizational means for implementing regional sewerage plans in the Tocks Island Region of the upper Delaware Basin. The researchers will examine the options for regional sewerage management currently included in the law in each of the three states in question. They will deal with: the present legal and fiscal options, the political situation and experience associated with these options and with the alternatives that may require new legislation or constitutional amendments. The final report will include: 1) a definition of the problem; 2) alternative structural possibilities, including local special districts or authorities, interlocal cooperation state special districts or authorities, direct state administration, interstate cooperation by compact, parallel laws, or DRBC and alternative management arrangements, 3) considerations of legal, political and fiscal feasibility; and 4) recommendations.

SUPPORTED BY Delaware River Basin Comm. - Washington

2.1885, ALLOCATION OF STREAM POLLUTION CARRYING CAPACITY

N.L. NEMEROW, Syracuse University, Graduate School, *Syracuse, New York* 13210

Can a river basin commission allocate in an equitable manner pollution carrying capacity among the many and varied users? Inherent in this question are many subsidiary matters which must be decided by the commission such as (1) in our social structure today do organizations exist as legal operating agencies which can assume the responsibility and task of allocating water pollution capacity and, if not, how does one go about forming and establishing such a commission? (2) will it decide to regulate by legislative and legal means the dwindling pollution-carrying of its basin or (3) will it be willing and able to establish a reasonable dollar value of each unit of resource and offer the units for purchase in an equitable manner.

It is our intent to use a simulation technique only during the final year of this project to study the reactions of a suitable com-

mission. All reactions will be on paper only and will not be publicized locally since they will neither have any legal basis nor be for the purpose of providing public information. The simulation study will be made solely to test the reactions of a suitable commission in policy-making situations. Information such as dollar benefits at various water quality levels as well as means for measuring water quality will be provided to the commission. The reactions of the commission will be of the utmost importance to the Federal Water Pollution Control Administration in developing policy and procedure for abating regional pollution. The project began in January 1967 and will terminate in June 1970.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1886, INSTITUTIONAL SEA GRANT SUPPORT
J.T. LYMAN, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

The University System of North Carolina plans to undertake the difficult task of developing an integrated sea grant program involving the campuses at Chapel Hill, Raleigh, and Wilmington, and East Carolina at Greenville.

The research will include an attempt to culture dolphin fish in addition to defining the sport fishery for this species off the North Carolina coast. Sturgeon and striped bass will also be investigted as species for potential culture. Studies on optimum ecological designs for estuaries fertilized with sewage effluent, will be undertaken. Legal and economic studies will be directed to the compilation and analysis of the legal structure of the state as it affects marine resource development. Coastal research involving such activities as the determination of the optimum means of stabilizing spoil from channel dredgings, and insect infestation on stabilizing dune grasses will be pursued. A seafood program will be initiated with a study on utilization of scallop wastes. The Engineering Department will initiate a study on the reliability analysis and optimum design of marine structures. Extension courses and advisory services will be developed for upgrading North Carolina industry.

SUPPORTED BY U.S. National Science Foundation

2.1887, ENVIRONMENTAL CONSIDERATIONS IN LAND AND WATER USE PLANNING IN RIVER BASINS
J.E. WUENSCHER, Duke University, School of Forestry, *Durham, North Carolina* 27706

Objectives: To develop criteria for ecologically sound land and water use planning in river basins of the North Carolina Piedmont. This will include development of a land and water use suitability classification system to guide use and development of river basins without destroying the integrity of the river basin ecosystem.

To demonstrate the feasibility of ecological land use planning as a tool for determining the optimum patterns of development of river basins.

To evaluate the recreation and open space potential of the Eno River Basin as a wild-land corridor within an expanding urban area.

To develop a comprehensive plan for the ecologically sound future use of the Eno River Basin.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1888, MULTI-DISCIPLINARY RESEARCH IN POLLUTION
D.G. BARNES, Saint Andrews Presby. College, Undergraduate School, *Laurinburg, North Carolina* 28352

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Research Corporation - New York, N.Y.

2.1889, MULTIPURPOSE REGIONAL MARINE SCIENCE CENTER (SEA LAB)
R.G. SOWERS, State Dept. of Conserv. & Dev., *Raleigh, North Carolina* 27611

The sea lab will be a multipurpose marine science center with each occupant of the center making significant contributions to the commercial fishing industry. The sea lab will serve to moderize the industry by putting the approach to the commercial fishing business on a more scientific basis. The building to be constructed will be a two story office-laboratory structure with the necessary accessory equipment needed for conducting diverse applied research activities involving sanitation, pollution, marketing, and product processing as well as aquaculture and other applied marine investigations that have a particular contribution to improving the commercial fishing industry.

Activities within the lab will involve seafood research and inspection management programs aimed at conserving the fisheries, economic and ecological position in the region's economy. Building scheduled for completion in September 1971.

SUPPORTED BY Coastal Plains Regional Commission

2.1890, COST-REDUCING TECHNIQUES OF WASTE DISPOSAL AND OPTIMUM USE OF WATER RESOURCES
W.M. CROSSWHITE, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03215)

OBJECTIVE: Determine the pattern of water use by plant processes. Determine the origin, nature and quantity of polluting matter by major processes. Evaluate the impact of selected factors on water utilization and pollution. Compare the relative costs of prevention and control of waste within the plant and treatment.

APPROACH: The analysis will be divided into three segments: a review of literature; analysis of water use by major processes within selected plants and the factors influencing the generation of wastes; development of specific cost-reducing techniques for the most important processes and publication of findings. The analysis of individual processes will allow for comparisons to be made which will reflect differences in water use, pollution level and costs.

PROGRESS: A research, development and demonstration project, developed cooperatively with Gold Kist Poultry Division, Cotton Producers Association, was approved by the Federal Water Pollution Control Administration for the two-year period July 1, 1969, to June 30, 1971. The collection of benchmark data on water quantities and waste- water characteristics is approximately 50 percent complete. Preliminary budgets for selected process and equipment changes are being developed. A proposal entitled 'An Economic Study of Municipal Surcharges on Industrial Waste' has been submitted to the Office of Water Resources Research for support beginning July 1, 1970. The Water Resources Research Institute is supporting preliminary work for the remainder of fiscal 1970. A research, development and demonstration proposal for a study of Water and Waste Management in Sweet Potato Processing has been drafted and is under informal review by FWPCA.

SUPPORTED BY U.S. Dept. of Agriculture

2.1891, PUBLIC PARTICIPATION IN WATER POLLUTION CONTROL POLICY AND DECISION MAKING
D.S. HOWELLS, Univ. of North Carolina, Water Resources Research Inst., *Raleigh, North Carolina* 27607

1. To examine public perception of water pollution control issues, including character and dimensions of the problem; methods of control; ecological, economic and social implications; alternative choices; responsibility of regulatory authority and programs; community leadership attitudes; awareness of hearing schedules and sources of information. 2. To examine participation in public hearing and related procedures for the review of pollution control policy and stream classification in the State of North Carolina including individual and special interest group; intragroup participation in statement formulation; economic and social interests in pollution control; and areas of public interest not represented. 3. Recommendations for public education in water pollution and its control. 4. Recommendations for strengthening opportunities for public participation in development of water pollution control policy and decision making.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1892, ECONOMIC EVALUATION OF CHANGES IN LAND USE OF A MUNICIPAL WATERSHED AS A GUIDE TO DECISION-MAKING
T.E. MAKI, Univ. of North Carolina, Graduate School, *Raleigh, North Carolina* 27607

The proposed research involves two major phases, the first of which consists mainly of photogrammetric analysis of six sets of photos taken at varying intervals over a 30-year-period, supplemented by field investigations, to delineate the nature and extent of changes in land use over the past forty years on the 168-square mile Lake Michie municipal watershed near Durham, North Carolina. Concomitantly, the Lake Michie reservoir records would be examined and compiled to provide data on variation in yield, quality, and treatment costs of the water over the same 40-year period. The data on land use changes and on weather factors would comprise the variables against which the reservoir water records would be assessed and correlated by appropriate statistical techniques.

The second major phase consists of an appraisal of research results at several hydrologic stations where vegetative cover manipulation has been studied in relation to streamflow. Relevant treatments would be selected and applied hypothetically in kind and degree to cover types on the Lake Michie watershed after a detailed field investigation of the composition and condition of the existing vegetative cover of the watershed to determine what increases in streamflow might be effected through alternative treatments and what the net benefits from such treatments would be.

Finally, an attempt would be made to develop guides that would be helpful to managers of municipal watersheds in decision-making.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1893, ENGINEERING ANALYSIS OF WASTE TREATMENT
R. SMITH, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Mathematical models have been developed to describe both the performance and cost for all of the conventional water renovation processes. The goal of this work is to optimize a system of water renovation processes to meet any specific need for water treatment at minimum cost. Computation is accomplished with digital computer.

Models for the advanced processes such as carbon adsorption and electrodialysis are being developed and will be combined with the models for conventional processes to study water reuse systems. Much information is still lacking, however, for the advanced processes. A secondary goal of the work is to lend continuity and guidance to the experimental programs underway in the Federal Water Pollution Control Administration. Work is also underway to improve the quality of the capital and operating cost relationships now being used.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1894, A SOCIO-ENVIRONMENTAL STUDY OF A RIVER VALLEY
M.R. ZAVON, Univ. of Cincinnati, School of Medicine, *Cincinnati, Ohio* 45221

This project will study the feasibility of establishing a long-term surveillance of the interactive effects of man and his environment in a single river valley complex. The Great Miami River Valley includes large cities, small towns and farmland. Animals and man living in the valley produce sanitary waste and the products of daily living; industries in the valley contribute heavily to the overall burden of waste which must disposed of by the air, the water, or put on the land. The people in this valley complex came from different geographical sources with differing cultural and social backgrounds. Their heritage predisposes them to certain ways of solving problems and to the organization of their social fabric.

The project represents an approach to research in which the social, biological, and physical sciences contribute data to a centralized facility. During the phase supported by the present grant, three individual research investigations will be carried out at the same time as the central project office will determine whether research conducted in this context may be done at less cost, more productively, and more meaningfully than similar research done without the unifying concept proposed.

SUPPORTED BY U.S. National Science Foundation

2.1895, COMMUNITY REACTIONS TO WATER RESOURCES PROBLEMS IN RELATION TO PLANNING
R.R. DYNES, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The proposal views flooding, water pollution and depletion as different forms of objective collective stress. It is suggested here that those types of collective stress which develop over long periods of time are more difficult to perceive and, therefore, it becomes more difficult to initiate planning and action to cope with them. The study focuses on interviews with a sample of community decision makers in five different communities. The five communities will be selected on the basis of having experienced different types of collective stress. In each community, the definition of the salience of such problems for the community will be determined. In each community the types of adaptation in terms of planning and inaction will be determined. Various social factors will be related to the differential perceptions and adaptations of each community.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1896, PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN
R.A. TYBOUT, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The project has three parts: 1) The measurement of demand for water-oriented recreation at numerous sites. 2) Analysis of costs of pollution abatement and recreation facilities at the same sites. 3) Evaluation of the relative merits of alternative public investments for recreation enhancement and of selected financial policies.

Each part is assigned a year of research time. Demand will be measured by a simultaneous-origin adaptation of the Hotelling-Clawson method. Shifts in demand due to pollution and income changes will be measured and, in fact, play an important part in the determination of benefits from abatement. The analysis of costs of pollution will seek to relate marginal pollution contributions at recreation sites to costs of abatement. The third, or final part of the analysis will explore the implications of combining the results of the first two parts in a cost- benefit framework with various methods of financing, including pollution taxes, user charges and other revenue sources.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1897, MATHEMATICAL AND COMPUTER SERVICES FOR THE ANALYSIS OF DATA AND DESIGN OF EXPERIMENTS FOR CERTAIN FWQA PROGRAMS
D.D. AUFENKAMP, Oregon State University, Computer Center, *Corvallis, Oregon* 97331

The Computer Center at Oregon State University is providing mathematical and computer services for the analysis of data and design of experiments for the following FWPCA programs: (1) fate of pollutants in coastal waters, (2) eutrophication, (3) power production, (4) paper and allied products, and (5) forestry and management.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1898, ECONOMIC BENEFITS FROM AN IMPROVEMENT IN WATER QUALITY
H.H. STOEVENER, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

This proposal is designed to study the value of water quality and water quality improvements in Upper Klamath Lake. It will

seek to estimate the benefits resulting from increased recreational use of the lake after technically feasible methods of retarding and/or reversing the eutrophic trends of the lake have been implemented.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1899, ECONOMIC EVALUATION OF WATER POLLUTION CONTROL
H.H. STOEVENER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00550)

OBJECTIVE: Determine the economic benefits accruing to society from a postulated improvement in water quality through increased recreational use of Upper Klamath Lake, Oregon. Determine the economic benefits accruing to the Klamath County economy from the postulated water quality improvement.

APPROACH: Modification of the methods used by Clawson and others will be utilized to derive demand functions for outdoor recreation at Klamath Lake, given an improvement in water quality of the lake. The development of methodological improvements for deriving these demand estimates will be emphasized. Objective (2) will be accomplished by studying the structure of Klamath County economy through an input-output model and tracing out the secondary effects of the water quality improvement. Data are to be collected from recreationists and businessmen in Klamath County.

PROGRESS: Work continued on a final preparation of a manuscript describing the research on the Yaquina Bay case study. This was an interdisciplinary effort involving economics, biology, and engineering. It is anticipated the manuscript will be completed and published sometime during the next fiscal year.

SUPPORTED BY Oregon State Government

2.1900, ECONOMIC BENEFITS FROM AN IMPROVEMENT IN WATER QUALITY
H.H. STOEVENER, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The research has the following principal objectives: 1. To determine the relationship between water quality and recreational use, permitting the prediction of the change in recreational use when a substantial improvement in water quality has been made in a large body of water. 2. To determine the economic benefits accruing to society from a postulated improvement in water quality and associated increase in recreational use determined under (1) above. 3. To determine the economic benefits accruing to the local economy in which the water resource is located from the postulated improvement in water quality and associated increase in recreational use.

The accomplishment of objectives 1 and 2 involves the development of a theoretical model to evaluate recreational benefits. Such a model is an extension of the techniques developed by Clawson and others. Water quality characteristics are to be included in the demand analysis to permit the empirical changes in recreational use and values. Interviewing techniques are used to collect data for the research. Recreationists are interviewed in the upper Klamath Lake area and a sample of other recreational sites in nearby regions.

To accomplish objective 3, an input-output model for the Klamath County economy resulting from an improvement in water quality in Klamath Lake and the associated increased use and expenditures made by recreationists. Data for this work are developed through interviews with business firms in Klamath County.

SUPPORTED BY U.S. Dept. of Agriculture

2.1901, APPRAISAL OF WATER MANAGEMENT INSTITUTIONS - SURVEY OF OREGON WATER LAW
O.D. CLARK, Univ. of Oregon, School of Law, *Eugene, Oregon* 97403

Object. 1. To conduct a survey study of Oregon water law. 2. To evaluate the adequacy of selected portions of Oregon water law, such as pollution controls. 3. To assess the vitality of common law principles expressed in early Oregon decisions. 4. To identify for further research legal problems of water resources management important to the Northwest.

Description of Work: Analysis will be made of Oregon court decisions, constitutional and statutory provisions, and Attorney General opinions regarding the use of the various water resources, surface and underground, of the state. This survey study will trace the historical development of Oregon water law, synthesize and evaluate existing Oregon water law, critically compare it with water law in other Western states, and otherwise seek to attain the objectives stated above.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1902, STATE WATER QUALITY MANAGEMENT INFORMATION SYSTEM
W.A. LYON, State Dept. of Health, *Harrisburg, Pennsylvania* 17120

To enhance and demonstrate a state-wide water quality management information system. The state has already done considerable work in this area. The purpose of the project is to expand the system and to provide a demonstration system which can be available for use by federal, other state and interstate water pollution control agencies. A further objective and purpose is to provide a base for a water quality management personnel. The design and implementation of this program will be the subject of an application (during the second year of this project) for a training grant under Section 5 of the Federal Water Pollution Control Act.

It is planned to: 1. Do the necessary systems design, programming and data processing so as to test, evaluate and demonstrate management information systems techniques related to the case status system, project status system, water quality control and forecasting system and plant operations control system. 2. Convert existing information handling techniques to modern EDP techniques. 3. Convert historical water quality data to a form useable by the system.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1903, THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS
J.R. FELDMEIER, Franklin Institute, *Philadelphia, Pennsylvania*

The Franklin Institute will establish, in cooperation with the Academy of Natural Sciences of the State of Pennsylvania, Lehigh University and Temple University, The Institute for the Development of Riverine and Estuarine Systems (IDRES). These institutions will conduct basic research programs focused on the long term objectives of better utilization of resources of the Delaware riverine-estuarine complex including effects of thermal pollution in the Delaware River, effects of thermal effluent discharge, the mechanics and thermodynamics of the distribution and mixing of thermal effluence, and the development of a conceptual model of sedimentation of the Delaware riverine-estuarine complex. In addition, an information center to serve the principal investigators conducting this research and as a focal point of coordination with other Federal and private information centers related to estuarine problems will be established by the Franklin Institute. Study and design of an industrial wasteline for the Delaware estuary with a view toward study of an alternative method to that now available for the disposal of waste will be begun.

SUPPORTED BY U.S. National Science Foundation

2.1904, ECONOMIC EVALUATION OF STREAM QUALITY PRESERVATION THROUGH URBAN LAND USE MANAGEMENT
R.E. COUGHLIN, Regional Science Res. Inst., *Philadelphia, Pennsylvania* 19104

Methods for evaluating the benefits and costs of preserving a major portion of a stream valley by conservation easements or similar land use controls for general water quality protection.

Development of mathematical statistical models to relate various urbanization parameters to channel size, flooding frequency and to basin water quality at base flow.

2. WATER QUALITY

Development of methods for determining the value of high water quality and high quality stream environments to residents using both subjective judgment data and land value data.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

2.1905, ECONOMICS OF WATER QUALITY IN A REGIONAL SYSTEM

W. ISARD, Univ. of Pennsylvania, Graduate School, *Philadelphia, Pennsylvania* 19101

Significance: Over the past several years, RFF has made considerable progress in furthering study of the economics of water quality management. In the early stages the staff and grant studies focused heavily upon clarification of concepts and empirical estimation of particular benefits and costs associated with improving water quality. Two books have already resulted from this effort and several other major reports are in preparation. In order to show the applicability and significance of the work already done, as well as to extend it, we have begun case studies of realistic situations characterized by differences in hydrology and in character and intensity of development. Two of these are under way dealing with the lower Potomac and the Miami tributary of the Ohio. The present study would be the third of the series. It would focus upon the Delaware Estuary. The estuary is heavily industrialized, has a large contiguous population and severe water quality problem.

Specific Aims and Expected Results: The project would use and improve existing tools for analyzing the water resources and economic development of the area. This would be done in order to assess the benefits and costs associated with alternative quality management programs. These might include such elements as regulation of river flows into the estuary, high-level treatment at certain times and locations, artificial re-aeration of the estuary, transporting wastes away from critical areas, and regulating reservoir system analysis, and forecasting of waste assimilative and transport capacities would be used in an integrated fashion. This would give new power and depth to water quality management analysis. The funds required to execute this study go beyond those which could be made available by RFF. Consequently the principal participants have worked out arrangements to obtain supplementary funds for certain of the natural service and engineering aspects of the work from the U. S. Public Health Service. It is expected that the project will result in several articles in professional journals and a publishable monograph.

SUPPORTED BY Resources for Future Inc. - Wash., D.C.

2.1906, STREAM QUALITY PRESERVATION THROUGH URBAN LAND USE MANAGEMENT - LEGAL AND GOVERNMENT ASPECTS

A.L. STRONG, Univ. of Pennsylvania, Graduate School, *Philadelphia, Pennsylvania* 19101

The Plan is a proposal for the wise use of the water and land resources of the Upper East Branch of Brandywine Creek, Chester Co., Pa. The Plan was developed for the Chester County Water Resources Authority by the Institute for Environmental Studies, University of Penna.; Regional Science Research Institute; United States Geological Survey; and their consultants. The aim of the Plan is to prevent deterioration of the water resources and thus to retain the amenities of related land when urbanization occurs in the Brandywine watershed. The Plan recommends 3 types of action: public purchase of conservation easements or other less than fee interests on flood plains, stream and swale buffers, steep slopes and forests; development and adoption of detailed water supply and sewage disposal plans in advance of urbanization; and enactment of strong local regulations for erosion and storm runoff control. Covers fiscal year 1/1/68 to 12/31/70.

SUPPORTED BY Ford Foundation - New York, N.Y.

2.1907, EFFECTS OF LAND USE CHANGES ON THE SCENIC QUALITIES OF PINE CREEK, PENNSYLVANIA

P.W. FLETCHER, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01842)

OBJECTIVE: Determine: flood plain's recent land use changes; nature, source, degree and extent of stream quality deterioration; flood plain's capability of providing potable water while accepting sewage wastes; and views of creek-front property owners on valley objectives, goals.

APPROACH: Trace recent flood plain changes from surveys of aerial photos, soils, and buildings; collect and analyze water quality samples along the main stream and on major tributaries; measure water percolation and groundwater movement rates of streambank soils; and conduct and analyze a mail opinionnaire and personal interviews.

PROGRESS: Preliminary water quality tests involving 17 criteria each were made at various day and night hours at weekly intervals throughout 15 summer weeks at 13 regular stations and several special points along 55 miles of Pine Creek and its major tributaries, using a Hach Direct Reading Engineer's Laboratory in conjunction with central laboratory facilities. Pollution was more pronounced in several headwaters stretches than in the lower stem. Paired dissolved oxygen tests in light and dark incubation were made twice at 4 headwaters locations at several points below 2 communities, one with primary treatment and one with secondary treatment. Special water tests were made below a farmland area and below a coal mine area. Preliminary tests indicated that the coarse, sandy streambank soils are capable of removing little of the nitrates and phosphates in effluents from septic tank sewage systems. An inventory was begun of the species of algae and aquatic vascular plants. A sample questionnaire was developed for securing facts and opinions from landowners along the stream.

SUPPORTED BY U.S. Dept. of Agriculture

2.1908, CRITERIA FOR DETERMINING ECONOMIC PRIORITIES IN AWARDING SEWAGE FACILITY CONSTRUCTION GRANTS

J.D. JANSMA, Penn. State University, Inst. for Res. on Land & Water, *University Park, Pennsylvania* 16802

The State of Pennsylvania uses a point system to determine relative needs in assigning priorities for awarding sewage facility construction grants. The relative needs considered are water pollution control (50 points), per capita costs (10 points) and financial need (40 points). The major objective of this research is to develop economic indices which measure financial need and per capita costs. Factor analysis will be the technique employed to group the various measures of a community's economic-well-being and thus provide the basis for the index of financial need. Alternative approaches for setting priorities will be evaluated in terms of economic efficiency and equity.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1909, SOCIO-ECONOMIC FACTORS RELATED TO THE INCIDENCE OF A WATER-BORNE DISEASE

G.C. UZDAVINI, Inter Amer. University, Undergraduate School, *San German, Puerto Rico* 00753

This study is to determine primarily the impact of Gastroenteritis, an illness caused by the water-borne enterobacteriaceae on the social and economic life in a community within the municipality of San German, Puerto Rico. Two areas within the community, one a public housing scheme and a slum area will be used to accomplish the following goals: (a) To determine the economic and social factors which lead to unsanitary conditions which enable enterobacteriaceae to develop and multiply, thereby causing an increase in the water contamination even though facilities are available; (b) To determine what the needs are that would alleviate this and other situations; (c) To mobilize the forces in the community to bring about changes in the physical and social environments which will diminish the incidence of this water carried organism and thereby create an atmosphere more conducive to physical health; (d) To develop a framework and background for further research in the area of the effects of water quality upon physical and mental health.

To accomplish these goals, the relevant sociological instruments and consequent analysis will be implemented.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1910, SOME LEGAL, SOCIAL AND ECONOMIC PROBLEMS OF GROUNDWATER POLLUTION
D.B. BURKE, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

This is an interdisciplinary proposal involving principal investigators from the fields of planning law, sociology and economics. The objective is to suggest ways by which groundwater quality can be maintained at satisfactory levels, at least cost, through legal means.

The quality level considered satisfactory will be defined by an attitude survey of users to arrive at a concensus as to where contamination becomes objectionable in various uses. The least cost analysis will be undertaken by comparing the cost of protection of a groundwater supply by a sewage treatment plant to the cost of constructing a surface impoundment for a new supply. The cost of treatment of contaminated groundwater will be an alternative consideration. The laws relating to groundwater control for the public interest are at present vague and uncertain. Preservation of future supplies of groundwater is difficult if some of the water is not in current use. To make this protection easier is the main objective of the legal aspect of this study.

Information and data will be obtained by a survey of households in a local watershed, utilizing previous engineering studies of costs of new supplies as well as compiling cost estimates of other alternatives and by a study of the existing laws pertaining to groundwater control.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1911, SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND
N. RORHOLM, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00117)

OBJECTIVE: Identify, measure and evaluate the economic and social values of the marine resources of the Bay to the State of Rhode Island. The project will be based on secondary source information currently available to the University of Rhode Island with additional surveys or interviews being made as necessary to supplement existing data. Identify, measure and analyze economic and social trends in Rhode Island which would be significant in terms of water pollution control or land use regulation of the Bay and that portion of the watershed which is significant in determining the quality of estuarine water resources. Explore how benefit cost analysis techniques may be best applied to determine the effects of various conditions of beneficial uses on the estuarine resources. Identify and recommend needs for future studies or basic data systems which would be useful in obtaining optimum public benefits from use of the Bay resources.

APPROACH: Not Provided.

PROGRESS: First part of project has been completed. Work indicated that as much as $830 million economic activity was generated by Narragansett Bay, exclusive of general summer tourism, and without assigning values to recreational pursuits such as swimming, sports fishing, skin-diving, etc. or to the effect of the Bay on the quality of the environment. No doubt these values are considerable, but data of good quality with which to estimate their monetary impact is lacking. The $830 million activities generated resulted in $373 million in personal income. This was approx. 11% of the total personal income in the state in 1968.

SUPPORTED BY Rhode Island State Government

2.1912, USE OF ADVANCED WATER RESOURCES PLANNING TECHNIQUES IN THE DEVELOPMENT OF REGIONAL WATER MANAGEMENT PROGRAMS
B.C. DYSART, Clemson University, School of Engineering, *Clemson, South Carolina* 29631

The objectives of the research described in this proposal are as follows: (1) To construct mathematical models for the water quality response to pollutants of a river in an industrialized and developing basin of South Carolina, (2) To apply recent advances in operations research and system analysis techniques to the planning and management of the basin's water quality, (3) To develop alternative long-term water quality management policies for the basin which will enable continued industrial and urban growth as well as the protection of water quality for other beneficial uses of the resource, and (4) To demonstrate to state and local planning agencies the utility of modern management techniques as a guide to rational and orderly development and protection of the water resources of South Carolina.

The Reedy River basin in Greenville County, South Carolina has been selected for study in this investigation. Appropriate state, federal, and local agencies will be consulted to obtain information regarding goals and objectives of water resources development in the basin as well as hydrologic, waste production, and economic data. Alternative objective functions and constraint sets will be formulated. The mathematical system representation will be optimized using dynamic programming. The effects of various management approaches will be demonstrated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1913, THE USE OF TAXES, SUBSIDIES, AND REGULATIONS TO CONTROL THE EFFLUENT OF THE TEXTILE INDUSTRY
H.H. MACAULAY, Clemson University, Graduate School, *Clemson, South Carolina* 29631

The purpose of the project will be to determine the differential effects of taxes, subsidies, and regulations on the use of water and the discharge of effluent by the textile industry. More specific objectives will be: 1. To estimate the economic values of nonmarket uses of water downstream from certain textile mills. 2. To determine the difference in economic results that stem from (a) regulations imposing higher stream standards, (b) a system of user charges or taxes, and (c) a system of subsidies. 3. To determine if a tax subsidy given at the local level (primarily by exemption from property taxes) differs in principle from a tax subsidy given at the national level (primarily by special deductions under the income tax). 4. To assess the difference in economic impact of higher stream standards on old mills and on new mills. 5. To estimate how the cost of cleaning up the effluent from the textile industry may affect the methods of processing textiles or lead to the development of new technology.

A theoretical model to provide for the optimum use of the resource will be constructed. An attempt will then be made to gather data which will make it possible to apply the model to the textile industry. Assumptions as to differences in taxes, subsidies, and regulations will be made to see how the use of water and the operation of the textile industry are changed by each of these conditions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1914, ECONOMIC EFFECTS OF SUBSIDIES FOR POLLUTION ABATEMENT
H.H. MACAULAY, Clemson University, School of Management, *Clemson, South Carolina* 29631

Businessmen and lawmakers have by a large majority expressed a preference for subsidies to reduce stream pollution, while economists have by an equally large majority preferred effluent charges. The latter have been analyzed by those supporting them, but the former have been subjected to little economic analysis. This study seeks to determine: 1) the forms of subsidies that have been proposed by different levels of government for this purpose; 2) the economic validity of arguments advanced in support of subsidies, e.g. is waste abatement equipment 'nonproductive?' 3) the expected economic effects from different subsidies as these effects apply to: a) the change in the quantity of waste discharge by the firm and by the industry; b) the change in the revenue or expenditure of the governmental unit granting the subsidy, c) the incidence of the cost of and the gain from the subsidy.

Results will be sought by the application of price theory to data on methods and costs of waste treatment in certain industries. Data will also be sought from various governmental units granting subsidies.

2. WATER QUALITY

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1915, ADMINISTRATIVE LAW, PROBLEMS AND POTENTIALS, IN WATER RESOURCES (PHASE 2) PLANNING FOR SOUTH CAROLINA
C.H. RANDALL, Univ. of South Carolina, School of Law, *Columbia, South Carolina* 29208

The proposed research plan involves analysis of problems and potentials of administrative law and administrative agencies as tools to control environmental quality and allocation of water resources. The investigation will embrace analysis of present and potential law of South Carolina, the City of Columbia, and pertinent federal law. Conferences with personnel in those levels of government, and analysis of specific regulatory proceedings conducted by them, will be undertaken.

Proposals for advancing the law of South Carolina in resource and environmental control, both present law and proposed, have invariably looked to administrative law as the organizational approach. Problems of the respective functions of the agency, the Attorney General, and federal authorities, as well as problems of the adequacy of representation of all interests, including conservation, recreation and ecological interests, arise, as do problems of the fairness of hearings. Possibilities of such approaches as stream zoning, and the legal and consitutional problems raised thereby, will be studied.

Emphasis in conferences with agencies and study of particular proceedings will be given to the office of the Attorney General, the Water Resources Commission and represented agencies therein, including the Pollution Control Authority. Proposals for strengthening the law and the methods of procedure in allocation and enforcement proceedings will be submitted.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1916, URBAN WATER POLICY AS AN INPUT IN URBAN GROWTH POLICY
K.B. KENNEY, Univ. of Tennessee, Graduate School, *Knoxville, Tennessee* 37916

The proposed research project will examine the existing and potential use of urban water and sewer extension policy to guide urban growth. The objective will be to prepare guidelines and recommendations for the use of water and sewer extension policy to foster a more pleasant, efficient, and healthful urban development pattern. This will be done through an examination and comparative analysis of present urban water and sewer extension policies and related public policies in two or more urban areas.

Information will be obtained through a literature search, correspondence, and visits to selected cities for data gathering and personal interviews. Reports on two or more selected urban areas will examine and evaluate their water and sewer extension policy in detail, giving consideration to the environment and constraints under which it is operative, and assessing its apparent impact on urban growth patterns. This information will then be used to develop guidelines and recommendations and perhaps suggest new and innovative policy directions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1917, THE ENVIRONMENT AND TECHNOLOGICAL ASSESSMENT
J.L. LIVERMAN, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831

The Oak Ridge National Laboratory will move toward a deeper involvement in the problems of the human environment. The institution believes that three steps are necessary: (1) expansion of some specific technical R & D activities that have immediate relevance to man, (2) establishment of ORNL in the broad scope of R & D disciplinary areas necessary for effective participation in the whole spectrum of environmental problems, and (3) development of activities in environment information and communications as needed and to size commensurate with the need. In order to initiate the three steps eight projects are proposed.

In order to expand specific technical R & D activities that have immediate relevance to man, Oak Ridge proposes three projects entitled: (1) Environmental Mutagenesis Program, (2) Techniques for Measuring Mutations Rate in Man, and (3) Water Treatment by Hyperfiltration with Dynamically Formed Membranes and Related Methods.

In order to establish ORNL in the broad scope of disciplinary areas of R & D necessary for effective participation in the whole spectrum of environmental problems, Oak Ridge proposes three projects entitled: (1) Programmatic Perception and Planning, (2) Case Study for National Systems Analysis: Technological Problems and Policy Alternatives for Stationary Power Plants, and (3) Regional Modeling, Environmental Systems Analysis and Public Policy. The development of activities in environment information and communications involves two projects entitled: (1) Environmental Information System and (2) Communication and Public Education.

SUPPORTED BY U.S. National Science Foundation

2.1918, WATER RESOURCES STUDY BY TEXAS WATER RESOURCES COMMITTEE
S. HAYNIE, State Legislative Council, *Austin, Texas* 78711

The 61st Legislature by enactment of H.C.R. 12 created the Texas Water Resources Study Committee to consider various facets of statewide water planning. Among specific areas being considered by the committee are: (1) the water situation in the state and the federal and state proposals concerning it; (2) changes in state statutes which are needed for water protection and development; (3) organizational structure of state water agencies and administration of state water law; (4) ecological effects should Texas Water Plan be implemented; (5) alternative methods of financing Texas Water Plan; and (6) review of water legislation enacted by the 61st Legislature (1969).

Committee will submit a written report and copies of proposed legislation to the 62nd Legislature in January, 1971.

SUPPORTED BY Texas State Government - Austin

2.1919, COMMITTEE FOR THE STUDY OF LAND USE AND ENVIRONMENTAL CONTROL
C. COLE, State Senate, *Austin, Texas* 78711

The 61st Legislature by enactment of Senate Concurrent Resolution 46 continued the Committee for the Study of Land Use and Environmental Control. Although this committee has studied and is studying all facets of the environment, one of its major concerns has been and is the study of water quality. Almost all of the water quality law of Texas was developed by this committee, and, at present, the committee is making further studies of water quality problems as a prelude to further legislation. The committee will submit a report and proposed legislation to the 62nd Legislature in January, 1971.

SUPPORTED BY Texas State Government - Austin

2.1920, ALTERNATIVE DEVELOPMENT PATTERNS, PLANS, CONTROLS AND IMPACT ASSOCIATED WITH NEW RESERVOIRS
F.W. SUGGITT, Texas A & M University System, Graduate School, *College Station, Texas* 77843

Investigation: Develop an 'ideal' plan based upon optimum utilization of the lake, the shore and the backland. This will assume that ways and means are available whereby such an optimum utilization of the resources can be obtained, to provide a maximum of recreation- residence-business satisfaction to the people of the local area, to absentee owners, and to visitors. Evaluation of implications: Develop a 'probable' development plan showing what would likely be attained without overall comprehensive planning and control, based upon whatever controls and guidance is now available, and transferring developmental history from other comparable lake situations. Evaluation of the ultimate costs, benefits, problems. Develop a 'practical' development plan that appears to be likely to be achieved with the installation of planning procedures and control. Evaluation of costs, benefits, deficiencies and problems. Procedure organization and

function of a Lake Livingston area regional planning commission, or council of governments, or development authority. Analysis of statutes, legal procedures, organization, finances, and operation of one or several instrumentalities. Measures needed to adopt and enforce ordinances and codes relating to land use, subdivisions, water supply, waste disposal, traffic control, (land and water), building and related codes. Steps needed to assure public understanding of recommended plans and organizations and ordinances. Evaluation of additional studies and efforts needed. Evaluation of additional sources of funds for such studies.

SUPPORTED BY Texas A. & M. University System

2.1921, ECONOMIC ANALYSIS OF ENVIRONMENTAL QUALITY EFFECTS ASSOCIATED WITH SEASONAL HOMES
M. BEVINS, Univ. of Vermont, Agricultural Experiment Sta., *Burlington, Vermont* 05401 (VT00197)

OBJECTIVE: Determine the environmental situations (positive and negative) associated with seasonal homes and analyze the attitudes, interests, and goals of people for a quality seasonal home environment.

APPROACH: Representative seasonal home communities will be chosen for study. Standard questionnaire will be developed and utilized. Interviews with public officials concerning water pollution and health hazards of seasonal home communities. Interview permanent residents and seasonal home owners to identify positive and negative effects of seasonal home communities.

PROGRESS: The first six months since project activation have been spent on problem delineation. Seasonal homes have both positive and negative effects upon environmental quality of a state or region. This is clearly recognized by top governmental officials and has led, in the State of Vermont, to the adoption of a new set of health regulations relating to land subdivisions. The need for research is pronounced at this point. Pollution caused by sewage effluent is the source of the major negative impact upon the environment. Research work is underway to make an economic evaluation of alternative means of handling sewage in seasonal home communities. Plans are underway for an intensive case study of a lakeshore community in Vermont where the negative environmental impact has been very great. Similar case studies will be made in other Northeastern States following a comparable format.

SUPPORTED BY U.S. Dept. of Agriculture

2.1922, ATTITUDES, OPINIONS AND GOALS CONCERNING REGIONAL RESOURCE PLANNING AND DEVELOPMENT
E.H. TOMPKINS, Univ. of Vermont, Agricultural Experiment Sta., *Burlington, Vermont* 05401 (VT00162)

OBJECTIVE: Determine attitudes of Vermont residents toward alternative goals of regional resource planning and development. Assist local and regional planning and development groups to conduct surveys of attitudes concerning alternative goals in their community or area. Determine goals or policy objectives of state and federal resource development agencies.

APPROACH: Surveys will be conducted in cooperation with regional and local groups which have been formed for the purpose of economic or resource planning and development. A core of questions will be used with additional questions at the option of the group concerned. Local assistance will be utilized as much as possible in conducting the survey. Two methods will be utilized. These will consist of mail surveys, and surveys administered to individuals attending group meetings. Information will be punched on cards for machine tabulation. Data from the surveys will be analyzed by the project leader. A report will be published for each survey conducted.

PROGRESS: An attitude survey of residents of the Washington County area was completed during the summer. This area has two planning regions--the Central Vermont Region and the Mad River Valley Region. A fourth partial report has been prepared on the findings from the Chittenden County Natural Resource Attitudes survey. Raw data have been made available to the Bennington County Regional Planning Commission. The final report on the Franklin County survey has been published. The survey shows that a majority of Franklin County residents want the following: a program for beautifying the county, new industries, stream pollution control, regional schools, better cooperation among towns, and more playgrounds. Findings from these studies are being used by local and regional planning and development commissions, state agencies, the Vermont Extension Service, and community improvement groups.

SUPPORTED BY U.S. Dept. of Agriculture

2.1923, PROGRAM PLANNING ON ACTIVITIES OF AGENCIES OF CONCERN TO PUBLIC WATERS
L.C. HALNON, State Fish & Game Department, *Montpelier, Vermont* 05602

Objectives: To participate in hearings, public meetings and on- site inspection of planned or proposed activities of state or federal agencies, or private enterprised which would directly affect the natural quality of the public waters of the state as they now exist. The object of the job is to be informed of any planned alterations of any agency, to prepare documentation as to the probable effect on public waters, and to participate in any meetings, public hearings or on-site inspection of proposed activities affecting fisheries management of the waters of the state.

Procedures: Project personnel will plan to attend meetings and hearings on proposals by other state agencies, Federal agencies, public utilities or other agencies as matters affecting fisheries management of public waters. On-site inspections of proposed changed affecting the aquatic environment will be made. Pre- and post- activity biological survey or field studies will be conducted as necessary.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.1924, A NEW LOOK AT THE OCEAN RECREATION MARKET
A.B. BIGLER, Compass Publications Inc., *Arlington, Virginia* 22209

The major problems in deficiency of shoreline recreation opportunities are discussed. These include (1) limited supply of prime beach and other shoreline recreation area, (2) discrepancy in available prime recreation shoreline with population location, (3) competition of other shoreline uses, and (4) effects of pollution and accelerated natural and man-made erosive forces. Various applications of marine science and technology are discussed for enhancing shoreline and near- shore recreation opportunities, including modification of shoreline configuration, development of offshore islands and platforms, preservation and enhancement of underwater areas, and artificial means of controlling waves and currents.

SUPPORTED BY No Formal Support Reported

2.1925, A STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES
R.G. KRUTCHKOFF, Virginia Polytechnic Institute, Research Division, *Blacksburg, Virginia* 24061

The purpose of this investigation is to find a stochastic model for pollution and dissolved oxygen in estuaries. With this model it will be possible to predict the proportion of time that pollution will be above any given concentration or that dissolved oxygen will be below any given level. It is hoped that this information will result in better management of water resource systems and aid in forming more realistic restrictions on the use of estuaries for disposal pollutants.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1926, ANALYSIS OF WATER RESOURCES ADMINISTRATIVE AGENCIES
W.R. WALKER, Virginia Polytechnic Institute, Water Resources Research Ctr., *Blacksburg, Virginia* 24061

The aim of this research proposal is to analyze and evaluate the various administrative agencies in the State of Virginia which are concerned in some aspect with water resources management.

The intermediate goal will be to provide an objective assessment of administrative agencies currently operating in Virginia and then to suggest alternative arrangements that might better meet the objectives of the state. The ultimate goal is to formulate various administrative models best suited to accomplish a variety of objectives.

The problems associated with comprehensive planning, water quality, fisheries, recreation, etc., have become increasingly complex. It seems imperative that if policy decisions are to adequately reflect these varied interests that the governmental structure should be examined to determine and assess the various alternative forms.

An attempt will be made to compare the underlying laws creating each agency and to appraise the relative efficiency of the various programs in terms of such factors as economy, technical proficiency, political viability and social and land use effects.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1927, ANALYSIS OF ENGINEERING ALTERNATIVES FOR ENVIRONMENTAL PROTECTION FROM THERMAL DISCHARGES

A.F. AGNEW, Washington State University, State Water Research Center, *Pullman, Washington* 99163

This is phase I of a two-phase research project to analyze and evaluate current and proposed engineering practices used in the protection of the water environment from the impact of thermal power systems. The phase I project will last two years and will develop the analytical framework for evaluation. This research will investigate ecological and social accounting systems to supplement economic analysis of engineering impacts, and will formulate descriptions of alternative engineering solutions for protection of the water environment from the impact of thermal power systems. A methodology to assess the dynamic impact of a series of power plant developments in a region will be stressed.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.1928, A PROGRAM TO DETERMINE THE ECONOMIC LOSSES TO THE STATE OF WASHINGTON OF VARIOUS DIVERSION PATTERNS

C.B. MILLHAM, Washington State University, School of Science, *Pullman, Washington* 99163

The purpose of this research will be to improve in sophistication and capability a dynamic-programming model of a two-river, three-dam, six-time-period river system, coded for the IBM-360 computer. The improved model, designed to determine economic losses due to diversion, will be expected to handle return functions from power generation, irrigation, pollution abatement, and recreation, with constraints for flood control, navigation, and water quality. The program will be implemented with data for the Snake-Columbia river complex to obtain the economic impact of diversions from this system to the State of Washington.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1929, SOCIO-ECONOMIC AND LEGAL CONSIDERATIONS IN THE MANAGEMENT OF PUGET SOUND ESTUARINE RESOURCES

J.A. CRUTCHFIELD, Univ. of Washington, School of Arts, *Seattle, Washington* 98105

The long-range objectives of this project are (1) to identify, measure and evaluate the economic and social values of the marine resources of Puget Sound; (2) to provide analytical and empirical bases for efficient development and management of those resources; and (3) to develop alternative legal-political institutions for more effective implementation of these policies. Most important is the development of alternative legal-political arrangements for integrated planning and management of the Puget Sound estuarine system. There is an urgent need for further analysis of recreational usage of the system. Work will continue on the thermal effects of nuclear or fossil fuel power generating plants on various parts of the Sound. The socio-economic project should be linked to forthcoming programs designed to provide detailed small area information. Preliminary work on the impact of technological changes in ocean going vessels and in transfer of cargoes from vessels to land based transportation indicates a need for one or more cases studies of port relocation. A background task to be initiated this year involves the development (and some analysis) of various types of organizations of users of Puget Sound.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1930, LAW AFFECTING INSTITUTIONAL DESIGN FOR WATER QUALITY MANAGEMENT

P.N. DAVIS, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

This is a tripartite legal study to investigate the legal and constitutional constraints on proposed broadening of powers of state agencies to regulate water quality and to operate pollution abatement works. The three areas of research are: (1) Common law of pollution in action - What influence if any does the common law riparian concept of 'reasonable use' have on the behavior of polluters? Field interviews will be conducted with riparian owners, and practicing attorneys. Local court records will be examined. Library research will determine the procedural and evidentiary problems in civil pollution actions. (2) Law affecting effluent charges -- library research will determine the legal and constitutional limitations on various effluent charge schemes proposed by economists. (3) Operation of pollution abatement works by the State of Wisconsin -- library research will determine the legal and constitutional constraints to broadening state agency powers to regulate water quality in a river as a single system and to operate pollution abatement works.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1931, LEGAL ASPECTS OF WATER RIGHTS AND WATER QUALITY IN EASTERN STATES

P.N. DAVIS, Univ. of Wisconsin, U.S.D.A. Nat. Resour. Ec. Div., *Madison, Wisconsin* 53706 (NRE3-2-52-01)

OBJECTIVE: Review, analyze, and compare the development and current status of laws applicable to water rights and regulation in the 31 Eastern States, with particular emphasis on ground water and water quality.

APPROACH: Analyses are made of state and federal statutes, constitutional provisions, court decisions and other factors applicable to water rights and regulation such as administrative regulations and contractual agreements, problems in acquiring or exercising private or public rights in surface and ground water for agricultural and other purposes, relationships to economic and physical factors including water quality considerations, and possible improvements in the applicable laws or their operation. Major emphasis in the analysis is on legal aspects of water quality in Wisconsin and other Eastern States.

PROGRESS: An article was published analyzing and comparing the suitability of Australian and American water allocation systems for use in the Eastern United States, examining the riparian and appropriation doctrines, temporal nonpriority permit systems and market place concepts. It concludes that a temporal nonpriority permit system may be the most suitable. A manuscript on water-use law and administration in Wisconsin is in the final publication stage and a preliminary manuscript on the origin and development of the riparian doctrine has been prepared. A manuscript reporting legal aspects of water quality management for the Wisconsin River area is in preparation. It includes a classification of water pollution cases according to riparian rights and nuisance doctrines, and tentatively concludes that: civil actions to abate pollution can be brought under rights or nuisance theories; the vast majority of cases recognize a common law right as against downstream riparians for a riparian to discharge wastes into a stream provided the discharge is reasonable, and no public or private nuisance is created; and the doctrine of comparative convenience has been applied in many pollution cases even though the courts frequently deny that the doctrine is applicable. A comparative analysis of the ground water laws of the 31 Eastern States was completed and will be reported in the next period.

SUPPORTED BY U.S. Dept. of Agriculture

2.1932, INSTITUTIONAL DESIGN FOR WATER QUALITY MANAGEMENT - A CASE STUDY OF THE WISCONSIN RIVER BASIN
I.K. FOX, Univ. of Wisconsin, Water Resources Center, *Madison, Wisconsin* (C-1228)

The Problem: Although a substantial amount of research is going forward on the technical and economic aspects of water quality management, relatively little attention is being devoted to the legal, policy, and administrative aspects. New policies and organizational arrangements are being tried but little scientific basis is being provided for institutional change that will assure proper implementation of the kinds of programs required for effective water quality management in the future.

The Objective: Using the Wisconsin River Basin as a region for study the specific objectives are: 1. To assess the advantages of a regional approach to water quality management 2. To evaluate the effectiveness of alternative institutional arrangements for conducting desirable programs of water quality management 3. To appraise the obstacles that are likely to be encountered in seeking desirable institutional changes.

Procedures: The research falls into two broad areas. One group of studies will seek to define the nature of effective programs for water quality management in the Wisconsin River Basin through application of recognized methods of water system design. The other group of studies will evaluate the effectiveness of alternative institutional arrangements for conducting water quality management programs through application of techniques of economic, political, legal, and administrative analysis.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1933, INSTITUTIONAL DESIGN FOR WATER QUALITY MANAGEMENT
I.K. FOX, Univ. of Wisconsin, Water Resources Center, *Madison, Wisconsin*

Specific objectives of this proposal are the following: 1. To integrate the set of studies undertaken in connection with the case study of water quality management in the Wisconsin River Basin into a final report which will indicate: a) The economies to be realized through a regional approach to water quality management, and b) the institutional patterns which offer most promise toward the realization of identified economies.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1934, ANALYSIS OF POLICY ISSUES POSED BY WATER AND RELATED LAND RESOURCES PROGRAMS IN THE METROPOLITAN REGION
I.K. FOX, Univ. of Wisconsin, Water Resources Center, *Madison, Wisconsin*

The excellent information and analysis developed by the Southwest Wisconsin Regional Planning Commission provides a solid basis for research into the effects of the policy-institutional framework upon water quality and riparian and flood plain land use in the major metropolitan area of Milwaukee. The proposed research will identify both the economic effect of the existing framework and the relationship between political participation and the incident of benefits and cost. An understanding of such relationships is of critical importance if policy advances are to be made and some of the urgent problems of metropolitan regions are to be solved.

Specific studies related to water quality management and riparian and flood plain land use will: a) estimate the economic efficiency of resource use relative to the program, b) estimate the incidence of benefits and costs to individuals and organizations according to useful categories, c) seek to establish the relative influence of the major features of the established policy-institutional framework, and individual and groups on the land use patterns and related public programs, and d) identify policy and institutional changes to improve economic efficiency and equitable distribution of benefits and cost, and expand the involvement of affected groups in the decision-making procedures to expand the relevancy of the program.

The first task to be taken in the summer of 1970 will be to review the water and land use patterns and programs and select specific program and land areas that merit intensive study. Government representatives and agency representatives will be consulted regarding study areas and topics.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1935, STUDY OF THE APPLICABILITY OF EFFLUENT CHARGES TO WATER QUALITY MANAGEMENT IN THE STATE OF WISCONSIN
I.K. FOX, Univ. of Wisconsin, Water Resources Center, *Madison, Wisconsin*

Many cities and communities in the United States have levied charges upon those who utilize the public sewage collection and treatment systems. However, to our knowledge there is no case where charges have been levied against those who discharge effluents directly into waterways. It is evident that the applicability and utility of effluent charges have not been thoroughly examined on the basis of carefully developed empirical information anywhere in the United States. This proposed study would seek to review the literature and experience on this subject and then test alternative concepts on the basis of empirical data developed for a specific river system.

The objectives of this study are as follows; (1) to arrive at alternative concepts of effluent charges, which may be applicable to the State of Wisconsin and to assess the potential advantages and limitations of each concept, (2) to examine the quality and economic consequences of applying alternative concepts of effluent charges in the Wisconsin River Basin by using empirical engineering and economic data presently being developed at the Water Resources Center.

It is to be emphasized that the report of this study will not recommend for or against the use of effluent charges in Wisconsin, nor will it offer other kinds of recommendations. The goal of the study will be to present completely objective, scientific analysis of all data and materials that can be marshalled so that state policy officials can make intelligent estimates of the physical and economical consequences of adopting one policy or another.

SUPPORTED BY Wisconsin State Government - Madison

2.1936, ECONOMIC AND LEGAL FACTORS IN PROVIDING, USING AND MANAGING WATER
W.B. LORD, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01212)

OBJECTIVE: Determine the economic considerations that affect use and management of water, identify and describe rights in water and arrangements that regulate water use.

APPROACH: Multiple regression analysis of data collected from 60 artificial lakes in Wisconsin and an analysis of consumer behavior relating recreation to selected characteristics. Update an existing bibliography of publications concerning water rights and related topics. Provide a method to measure economic effects of state and federal water- based recreation projects on the economies of local political subdivisions; and illustrate the use of the model to analyze the adequacy of present and proposed public decision-making institutions relating to the development and expansion of water based recreation areas.

PROGRESS: Developed and administered a questionnaire to a statewide sample of families to test relative effect of perceived water pollution as a deterrent to water-based outdoor recreation. Collected and analyzed Wisconsin River Basin property values to estimate opportunity costs of reservoir drawdown. Reservoirs subject to pronounced summer drawdown and those with minimal fluctuation were included. Developed two computer simulation models which compute the location, amount and timing of hydroelectric power generation and value of power generated for any pattern of flows in Wisconsin River. The first model utilizes river flows and the operating characteristics of existing hydropower plants to determine power output. The second uses hydropower output together with power load analyses and operating and cost characteristics of thermal power generating facilities to estimate the alternative costs of meeting projected power de-

mands with any stipulated pattern of river flow. Together the simulation models provide a means of estimating the opportunity costs, in terms of changes in the overall costs of meeting anticipated power demands. Findings are that the existing system of fossil fuel and gas turbine plants is sufficiently flexible; and the old and relatively small-scale hydropower system is sufficiently inflexible; that changing the pattern of river flows within rather wide limits has little effect on the system operating costs and with current interest rates, technology and river flows, new thermal facilities can provide lower-cost power than new hydro facilities.

SUPPORTED BY U.S. Dept. of Agriculture

2.1937, SOCIAL AND ECONOMIC ASPECTS OF THE GREAT LAKES PROGRAM

R.A. RAGOTZKIE, Univ. of Wisconsin, School of Natural Sciences, *Madison, Wisconsin* 53706

The Socio-Economic portion of the Sea Grant activities continues many of the programs described in the annual progress report of July 1970.In particular, studies of Great Lakes shipping season and port development continue, as do the studies of recreational usage in the Green Bay area and elswhere, disposal of dredged spoil (2 projects) and Lake Superior fisheries.

New projects underway include a study of the legal jurisdictional aspects of use of the sea. Professor Richard Bilder has examined the new Canadian Arctic Waters Pollution Prevention Act as a possible pacesetter for expanding disagreements about national jurisdiction over coastal waters.

A new project to examine the assumptions and research needs for the overall plans for the Lake Superior basin has been begun. It is hoped that this project will result in a clear definition of new research needs to avoid degradation of this large pure body of fresh water.

SUPPORTLD BY U.S. Dept. of Commerce - N.O.A.A.

2.1938, GREEN BAY RESEARCH PROGRAM

R.A. RAGOTZKIE, Univ. of Wisconsin, School of Letters, *Madison, Wisconsin* 53706

The Program is being developed as a multidisciplinary effort to provide information on the total environment of Green Bay, which presently receives an exceptionally heavy load of industrial and domestic waste via the Fox River. Within a systems framework, the program has a goal objective evaluation of alternate solutions to the pollution problem. Inital efforts will assess the effects of man's socio-economic activities on the aquatic ecosystem as well as the reverse effect of current environmental conditions of the Bay on man's cultural activities. Included in the first phase of the program are studies dealing with : (1) the nutrient inputs from the Fox and Wolf River drainage basins (2) an acoustic profiling of the bottom and sub- bottom structure of lower Green Bay as related to sedimentation, (3) the primary productivity of algal and plant species, (4) the nitrogen fixation activity of the phytoplankton community in the lower Bay, (5) the role of the sediment environment in the degradation of organochlorine pesticides, (6) the effects of eutrophication on the benthos and plankton communities, (7) the flushing rate of the Bay in terms of the Fox River water, (8) the effects of perceived water quality on recreational pursuits, and (9) the economic impact of commercial shipping and the Seaway on the port of Green Bay.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.1939, INTERORGANIZATIONAL STRUCTURE RELATING TO WATER QUALITY ADMINISTRATION AND POLICY

W.K. WARNER, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The general objective of the proposed research is to explore the interorganizational structure relating to water quality administration and policy in a selected geographic area. The specific objectives are to: (1) delineate the public and private organizations relating to water quality administration and policy, (2) determine the nature of their concern for, and/or impact on, such administration and policy, (3) explore the structure of relations among those organizations, and (4) explore the influence of the interorganizational structure on administration and policy.

The procedure for data collection will include compilation of existing information from publications, records, and other sources, but will rely mainly on interviews and/or questionnaires.

Results of this study should assist the understanding of problems in coordinating the diverse organizational programs concerned with water quality.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1940, VALUE OF THE GAME AND FISH RESOURCES IN RELATION TO THE FUTURE UTILIZATION OF THE WATER OF THE GREEN RIVER DRAINAGE IN WYOMING

G.T. BAXTER, Univ. of Wyoming, Water Resources Research Inst., *Laramie, Wyoming* 82070

The evaluation of the game and fish resources of the Green River, and their potential value under different types of future water utilization, particularly as anticipated under either the Wild Rivers Act or prospective state or federal developments including irrigation, industrial, trans-basin diversions, etc. This study will be essentially a refined inventory of the Green River, to include lengths of stream, water surface areas, stream classification, fish and game populations, general productivity, land ownership status, review of flow records as they pertain to fisheries, and present utilization of sportsmen. Various aspects of water quality - present and anticipated - will be analyzed. A prediction of the effects of various types of water utilization on the game and fish resources will be made on the basis of the data obtained during the course of the study.

Field work will be undertaken near Pinedale, Wyoming. All other portions of the study will be on the campus of the University of Wyoming.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.1941, WATER RESOURCE OPERATIONS STUDY

P.A. RECHARD, Univ. of Wyoming, Water Resources Research Inst., *Laramie, Wyoming* 82070

The basic purpose of the research is to learn more about the relationships among the many kinds and aspects of water resource operations, including how better to accomplish such multidisciplinary research.

As partial objectives, four study areas have been selected for investigation: (1) Criteria for Water Resource Planning, by studying the basic problems relating to Trans-basin Diversions in Wyoming; (2) Bio-Physical Relationships in the Hydrologic Cycle, by implementing the Multiple Use of the Water Resource Observatory; (3) The Interrelationships of Water Quality and Water Utilization; and (4) Principles of Analysis of Water Resource Operations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

DESCRIPTION OF RESEARCH TASKS

3. SOLID WASTE MANAGEMENT

A. AGRICULTURAL SOURCES

Animal Feedlot Residues, Plant Waste, Farm Domestic Wastes, Manure Disposal.

3.0001, THE ROLE OF SOIL IN FARM WASTE MANAGEMENT
R.W. PEARSON, Auburn University, U.S.D.A. Soil & Wa. Cons. Div., *Auburn, Alabama* 36830 (SWC-026-BAU-3)

OBJECTIVE: Determine effects of organic farm wastes when applied to the soil at high rates, on soil properties, crop yield and quality, and runoff and percolating water quality.

APPROACH: Study will involve experiments in the Rhizotron for measurement of direct effects on plant roots, use of small plots for defining the effect of rate and method of application on crop yield, organic C accumulation and recycling of N, and P and K, and instrumented runoff plots for evaluating effect of wastes on runoff and percolating water. In addition, an evaluation of current lagoon design criteria will be made by periodic analysis of effluent and measurement of sediment in lagoons currently being planned by SCS for construction under A.C.P. cost sharing.

SUPPORTED BY U.S. Dept. of Agriculture

3.0002, EVALUATION OF THE NITROGEN, PHOSPHORUS AND POTASSIUM CONTENT OF POULTRY MANURE
L.H. HILEMAN, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00546)

OBJECTIVE: Determine the nitrogen, phosphorus and potassium content of poultry manure under on-the-farm conditions and some of the factors affecting its composition. Determine crop response to applications of poultry manure of known nitrogen, phosphorus and potassium content, measure the effect of these applications upon soil chemical analysis.

APPROACH: Emphasis will be placed upon analysis of manure from commercial broiler houses. Statistical random sampling methods will be used in houses selected. Data collected will be subjected to statistical analysis for publication upon completion of chemical analysis. Field evaluation will be initiated after completion of the major part of the chemical analysis. The effect of rate and time of manure application on yield of pasture plants will be measured as well as any soil chemical changes.

PROGRESS: Field experiments were conducted to determine the effect of rate of broiler litter application on yield and plant nutrient uptake of grain sorghum, forage sorghum and soybeans. Yield and nutrient uptake of N,P,K was increased as rates of application were increased. A comprehensive greenhouse experiment was conducted using 5-10-15-20 tons litter per acre incorporated into the soil. Three soil types were used. Results show that the release of ammonia during decomposition drastically changes the soil nutrient balance and thus can be considered as a polluting agent. As soil clay content increased the soil chemical changes are decreased. Three months of daily leaching and mixing were required before adequate plant growth could be obtained. These soils similarly treated with broiler litter compost did not show these effects.

SUPPORTED BY Arkansas State Government

3.0003, EFFECTS OF GARBAGE COMPOST ON SOIL AND CROP PRODUCTION
C.C. HORTENSTINE, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-SI-01347)

OBJECTIVE: Evaluate the effects of garbage compost incorporation on the soil structure, fertility, and biological activity.

APPROACH: Laboratory greenhouse, and field studies will be conducted to determine the toxic or beneficial effects of garbage compost on plant life. Emphasis will be on the utilization of garbage compost as a plant nutrient source. The effects of this material on soil microbiological activity, organic matter, water holding capacity, cation exchange capacity, and pH will be determined.

PROGRESS: Effects of soil amended with municipal refuse (compost), cow manure, chicken manure, or sewage sludge on soil microbial activity were evaluated. The amounts of N which must be applied to obtain adequate nitrification in soil treated with compost were investigated. A minimum of 50 ppm of ammoniacal-N were needed to obtain nitrification within 6 to 8 weeks when 1g/100g soil (10T/A) were used. A general reduction in nitrification occurred when increased amounts of compost were added to soil treated with cow manure. African Giant earthworm survival was increased by as little as 2.5% compost added to Arredondo fine sand. Aspergillus niger growth in mycological broth was reduced by the addition of compost extract. In a field experiment, nematode populations (Helicotylenchus spp.) were reduced by additions of compost to Leon fine sand. After the second annual application of compost to phosphate mining tailings, sorghum seedhead weights were relatively greater than the preceding year. The overall average yield from all plots in 1968 was 272 g as compared to 669 g in 1969. The relative yields in 1969 were -- 100% (fertilizer only), 142% (fertilizer 35 tons/ha compost), 199% (fertilizer 70 tons/ha compost), 24% (35 tons/ha compost only), and 69% (70 tons/ha compost only). Where there was no growth of oat plants on the compost only plots in 1968, enough growth will be produced in 1969 for yield measurements. The increased sorghum and oat plant growth in 1969 indicates that there is a residual benefit from compost applications.

SUPPORTED BY Florida State Government - Tallahassee

3.0004, EVALUATION OF POULTRY MANURE AS A FERTILIZER
M.B. PARKER, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO-01-0019)

OBJECTIVE: Evaluate Poultry manure as a fertilizer for corn, forage, and horticultural crops; determine the desirable or practical application rates for various crops; and determine the fertilizer nutrients needed to balance poultry manure as a fertilizer for various crops.

APPROACH: Manure rates will be combined with various fertilizer treatments. Residual effects of manure will be measured with corn and forage. Soil samples will be collected before initiation of each experiment and periodically thereafter to measure the effect of manure on soil pH and on the buildup of P and K in

the soil. Nitrogen content, yields, and clover percentage, when applicable, will be taken from the forage experiments. Yields and other pertinent data will be recorded from the row crop experiments.

PROGRESS: Four years results on the effects of chicken manure and commercial N on Midland bermudagrass forage have been obtained with the following measurements: Yield, ash, protein, fat, fiber, P, K, NFE, and D.M. disappearance (fistulated steer). These values by individual plots have been transferred to IBM cards and are ready for processing. Yield data indicate that manure N is about 60% as effective as commercial N. With N rates up to 400 lb/A., in increments of 100 lbs., forage N increased with N rates from 1.9 to 2.8%, P decreased with N rates from 0.33 to 0.30%, and K increased with N rates from 0.88 to 1.16%, N-P-K removal (forage yield X composition) indicates that the N- P-K ratio changes slightly with changes in N application. With 200 lbs. of N per acre the N-P-K ratio in the forage was 7.4 - 1.0 - 3.4 as compared with 9.3 - 1.0 - 3.8 ratio with 400 lbs. of N applied annually. These data also indicate that N rates annually should be above 200 lb./A. to promote yield, increase protein, and to insure that more N is being applied than removed by the crop. Forage removal of N with 100, 200, 300, and 400 lb/A. annually amounted to 143, 107, 90, and 80% respectively of that applied.

SUPPORTED BY Georgia State Government

3.0005, POULTRY MANURE MANAGEMENT ON FARMLANDS IN THE SOUTHEAST

S.R. WILKINSON, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Watkinsville, Georgia* 30677 (SWC-026-BAW-04)

OBJECTIVE: Determine pollution hazard to surface and ground water, soil, and crop plants of applying large rates of poultry manure to farmland. Determine changes in soil, plant composition associated with heavy applications, and the potential cause and effect of these changes on animal health disorders.

APPROACH: Apply poultry manure up to rates of 200 tons/year to small plots in Coastal bermudagrass, tall fescue, or fallow. Collect runoff from plots receiving either simulated rainfall or natural rainfall. Sample groundwater at several depths. Soil and forage samples from small plots receiving various treatment levels of poultry manure or of N, P, K, will be analyzed for inorganic and organic constituents important from nutrition or health viewpoint. Changes in soil and plant composition will be followed in a pasture ecosystem over a 4-year period with concurrent observations of animal disorders.

PROGRESS: Applications of 4, 8, and 16 tons of broiler house litter/ac/yr produced grass yields 50% of that achieved from 100, 200, and 400 lb/ac N from inorganic sources. High manure fertilization resulted in forage containing high levels of K, and K/CA Mg ratios well above the tetany-prone level of 2.2. Magnesium and calcium contents were safe from a tetany viewpoint because of previous liming with dolomitic limestone. Fescue fertilized heavily with broiler house litter accumulated NO3-N to 0.7%, with up to 35% of the total N in the non-protein fraction. Non-protein N increased with increasing levels of N-fertilization. Spring applications of more than 8 tons manure resulted in accumulation of non-protein N to potentially toxic levels. Two of 20 Angus cows developed fat necrosis after one year of grazing broiler litter fescue. None of the cows on the inorganic fertilized fescue (control) developed fat necrosis. Oral dosing with magnesium alloy bullets did not appear to be effective in preventing low blood serum Mg levels, and their short lifetime in the rumen of fistulated steers (about 3 weeks vs. 6 weeks expected) suggests ineffectiveness in preventing tetany. Coastal bermudagrass tolerated broiler house litter disposal at rates up to 20 tons per month during July, August, and September without loss of ground cover.

SUPPORTED BY U.S. Dept. of Agriculture

3.0006, AGRICULTURAL BENEFITS AND ENVIRONMENTAL CHANGES FROM USE OF ORGANIC WASTE ON FIELD CROPS

T.D. HINESLY, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-15-0362)

OBJECTIVE: Evaluate the use of digested sludge as a source of nutrients and water for growing field crops. Investigate factors relevant to water contamination and soil pollution when digested sludge is applied on crop land at various loading rates, frequencies, and time of year.

APPROACH: A set of 44 highly controlled small field plots or lysimeters will be constructed in such a way that all of the water that leaves each of them can be measured and samples collected for chemical and biological analysis. Laboratory and greenhouse studies will be designed to elucidate in greater detail the sequence of chemical and biological events that occur during the degradation of organic wastes under a wide range of treatments, soils, and environmental conditions.

PROGRESS: Phosphorus and nitrogen fertility for several crops can be supplied by digested sludge applications. Concentrations of Zn, Mn, and Fe in leaf tissue of corn, soybeans, and Reed canary grass were higher with than without sludge application while concentrations of Mg, Cu, and Ni were generally not affected by treatment. All of the metals accumulated in the soil but plant toxicities were not noted. Drain water samples collected from the South Farm lysimeters contained higher concentrations of nitrate-N, Zn, and Mn where sludge was applied. Runoff water from the N.E. Research Center plots contained only small amounts of ammonium-N and nitrate-N. The number of fecal coliforms in the sludge cake which has developed in the soil surface of the South Farm lysimeters decreased rapidly. No buildup of the fecal coliform population was observed within the sludge layer. Soil core samples were taken at the N.E. Agronomy research center where some plots have been amended with liquid digested sludge for two years. It was ascertained that, for these plots, the fecal coliforms did not develop within the plow layer. It was also found that the fecal coliform population rapidly decreased in samples of sludge and runoff water from sludge treated areas. Routine analyses for fecal coliform densities have been performed on the drain and runoff water samples originationg from the lysimeter facilities of the N.E. Agronomy Research Center. The data, so far accumulated, indicate that the sandy soil plots (Plainfield) are performing their filtering role satisfactorily.

SUPPORTED BY U.S. Dept. of Agriculture

3.0007, ABSTRACT SERVICE ON ANIMAL WASTE TECHNICAL LITERATURE

J.R. MINER, Iowa State University, School of Agriculture, *Ames, Iowa* 50010

The object of this work is to prepare abstracts of technical literature pertaining to the collection, transport, treatment and utilization of livestock wastes. Abstracts will be provided to WRSIC and to the FWPCA Laboratory in Ada, Oklahoma. The project will be initiated July 1, 1970 and is currently scheduled to terminate June 30, 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0008, UTILIZATION OF LIVESTOCK WASTE TO ABATE POLLUTION

O.E. CROSS, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-11-031)

OBJECTIVE: Determine maximum allowable rate of loading livestock manure on cultivated soil without pollution of surface runoff or underground water, physical and chemical changes of soil resulting from manure loading rates, effects of manure loading rates on crop production, economic feasibility of manure applications on surface irrigated lands.

APPROACH: Test plots of irrigated sorghum followed by rye will be set-up. Variable will include: four rates of manure application, three depths of planting, three plant populations, and four replications. Quality and quantity of surface water runoff will be determined for natural rainfall and irrigation events. Deep probing soil samples will determine movement and accumulation of soluble contaminants in the soil profile and changes in soil physical and chemical properties.

PROGRESS: Because of variability of soil type, the field area initially selected for this project was abandoned. A replacement area was selected and preliminary soil borings were taken and the soil types classified. This second area was acceptable and negotia-

tions were finally completed allowing use of this area on this project. Soil borings have been completed and the soil types completed. The field area has been seeded to a winter cover. The late date of officially obtaining permit to use the area excluded the fall application of manure. A prototype instrument for sampling surface runoff has been developed and laboratory tested. The remaining 15 units of identical instruments are about 80% completed. Flumes have been made and are being calibrated to measure quantity of surface runoff. An accompanying depth of flow device is yet to be selected and procured.

SUPPORTED BY U.S. Dept. of Agriculture

3.0009, DECOMPOSITION AND DISPERSION OF EXCRETA FROM LAYING HENS AND TURKEYS

T.E. HARTUNG, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-22-015)

OBJECTIVE: Evaluate physical, chemical and biological decomposition parameters of excreta from laying hens using indoor collection pits. Investigate build-up and dispersion of wastes from high density turkey rearing systems.

APPROACH: Both macro and micro indoor tanks will be used evaluating the decomposition of laying hen excreta. Modification of the conditions (physical, chemical and microbiological) within these tanks will be studied. Aeration, its rate and agitation and its rate will be considered. Measurements will include pH, solids, temperature, odor, microbial types and numbers. Measurement of static and run-off wastes will be made on confined turkey production systems. Measurements will be made prior to populating the facilities with turkeys and subsequently after turkeys are placed in them. Measurements will include organic material, microbial types and numbers and chemical changes of soil.

PROGRESS: Intensive rearing of turkeys in semi-confinement were carried during this period. Two densities of pen space (18 sq.ft. and 13 sq.ft.) for toms and hens were compared to performance of range reared turkeys. No growth performance differences were noted between the densities with each sex. Growth was superior under semi-confinement than range conditions. Soil samples were taken prior to the growing season (8 wks. of age) and at the close of the test after 20 weeks for hens and 24 weeks on the toms. Measurement of the following factors are underway: General microbiol conditions, specific pathogens (Salmonella), parasite eggs, soil organic content, pH of soil, and soil mineral content. Original values have been measured for the first growing period during 1968. Comparisons will be made to determine trends in any build-up. Aeration system designs have been understudy for liquid indoor manure tanks. Excessive estimated cost prevented installation of early system. Presently new cost systems are being drafted.

SUPPORTED BY U.S. Dept. of Agriculture

3.0010, AGRICULTURAL WASTE INVESTIGATIONS

UNKNOWN, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00480)

Progress: Agricultural Waste investigations. Because of a lack of funds during the year little progress was made on the evaluation of the quantity of waste generated by agricultural pursuits. However, some parameters have been considered. It is felt that the initial studies should be limited primarily to the animal waste problem because of the nuisance factors and the potential health factors. Based upon the animal population of the state an estimate has been made that there is approximately 5000 tons of animal waste per day in the state. It is recognized that an estimate of the tonnage produced per day is of little significance unless one knows where these quantities are located, how it is disposed of and the method of disposal. Plans are being developed for a total inventory of the animal waste in the state. Sources of funds for conducting this survey are being sought. It is hoped that this survey can be started during 1969. Members of the staff were involved in the undergraduate and graduate teaching programs and High School Science Program, Science Fair. Parts or all of the following courses were taught: 370-403 (Chemistry of Pesticides), 375:407 (Environ. Toxicol. and Epidemiology); 015:497, 498 (George H. Cook Honors Program); 275:503 (Environmental Chemistry and Analysis). In addition a "Short Course in Pesticide Residues" was offered by the Department. Staff members served on several graduate student committees. Numerous inquiries from the staff and public on chemical problems were handled.

SUPPORTED BY New Jersey State Government - Trenton

3.0011, POLLUTION IMPLICATIONS OF ANIMAL WASTE

M.R. SCALF, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

The project is concerned with defining the chemical, physical, and biological properties of various animal wastes and describing the location and extent of the problem. In addition, present technology for collection, transportation, treatment, and utilization of animal wastes will be described along with past and current research. The final phase of the project is to indicate areas of future research.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0012, STABILIZATION OF ORGANIC WASTES FROM CATTLE FEEDLOTS IN SEMI-ARID CLIMATES BY COMPOSTING TECHNIQUES

W. ULICH, Texas Technological University, Agricultural Experiment Sta., *Lubbock, Texas* 79409 (901-031-B607)

OBJECTIVE: Determine the effects of various feedlot management systems on physical, chemical and biological properties of animal wastes, evaluate various procedures for aerobically and anaerobically composting these wastes, and develop systems for effectively composting these wastes thus reducing the potential for environmental pollution of soil, water, and air.

APPROACH: Beef cattle in feedlots will be fed three different rations and weekly samples of wastes will be collected over 120-day finishing periods. Treatments will be replicated with at least 12 animals per treatment. Rainfall simulation will be provided as needed to vary moisture conditions. Evaluations will be made of the influence of moisture vs. no moisture, roof vs. no roof, and solid floor vs. slotted floor. Samples of solid wastes will be analyzed for chemical and biochemical oxygen demand and small management systems for composting developed.

PROGRESS: Work was completed on facilities and equipment for collecting and stabilizing solid waste from cattle feedlots. Modifications on feedlots were made to enable the total collection of waste from cattle maintained under difficult management systems. Waste was also collected in environmentally controlled chambers to determine the effects of various climatic parameters on the characteristics of waste. Test equipment was purchased, computer programs set up, and laboratory and test equipment operators trained. A full analysis of accumulated waste and runoff was made. The waste was obtained from cattle fed various rations and held on lots with various surfaces, rainfall rates, and population densities. Aerobic and anaerobic solid waste stabilization studies were conducted under controlled conditions. A full chemical and biological analyses were made during the composting period. Three controlled dry type laboratory digesters have been constructed to determine techniques for speed-up of composting process and are now in operation.

SUPPORTED BY U.S. Dept. of Agriculture

B. INDUSTRIAL SOURCES

Includes Processing Slurries, Spoil Banks, Ash, Mine Refuse

3.0013, INVESTIGATION OF FISH DIVERSIFICATION AND DISTRIBUTION IN BIG CREEK AND ITS WATERSHED

G.L. HARP, Arkansas State University, Graduate School, *State University, Arkansas* 72467

Big Creek is a relatively small deltaic stream in Northeastern Arkansas. Of recent years it has been dredged in the interest of flood control for surrounding farm land. A dam near the headwaters also aids in this control. Lost Creek and Mud Creek are the major tributaries of Big Creek and collectively drain the Big Creek Watershed.

Only one prior investigation of fish population from Big Creek is known (Osoinach 1969). This survey was conducted two miles south c. Jonesboro, Arkansas, in a one-half mile stretch of water. Case (1970) provides physicochemical data from two locations on Big Creek. Jackson (1968) studied the physichochemical and ichthyofaunal characteristics of Lost Creek, but no survey has been conducted on Mud Creek.

It is the purpose of this study to determine qualitative variation of fish populations in Big Creek, Mud Creek, and Lost Creek and the co- existing physicochemical conditions. Further, the effect of pollution resulting fr om the Jonesboro sewage effluent and Broadway Meat Packing C ompany waste on the fish population will be determined.

SUPPORTED BY Arkansas State University

3.0014, REDUCING WASTES FROM COMMERCIAL FRUIT PEELING OPERATIONS
R.P. GRAHAM, U.S. Dept. of Agriculture, Western Utilization Res. Div., *Albany, California* 94710 (W3-1-165)

OBJECTIVE: Devise ways to peel fruit so that the peel will be free of added water and can be kept separate from the liquid effluent of the processing plant.

APPROACH: Investigate various procedures and equipment to eliminate the use of water in commercial fruit cannery peeling procedures. Design, test, and evaluate mechanical equipment for removal of peel after caustic soda treatment. Study other process modifications for fruits unsuited to dry caustic peeling.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

3.0015, PROCESSING OF WINE FOR PRODUCT IMPROVEMENT AND POLLUTION REDUCTION
K. POPPER, U.S. Dept. of Agriculture, Western Utilization Res. Div., *Albany, California* 94710 (W3-1-162)

OBJECTIVE: Create markets for surplus grapes by developing methods for producing quality wines from non-wine varieties and decrease pollution attendant to wine making.

APPROACH: Investigate optimal wine flavor enhancement with Botrytis culture or extracts; vinification with Hansenula; chemical or biological substitutes for sulfur dioxide (or means of removal); improved fining with K-carboxymethylcellulose; ion exchange and dialysis processes for removal of tartrate. Test Uniflow filter and auxiliary processes for in-field separation of grape juice from pulp and debris; recovery of by-products from winery waste. Evaluate improved products chemically and organoleptically.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

3.0016, NAVY ENVIRONMENT - FATE OF OIL AFTER A MAJOR OIL SPILL
N.A. VEDROS, Univ. of California, School of Public Health, *Berkeley, California* 94720 (N00014-69-A-0200-1001)

Technical Objective: With the exception of a few nuclear powered vessels, contemporary Naval fleets depend upon oil as their source of fuel. Occasionally carelessness, routine cleaning of fuel tanks, and accidents cause oil pollution of the marine environment. The objective of this effort is to determine the fate of oil in beach sand.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0017, ARCTIC ENGINEERING GEOLOGY (TAPS)
O.J. FERRIANS, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

State to which the project pertains: Alaska.

The principal activities and objectives of this project are: (1) for the Technical Advisory Board to the Department of Interior Task Force on Oil Development, review reports and proposals concerning the Trans Alaska Pipeline System (TAPS) in terms of their accuracy and merit, prepare (in collaboration with other government agencies) environmental and technical stipulations controlling the planning, construction, and operation of the proposed pipeline, and make recommendations in regard to possible alignment changes and special engineering-geologic problems, all of which are intended to help in minimizing any adverse effects the pipeline might have on the environment. (2) Collect, synthesize, and prepare for publication, engineering-geologic data that will aid in determining the proper route, design, construction, and maintenance of TAPS, and that will provide similar aid to other engineering activities generated by the petroleum- related development of northern Alaska. (3) Collect and synthesize basic geologic data concerning the character and distribution of permafrost and engineering soils along the pipeline route. (4) Evaluate new techniques such as remote sensing, that will aid in the rapid determination of th distribution and character of permafrost and other geologic- environmental features, and consequently, will facilitate solving engineering- geologic problems.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

3.0018, OIL POLLUTION OR STUDY--NSRDC
W.F. BURKART, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Technical Objective: Survey and collect data of oily-waste production and oily-waste processing elements/systems data from selected shore facilities.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0019, NAVY ENVIRONMENT - BIODEGRADATION OF OIL IN SEAWATER
W. HAYNES, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Technical Objective: The majority of the naval force afloat utilizes fuel oil as the predominant source of energy. Accidents, carelessness, and routine cleaning of fuel tanks often lead to oil pollution of the ocean. This research will provide a better understanding of how natural biological degradation takes place in the marine environment and will give an insight into methods for enhancing this natural process.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0020, BIODEGRADATION OF OIL IN SEAWATER FOR NAVAL POLLUTION CONTROL
N.S. STEHLE, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Technical Objective: To find microorganisms that are capable of quickly and efficiently degrading oil spills and thereby eliminate the hazards and nuisance of oil.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0021, THE ECOLOGY OF THE MICROBIAL POPULATION OF ACTIVATED SLUDGE
P.H. JONES, Univ. of Toronto, School of Public Hlth, *Toronto, Ontario, Canada*

(a) Proposed Research: A study of the population dynamics (b) Objective: To determine the dominant population under different conditions and thereby predict the optimum conditions for the degradation of specific high strength (or toxicity) industrial wastes. (c) Relation to the Health Field: To control waterborne transmission of toxic and pathogenic matter through better understanding of the mechanism of degradation or inactivation.

SUPPORTED BY Canadian Government - Ottawa

3.0022, POLYMER-IMPREGNATED CONCRETE PIPE RESEARCH PROGRAM
W.C. COWAN, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The investigation and development of improved construction materials has become increasingly important as the economy and needs of this country continue to grow. Increasing construction labor costs necessitate the utilization of more economical materials. Polymer concrete conduits are proving resistant to aggressive

chemicals and will be useful in piping industrial wastes and other pollutants.

Before a system of polymer-impregnated concrete pipe can be specified for usage, a thorough design knowledge must be obtained and the service requirement standards must be investigated.

The program is designed to compare unreinforced precast polymer- impregnated pipe with reinforced precast concrete pipe. Goals of the program are to yield complete design information, service requirements, manufacturing techniques, and an evaluation of the economic benefits.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

3.0023, GEOCHEMISTRY OF MERCURY
A.P. PIERCE, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

State(s) to which the work listed herein pertains: Nevada, Idaho.

The objectives of the project are to make environmental studies of mercury distribution in and around selected mineral deposits, to determine physical and chemical causes controlling the distribution of mercury and to develop methods of interpreting mercury anomalies. Studies to date have involved geochemical reconnaissance of mercury in soils, rocks, ore and gangue minerals.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

3.0024, NORTHERN ANTHRACITE FIELD
M.J. BERGIN, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

State(s) to which the work listed herein pertains: Pennsylvania. Long-range objective is to geologically map and study the Northern Anthracite field. Emphasis is on the coal bed in rocks of Pennsylvanian age: (1) Their correlation, distribution, stratigraphy, and structure, (2) their status as energy resources, (3) their depletion by mining and accessibility for additional development, (4) the environmental problems caused by their mining. Distribution, stratigraphy, and structure of the older rocks surrounding the Northern Anthracite field are being studied to determine regional correlations and relationships to the Southern, Western-Middle, Eastern-Middle, Anthracite fields. The currently authorized project entails geologic studies of the southwestern part of the field, namely in the Kingston, Pittston, Wilkes-Barre East, Wilkes-Barre West, Nanticoke, and Shickshinny quadrangles. Upon completion of mapping here, probably in less than 5 years, studies will be undertaken in the northeastern part of the field, namely in the Avoca, Scranton, Carbondale, Waymart, and Forest City quadrangles.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

3.0025, NAVY ENVIRONMENT - BIODEGRADATION OF OIL POLLUTANTS BY YEAST AND YEAST LIKE FUNGI
D.G. AHEARN, Georgia Inst. of Technology, Graduate School, *Atlanta, Georgia* 30332 (N00014-71-C-0145)

Technical Objective: The majority of the Naval force afloat utilizes oil as the source of energy. Accidents, carelessness, and routine cleaning of fuel bunkers often lead to oil pollution of the marine environment. This research will provide a better understanding of how biologic degradation takes place in the marine environment and will give an insight into methods for enhancing this natural process.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0026, SURVEY OF REFUSE ORIGINATING ABOARD NAVAL VESSELS AT SEA
G.C. NICKOL, U.S. Navy, Ship Research & Dev. Lab., *Annapolis, Maryland* 21402

Technical Objective: To determine the approximate quantities and characteristics of solid wastes discharged from the various classes of naval ships while at sea and when berthed. To put emphasis on rubbish characteristics such as plastics, non combustibles, etc. that would affect incineration, compaction or grinding. This is part of a CNO- sponsored plan toward alternative methods for disposal of shipboard rubbish.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0027, UNIT OPERATIONS STUDIES - WHITE PHOSPHORUS AND WASTE CONTROL
W.P. JUNKIN, U.S. Army, *Edgewood Arsenal, Maryland*

Technical Objective: Study means for controlling wastes and effluents from plants which load white phosphorus (WP) into munitions systems. Develop leak detection devices.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0028, BIODEGRADABILITY OF ORGANIC COMPOUNDS INCLUDING DETERGENTS, METAL WORKING FLUIDS, ETC. THAT MAY CONTAMINATE WATER
M.R. ROGERS, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Conduct studies of the biodegradability of organic compounds to develop standards and test procedures for their use in Army materials including detergents, metal working fluids, gelled fuels, and liquid hydrocarbon fuels.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0029, VEGETATIVE RECLAMATION OF IRON MINE WASTES
S.G. SHETRON, Michigan Technological Univ., Ford Forestry Center, *L'Anse, Michigan* 49946

Research will be conducted on the establishment of vegetation on nonfertile waste rock dumps, retaining tailings dams and tailing deposits at iron and copper mines in Michigan's Upper Peninsula. Results to date show that adequate growth of grass and legumes can be obtained with proper fertilization. Treatments varied from no fertilizer, sawdust, sawdust-fertilizer, and fertilized three times. Growth and survival of tree species was poor. Establishment costs varied from $20 to $1,200 per acre, depending on the type of treatment used.

New studies have been initiated concerning the following: (1) application of vinyl polmers for preimmergent wind and water erosion control, (2) soil micro-biological regimes before and after vegetative establishment, (3) development of wind breaks, (4) planting of tree and grass species that are not native to Michigan s Upper Peninsula.

SUPPORTED BY Cleveland Cliffs Iron Company - Michigan

3.0030, SINKING METHODS FOR REMOVAL OF OIL POLLUTION FROM WATER SURFACES
E.C. ROSHORE, U.S. Army, Waterways Experiment Station, *Vicksburg, Mississippi* 39180

Technical Objective: To identify all existing oil sinking materials that could be used in cleanup operations associated with massive oil spills and leaks from tankers and drilling plantforms. To develop standard procedures for testing each material. To qualitatively and quantitatively evaluate the effectiveness and partial utility of each material.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0031, NAVY ENVIRONMENT - BIODEGRADATION OF OIL SLICKS IN MARINE ENVIRONMENT
R. BARTHA, Rutgers the State University, School of Arts, *New Brunswick, New Jersey* 08903 (N00014-67-A-0115-0005)

Technical Objective: With the exception of a few nuclear powered vessels, contemporary Naval fleets depend upon oil as their fuel, occasional carelessness and routine cleaning of fuel tanks, among other things, cause oil pollution of the marine environment. This effort will be devoted to obtaining a better understanding of how biological degradation of oil takes place and may give an insight into means of artificially increasing this process.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0032, STUDIES ON MODIFICATIONS OF SOLID INDUSTRIAL WASTES
C.S. GROVE, Syracuse University, Research Institute, *Syracuse, New York* 13210

Collection of data and information on the 'Survey Review - Solid Wastes: Scope, Quality and Quantity' will be continued, through literature coverage but emphasizing personal solicitation and confirming data through direct correspondence and interviews. It is planned to prepare semi-annual reports for distribution. The experimental studies on modifications of solid industrial waste beds will be continued to investigate the effects of porosity, particle size, and leaching rates on rapidity of possible rehabilitation and potential load-bearing capacity and growth of desirable vegetation. Two types of solid wastes will be studied further: (1) Solvay process wastes; and, (2) Ground overburden and washings from anthracite coal mines. The rates of removal of soluble salts from soils and insoluble particulates has been shown to be some function of the organic humus content. This parameter will be investigated in more detail.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0033, ORGANIC MATTER RELATIONSHIPS OF SPOIL BANKS
J.P. VIMMERSTEDT, Ohio Agric. Res. & Dev. Center, *Wooster, Ohio* 44691 (OHO00383-S)

OBJECTIVE: Study tree litter and root conversion to organic matter in spoil banks.

APPROACH: Determine abundance and biomass of macroscopic soil animals on spoil banks. Energy available in litter and dead roots for animals and rates of consumption by soil aniamls. In 1967 plan to establish colonies of earthworms.

PROGRESS: Earthworms (Lumbricus terrestris L.), placed on an acid (pH 3.5-4.0) shale spoil bank revegetated with black locust (Robinia pseudoacacia L.) or in undisturbed cores from the spoil bank surface, actively buried litter and ectorganic humus, depositing castings on the surface. In undisturbed cores in a greenhouse, burial of a 60 mm thickness of litter and ectorganic humus was quite complete after 180 days. Exchangeable K, Ca, and Mg and available P contents of the mineral spoil increased as follows: K from 0.16 to 0.19, Ca from 1.7 to 2.7, and Mg from 1.8 to 2.5 meq per 100 grams of spoil; available P increased from 1.7 to 4.2 ppm. Earthworm activity did not influence growth of red oak (Quercus rubra L.) seedlings. Earthworms, caged on the spoil bank, survived for at least 2 years, and reproduced. They buried or consumed about 5 metric tons/ha of litter and 23 metric tons/ha of ectorganic humus. In the greenhouse, during 175 days, 14 metric tons/ha of litter and 68 metric tons/ha of humus were consumed or buried. The weight of earthworm casts deposited on the surface of the cores was equivalent to 16.8 metric tons/ha. Earthworms can promote the incorporation of organic matter into mineral spoil.

SUPPORTED BY Ohio State Government

3.0034, NAVY ENVIRONMENT ENZYMATIC REMOVAL OF OIL IN THE MARINE ENVIRONMENT
R.K. GHOLSON, Okla. St. Univ., School of Arts, *Stillwater, Oklahoma* 74075 (N00014-71-A-0004-0001)

Technical Objective: With the exception of a few nuclear powered vessels, contemporary Naval fleets depend upon oil as their fuel. Occasionally carelessness and routine cleaning of fuel tanks, among other things, cause oil pollution of the marine environment. This study is devoted to the isolation of microbial enzymes systems which will degrade hydrocarbons.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0035, FOOD PROCESSING WASTES
M.R. SODERQUIST, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00899)

OBJECTIVE: Initiate a research program dealing with the wastes generated by Oregon's primary food processing industry, involving: evaluation of waste occurrence and waste disposal systems currently being used; estimation of the extent and seriousness of present and future problems; establishment of guidelines for the selection of research which could most reasonably help alleviate the critical problems; and implementation of individual research projects involving waste reduction, waste treatment and by-product development.

APPROACH: The industry will first be surveyed by a questionnaire designed to reveal the origin, quantity, nature, composition, importance & cost & method of disposal or utilization of solid, aqueous & gaseous wastes. This will be followed by one-site analyses, using a portable laboratory built for this purpose, of specific waste streams to gather more detailed data on each segment of the industry. From these data, problems will be categorized by common methods of approach & research will be undertaken to alleviate these problems.

PROGRESS: The first phase of the project has been completed. The questionnaire results have been tallied, analyzed and interpreted. A report on the findings will soon be published. To implement the second phase of the project, outlined under 'Approach' on Form AD 416, a portable laboratory has been designed and is now being constructed. This will be used in an on-site sampling and analysis program beginning this summer.

SUPPORTED BY U.S. Dept. of Agriculture

3.0036, FERMENTED FOOD PRODUCTS
H.Y. YANG, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00677)

OBJECTIVE: Improve the quality and processing methods of fermented food products. Describe the nature of defective fermentation of food products and provide means of control. Develop new food products through the fermentation process. Define the fermentation processes in terms of specific reactions which change the flavor, textural and other sensory attributes of the products.

APPROACH: Work on the pear wine formulation and pickle coloring and flavoring will continue through the next year. Pear concentrates from the Hood River area will be tested as well as the Medford concentrates. Pear wastes retained by the pulper and finisher will likewise be tested for their suitability in the production of formula wines. These wastes, though not fit for making pear concentrates, retain about 13 per cent of sugar and most of the other pear constituents. They are not utilized now and they cost money to be hauled away, in addition to the pollution and contamination problems.

PROGRESS: During the year, efforts were concentrated on the fermentation of vinifera grapes as there was much interest on this subject generated throughout the state. A total of 733 pounds of grapes were crushed and fermented into wine, for experimental purposes. The varieties of vinifera grapes tested were Pinot Noir, Gewurztraminer, Sylvaner, Pinot Chardonnay, White Riesling, Zinfandel, Semillon, Sauvignon Blanc, Cabernet Sauvignon, and Pinot Blanc. Some of the varieties were picked three or four times during the season. The unusually cold and rainy season hurt the grapes, as it did other crops. The vinifera grapes were high in acidity and low in sugar content. Tight clusters were moldy, although in some cases the mold was Botrytis cinerea (noble mold), which is considered desirable for the development of sugar and flavor in some grapes. Two small rooms were converted to fermenting rooms with the installation of refrigeration units. The rooms are being used for fermenting, stabilizing, and aging of wines.

SUPPORTED BY Oregon State Government

3.0037, PHYSIOLOGICAL EVALUATION OF TREATED TOXIC WASTES
G.R. BOUCK, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

The project seeks to evaluate the needed degree of waste treatment for Paper Trade Wastes. Various life stages of Pacific Salmon and steelhead trout are the test organisms and these are exposed to the above wastes for thirty days or more using continu-

ous renewal of toxicant. Physiological tests include histopathology, autofluorescence of tissues, protein composition of plasma and tissues, enzymes in plasma and routine hematology.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0038, SLIME CONTROL ASSOCIATED WITH PULP MILL EFFLUENTS
M.D. KNITTEL, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

The purpose of this investigation is to learn the minimum requirements of nutrients that support the growth of Sphaerotilus natans. Further, the project plans to define the carbon and nitrogen source that supports growth of this bacterium. This information will be helpful to those who must design effective waste treatment methods for industrial wastes.

A second major area of this project is to find, test and develop effective biological control methods for S. natans.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0039, CARBONIZATION OF MUNCIPAL AND INDUSTRIAL WASTE
D.E. WOLFSON, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

The Bureau of Mines-American Gas Association (BM-AGA) pilot plant is available and is capable of processing thermally degradable feed stocks and recovering the solid, liquid, and gaseous products in sufficient quantity for analysis and processing.

Samples will be obtained from refuse collection depots and sources of industrial waste. Pyrolysis experiments will be made at temperatures up to 900 degrees C to determine the yield and quality of the products. Other variables to be studied include bulk density, moisture content, and the separation or inclusion of noncombustible constituents.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0040, REVEGETATION OF HIGHLY ADVERSE SITES CREATED BY COAL MINING
R.J. HUTNIK, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01745)

OBJECTIVE: Determine levels of physical and chemical factors restricting revegetation. Identify and develop resistant species and varieties. Test soil amendments to ameliorate limiting factors. Determine effects of sewage and industrial wastes on spoil materials.

APPROACH: Both laboratory and field measurements will be made to determine properties of sites for comparison with known tolerance levels of plants. Selected species and varieties will be screened in greenhouse tests using spoil substrates. Mulches and chemicals will be laboratory and field tested as ameliorating agents. Sewage sludge, effluent, and fly ash will be used in laboratory lysimeter tests.

PROGRESS: The environment of a deep-mine refuse bank was studied. Soil moisture and temperature were measured. Although the refuse dried out rapidly near the surface, it remained moist throughout the summer at a depth of nine inches; the surface reached a maximum of 160 F, and on several occasions, it remained above 140 F for more than four hours on all aspects except the northwest; the temperature 1/3 inch below the surface reached a maximum of 131 F, and stayed above 122 F for 4-1/2 hours; temperature gradients as steep as 40 F between the surface and 1/3 inch below, and 48 F between the surface and 1/3 inch above were measured. A study was made of the chemical quality of percolate through mine spoil after applications of sewage sludge and weekly application of sewage effluent. Pyrite-bearing spoil was used with a 4.1 pH. Renovation of the solution was satisfactory for Ca, P and LAS. S concentrations decreased to 50 ppm S in the 38th week. Concentrations of Fe were low except for sludge treatments where they had decreased to 30 ppm after thirty weeks. K concentrations remained above effluent concentrations for sludge treatments throughout the study. The pH of the percolates remained about 4 for all treatments except for some sludge treatments where it increased in thirty weeks to about 6.5. Ammonia was generated in some sludge treatments. Percolate from some sludge treatments was discolored and had an offensive odor.

SUPPORTED BY U.S. Dept. of Agriculture

3.0041, RECOVERY OF AMINO ACIDS FROM POTATO STARCH FACTORY SECONDARY WASTES
W.L. PORTER, U.S. Dept. of Agriculture, Eastern Utilization Res. Div., *Wyndmoor, Pennsylvania* 19118 (E3-6-54)

OBJECTIVE: To reduce pollution by potato starch factory effluents by laboratory evaluation of new ion-exchange methods of recovery of amino acids from such wastes; construct a portable demonstration plant, recover crude amino acid mixtures and protein for use in utilization studies and market development, and to obtain cost estimate and design for full scale operation.

APPROACH: Apply newer ion-exchange techniques to EU process for recovery of amino acids from potato processing waste. Obtain information to expand to plant scale, including charge and elution behavior, resin life. Characterize amino acid product, composition, BOD and COD of process influent and effluent. Apply Dutch steam-injection process for protein recovery to clarify input. Determine if reverse osmosis is practical or potential way to increase concentration of values in protein water. Construct portable demonstration protein and amino acid recovery plant for use at starch factories to show application of process to pollution abatement, produce 500 pounds of each product. Determine product value in feed, food, drug or other field. Estimate costs for process as applied to effluent from 10, 30 ton potato starch plants as means of pollution abatement.

PROGRESS: Coarse membrane reverse osmosis modules have been tested for protein removal from waste stream. Flow rates were considerably lower and small molecule retention higher than hoped. Causes are being sought. Batchwise rather than continuous mode is more efficient for reverse osmosis preconcentration for subsequent processing. Ion exchange removal of cations before recovery of amino acids improves recovery of both materials. Process variables (temperature, flow rates, volumes, concentrations) being optimized and control instruments developed. Conductivity monitoring for both cation and amino acid columns is satisfactory. A run of 3 complete cycles was successful, with solids reductions nearly theoretical. Operating procedures for organic acid recovery are being reduced to minimal; eluate solids concentration of nearly 7% has been attained. First uses of this fraction as detergent builder replacing phosphates were promising. Material balances have been calculated prior to process cost estimates.

SUPPORTED BY U.S. Dept. of Agriculture

3.0042, NAVY ENVIRONMENT - BIOLOGICAL OXIDATION OF PETROLEUM POLLUTANTS
J.F. FAIR, Houston Research Incorporated, *Houston, Texas* 77023 (N00014-71-C-0307)

Technical Objective: The majority of the Naval force afloat utilizes oil as the primary source of energy, accidents, carelessness, and routine cleaning of fuel bunkers often lead to oil pollution of the marine environment. This research will provide a better understanding of biological degradation of hydrocarbons and will give an insight into methods for enhancing this natural process.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0043, TREATMENT OF TAILINGS TO ENHANCE PLANT GROWTH AND PROMOTE STABILIZATION OF TAILINGS
H.B. PETERSON, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00726)

OBJECTIVE: Compile a bibliography of biological stabilization or utilization of mine tailings. Survey and screen plant species for use in stabilizing mine tailings. Determine growth deterrents and nutrient deficiencies and evaluate various treatments on mine tailings to promote plant growth. Study effects of tailings-grown plant material on animal life.

3. SOLID WASTE MANAGEMENT

APPROACH: Wastes from copper, lead, zinc, uranium and gold milling operations will be studied. Laboratory and greenhouse tests will be made to determine phytotoxic agents in tailings and levels of these agents required to produce toxicity in plants. Deficiencies of nutrients required to support plant life will be determined in the tailings, and studies will be made to alleviate these deficiencies through soil additions or ammendments. When accepted vegetative growths are attained the plants will be fed to animals to determine if materials extracted from tailings create adverse health effects.

PROGRESS: Field trials were initiated on tailings ponds. Results to be presented in annual report to FWPCA. Major activity on progress preparation of manuscripts. A bulletin is in preparation.

SUPPORTED BY: Utah State Government

3.0044, TECHNOLOGICAL CHANGE IN FOREST INDUSTRIES

W.R. BENTLEY, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01364)

OBJECTIVE: Develop and test hypotheses concerning relationships between causal factors and effects of technological change in the forest industries; identify and model effects of present and possible future levels of technology in the forest economy.

APPROACH: Develop hypotheses and measures relating technological changes to causal factors using tool of historical analysis, statistical analysis, and industrial interviews; investigate the secondary effects of technological change using an input-output analysis.

PROGRESS: First, investigations regarding the nature of technological change have identified three sources of increased value productivity in the forest industries: 1. Response to changes in the relative prices of inputs (esp. labor, equipment, timber, and energy) and product outputs. 2. Shifts in present input combinations to attain greater technical efficiency. 3. Initiation of essentially new technology in processing and/or products. Second, the primary causal factor is hypothesized to be managerial quality. Efforts are now being made to design methods for testing this hypothesis and providing measures of technological change (productivity increase) associated with each of the sources listed above. Third, specific empirical research is focusing on pollution abatement by the pulp and paper industry. It is hypothesized that technological change alone has been the major course of reduced pollution loadings by pulp and paper mills. This problem has been formulated in terms of positive and negative increments to present net worth associated with reductions in 5-day BOD and suspended solids. A technological matrix has been formulated for each major pulping and paper-making process (Fig. 1). Technical stages in each subprocess reflect sequentially lower loadings. A cost matrix by plant size is now being constructed to predict loadings associated with economically optimal plants and the cost of decreasing loadings still further. Older plants with mixed levels of technology also can be simulated.

SUPPORTED BY: U.S. Dept. of Agriculture

3.0045, PACKAGING

R.S. KURTENACKER, Univ. of Wisconsin, U.S.D.A. Forest Products Lab., *Madison, Wisconsin* 53706 (FPL3507)

OBJECTIVE: Develop procedures for efficient utilization of wood, wood-base materials and composites in pallets and containers, emphasizing lower grades and lesser used species; integrate transportation environment and engineering analysis into containers to improve protection and reduce damage.

APPROACH: Improve necessary properties and characteristics of paperboard components to impart optimum performance to container; increase the use of wasters, residues, and bark through engineering design of paper sheets to develop necessary properties; improve production efficiency by analyzing component and equipment characteristics; improve fastener systems, utilize tree residues and foreign woods to augment timber supply; establish transportation environment conditions, especially those involving shock and vibration; and utilize this information to develop efficient container designs, establish blocking and bracing requirements, and provide desired degree of product protection; consider impact on waste and pollution.

PROGRESS: Review of related literature involving development of package design criteria and work on water-resistant corrugating adhesive continued. In order to improve corrugated fiberboard compressive strength, the effect of glue skips and means of eliminating them were studied. Theoretical and actual bending stiffness of corrugated fiberboard were compared to provide a basis for computing the anticipated bending stiffness of a combined board from preselected components. Improvements were made on the method for measuring flute height. Additional performance data was obtained on behavior of pallet fastening systems involving resilient adhesives. Studies proved serviceable bin pallets can be made from Applachian hardwoods, also pallet stringers with built-up cutouts utilizing low-grade hardwood could provide better wood utilization than conventional stringers with sawn cutouts and perform equally as well. Knowledge developed on severity of shock experienced by container contents should result in more efficient utilization of wood-base cushioning material. A method of studying puncture and tear resistance of paper bags and an equation for determining the performance index of sacks were developed.

SUPPORTED BY: U.S. Dept. of Agriculture

C. MUNICIPAL SOURCES

3.0046, CONSERVATION OF RESOURCES IN MUNICIPAL WASTES

C.E. SCARSBROOK, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-03-0017)

OBJECTIVE: Determine the effect of municipal garbage compost on the growth of plants and on soil properties.

APPROACH: Compost will be soil incorporated and used as a mulch to determine its effect on the establishment and growth of roadside cover. The nutrients required for growth of various plants in garbage compost will be determined. The rate of decay and duration of effects of compost on soil will be measured in the field and in the laboratory. The effect of compost on the activity of herbicides in the soil will be determined.

PROGRESS: Garbage composts produced at the municipal plant, Mobil, Alabama, were used in all experiments. To obtain normal growth of Gahi- 1 millet, it was necessary to add extremely large amounts of N and P to composts. Where the composts were kept moist in the greenhouse for one year the compost released sufficient nutrients for fair plant growth whereas initially the composts would not support plant growth. There were no toxic effects of composts on germination of millet. Compost reduced the toxicity of excessive rates of trifluralin and fluometuron added to soil but had little effect on bromacil, nicloram, and simazine. Laboratory incubations experiments show that N added with the composts is first immobilized and then gradually released over an 18-week period. Nitrogen contained in the compost is not appreciably mineralized after 18-weeks incubation. Compost used as a mulch for chrysanthemums and petunias was as satisfactory as sawdust and fine straw. Where compost was added to a potting mixture there was a reduction in height and weight of chrysanthemums, a reduction in weight of geraniums, a reduction in leaf size and weight of gloxina, an increase in flowerhead length in snapdragons, and an increase in plant height and flower number in easter lily. Chrysanthemums grown in soil containing compost contained 3-4 times more B than plants grown in peat amended soil.

SUPPORTED BY: Alabama State Government

3.0047, IMPROVEMENT OF CEREAL GRAINS UNDER IRRIGATION

A.D. DAY, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2014-4156-003)

OBJECTIVE: Develop new cultivars of barley and oats for hot-steppe regions with higher yields, higher quality, more resistance to lodging, and more resistance to the Barley Yellow Dwarf Virus (BYDV). Breed new salt-tolerant cultivars of barley, wheat, and corn. Conduct in-depth studies to determine the ef-

fects of municipal sewage effluent on the quality of protein in small grains.

APPROACH: New cultivars of barley and oats will be developed for the southwestern U. S. using the Pedigree and Recurrent Selection methods of breeding. New salt-tolerant barleys and wheats will be selected from Composite Crosses of spring barleys and wheats from the World Barley and Wheat Collections. A new salt-tolerant corn will be selected from an Arizona Corn Composite Cross. Grain from cereal grains grown with sewage effluent will be analyzed to determine the effects of sewage effluent on protein quality (amino acids).

PROGRESS: Results from experiments in which 39 barleys, with geographical origins similar to 'California Mariout', were germinated in salinized water and soil cultures were reported in the Agronomy Journal. One-third of the barleys studied equalled or exceeded California Mariout in germination in highly saline cultures. Their emergence in salinized soil followed the same trends as their germination in petri dishes. Most commercial varieties had lower germination salt-tolerance than California Mariout and the more tolerant USDA introductions. At moderate salinity levels, most barleys had uniform emergence in soil cultures while at higher levels of salinity only the salt-tolerant barleys produced satisfactory seedling growth. The two-year experiment conducted at Tucson, Arizona to study some of the effects of withholding water from wheat at different stages of growth was published in Progressive Agriculture. The most critical period for water in the growth of spring wheat planted in December was the jointing stage of growth.

SUPPORTED BY: U.S. Dept. of Agriculture

3.0048, COMPILATION OF READINGS AND CASE MATERIALS ON TECHNOLOGY ASSESSMENT
C.H. DANHOF, George Washington University, Prog. of Pol. Stud. Sci. Tech., *Washington, District of Columbia* 20037

The assessment of technology is a special characteristic of government regulatory activities having to do with the consideration of the need for constraints on the use of new technology or on well established technology which can be subjected to new analysis using detection equipment.

This project involves the selection of case studies in government action resting upon a technology assessment and involving the application of values established by statute or administrative action. Cases are classified as relating to human health and safety, the environment (including air, water, noise), solid wastes, and with a small section devoted to population questions. The compilation concludes with a selection of proposals relating to the improvement of the regulatory process, principally through improvements in the assessment procedures. Each case is provided with a brief foreword placing its subject-matter in perspective.

SUPPORTED BY: U.S. Natl. Aero. & Space Adm.

3.0049, CHEMICAL INDICATORS OF FECAL POLLUTION
J.E. SINGLEY, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

The proposed research project will focus attention upon the development of a qualitative and quantitative analytical procedure for the determination of a product of higher animal metabolism that occurs in the feces in high enough concentration to be detected.

The initial phases of the study will concentrate upon the optimization of a gas chromatographic analysis for coprostanol (5 B-cholestan-3 B-ol). Preliminary studies have shown good sensitivity and accuracy. The major improvements that need to be made are in the preliminary extraction and cleanup steps and in column characteristics. Other analytical techniques will be evaluated in an attempt to develop a rapid, simple and accurate method of analysis.

The ultimate objective of the study is the replacement of the standard bacteriological methods of analysis of fecal pollution.

SUPPORTED BY: U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0050, CLAY-WATER SYSTEMS IN RELATION TO ENGINEERING PROPERTIES OF CLAY MATERIALS
W.A. WHITE, State Geol. Survey, *Urbana, Illinois* 61801

The study concerns the effects of rocks, detergents, water softeners, fabric softeners, and starch on the plastic properties of earth materials.

There have been land creeps and landslides in residential developments in Illinois and other states where there are discharge fields from septic tanks. It is possible in some of these instances that the compounds in the effluents from the septic tanks have contributed to the instability of the land. The effects of these compounds have been studied, and they seem to affect the plastic properties of clay materials to some extent--some more than others. The project is being continued, using two or more products that occur in household wastes.

SUPPORTED BY: Illinois State Government - Springfield

3.0051, THE EVALUATION OF ACROLEIN AND ANALOGS TO DEODORIZE SEPTIC WATERS
W. GARNER, Midwest Research Institute, *Kansas City, Missouri* 64110

Acrolein and other alpha, beta unsaturated aldehydes react instantaneously and completely with H2S in septic aqueous systems. Additionally, they react with -SH bearing enzymes in bacteria and inhibit growth. The titled project is investigating the chemistry, microbiology, engineering, and economics of this patented process with the view to developing it for field use in wastewater systems and agricultural waste management.

SUPPORTED BY: No Formal Support Reported

3.0052, APPLICABILITY OF ARDOX CATALYSTS TO THE OXIDATION OF MUNICIPAL SEWAGE EFFLUENTS AND OF WASTES PRODUCED DURING MANNED SPACE FLIGHT
B. INTORRE, Arde Incorporated, *Paramus, New Jersey* 07652

To perform a study to determine the applicability of ARDOX Catalysts to the oxidation of municipal sewage effluents and of wastes produced during manned space flights.

Using the appropriate Ardox catalyst and continuous operation of the reactor system, experimental runs shall be carried out to determine the effect of operating variables upon the extent of oxidation and to select optimum values of the variables for carrying out further work with municipal secondary effluent.

SUPPORTED BY: U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0053, EFFECT OF MUNICIPAL SEWAGE PLANT EFFLUENT UPON AQUATIC SNAIL POPULATIONS
R.C. CRAIG, State University of New York, School of Arts, *Plattsburgh, New York* 12901

A study is in progress to determine the effect of sewage plant effluent on the numbers, types, and distribution of snails in the Saranac River, Plattsburgh, New York. This study was suggested when a search for snails along the north and south banks of the river revealed that no snails were located on the south bank below the City of Plattsburgh sewage plant discharge pipe while 50 yards away on the north bank numerous snails (4 different genera) were located. The same general type of vegetation exists on both sides of the river.

In addition to the snail population study, water samples from the river will be analyzed for nitrates, phosphates, copper, mercury, and chlorine content. Water temperature, pH, dissolved oxygen, and turbidity determinations will be recorded.

A control area further south on the shore of Lake Champlain has been selected which approximates the Saranac River area in vegetation, water movement, and bottom type but lacking the gross pollution of the river.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY Amer. Mus. of Natl. Hist. - New York, N.Y.

3.0054, BOD FOR HOUSEHOLD SEWAGE
E. OLSSON, Natl. Swedish Inst. Bldg. Res., *Stockholm, Sweden*

Work - Curves of BOD (biochemical oxygen demand) are taken in a 'Sapromat' apparatus during a max. time of 60 days, and for different kinds of household sewage. Results compared with BOD taken with other methods.

SUPPORTED BY Swedish Government

3.0055, STUDY OF COST FOR RE-USING MUNICIPAL WASTE FLOWS IN SELECTED TEXAS CITES
H.I. HOFFMAN, Southwest Research Institute, *San Antonio, Texas* 78228

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Texas State Government - Austin

3.0056, SOLID WASTE CELLULOSE DEGRADATION BY THERMOACTINOMYCES
F.J. STUTZENBERGER, Weber State College, School of Arts, *Ogden, Utah* 84403

The role which actinomycetes play in the degradation of cellulose in solid waste materials has been relatively neglected. A cellulolytic actinomycete of the genus 'Thermoactinomyces' was found to be prevalent in the open windrow composting process at the Joint PHS-TVA Composting Project at Johnson City, Tenn. the cellulase which it produced in pure culture exhibited pH and temperature optima (pH 6.0 and 65 C) identical to those of the crude cellulase extracted from compost samples of windrows undergoing degradation. These findings indicate that this actinomycete is of prime importance in cellulose degradation during the composting of municipal solid wastes.

In efforts to increase the rapidity and completeness of the solid waste composting process, knowledge of the requirements and capabilities of active flora and their extracellular enzyme systems is essential. Such knowledge will provide a basis for meaningful manipulation of physical and chemical conditions to improve the degradation of important solid waste materials such as cellulose. The present proposal includes research to: 1) determine the minimal nutritional requirements for rapid growth and cellulase production by this 'Thermoactinomyces' species, 2) study the effects which metals common in high concentrations in municipal solid waste have upon growth and cellulase production, 3) ascertain the stability of the cellulase under varied conditions of pH, temperature, and ionic strength, 4) measure the efficiency with which the actinomycete degrades cellulosic materials covering a wide range of enzymatic susceptibility, 5) characterize the sugars which the actinomycete cellulase system liberates during cellulose hydrolysis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

D. COLLECTION, TRANSPORTATION, PROCESSING AND DISPOSAL METHODS

Includes Incineration, Ocean Dumping, Sewage Treatment and Processing, Sanitary Landfill Management, Sludge Application to Cropl;ands

3.0057, ECONOMICS OF GRADE A DAIRYING
J.H. BLACKSTONE, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00221)

OBJECTIVE. Obtain physical input-output physical input-output data and study costs, returns, and efficiency of different systems of milk production, evaluate problems in herd management and milk production and use controlled experiments to solve these problems, and determine alternative systems of milk production that result in increased stability and higher incomes.

APPROACH. Dairy herds owned by Alabama Experiment Station System that are in a unique position will be used in various types of controlled experiments--conventional pasture, drylot, combinations of two, different levels of grain feeding, various kinds of stored roughages, etc. Physical and economic data from these experimental units will be used to compare returns and efficiencies of different systems and provide information for budgeting alternative systems.

PROGRESS. Number of Alabama Grade A dairy herds has been decreasing while remaining ones have been getting larger in capital investment, number of cows milked, and in total pounds of milk produced. Dairy herds owned by Auburn University were decreased by 2 during the year. Remaining herds have increased capital investment, number of cows milked, and milk production. Changes have been made to conduct controlled research on herds with concentrates mixed with silage and fed outside the milking barn versus concentrates fed in barn and silage outside; all drylot feeding versus daytime drylot and nighttime grazing; use of individual stall housing versus open lot pens; use of different barn cleaning methods; and with 3 different methods of solid waste disposal. New capital investments have been made in automated feed equipment, new feed storage tanks, flush water holding vats, stall housing and new holding lots. Several short-term tests were run in order to check equipment and to acquaint cows with new arrangements. All inventory data, capital cost data, and related economic data have been collected. Forms have been developed for keeping day-to-day records.

SUPPORTED BY U.S. Dept. of Agriculture

3.0058, SWINE WASTE TREATMENT AND DISPOSAL
R.E. HERMANSON, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00276)

OBJECTIVE. Determine design criteria for swine waste treatment system consisting of multiple treatment units with various methods of final disposal. Final system effluent shall not contribute to stream pollution.

APPROACH. Treatment system consisting of series connected anaerobil lagoon, aerated lagoon or oxidation ditch and final aerobic lagoon. BOD loading rate will be varied to afford determination of system design parameters. Influent and effluent characteristics will be determined for each stage of treatment. Final disposal of system effluent will be by discharge to a stream. Irrigation, field spreading, and high intensity soil incorporation will be investigated for disposal of effluent from each stage of treatment.

PROGRESS. Research performed. A survey of existing lagoons on several of the outlying substations, an evaluation of the effect of floor types and methods of waste disposal on the performance of nursery pigs was initiated at the Sand Mountain Substation, and a waste treatment and disposal system was constructed at the main station swine farm. Observations of BOD, COD, pH, temperature, percent solids, sludge accumulation and general performance of lagoons were made. Results of these observations will be used for evaluation of loading parameters in this research and for updating of recommendations. Facilities at the Sand Mountain Substation will include 2 slatted-floor houses. One house will use a liquid pit beneath the floor for manure collection with disposal. An experimental treatment and disposal system has been developed and constructed at the main station swine farm. The system consists of an anaerobic lagoon followed by an aerobic lagoon that is aerated mechanically. The system was designed to economically provide flexibility in loading rates and detention times. Treatment and disposal of the waste can be by stream dilution, irrigation, field spreading and high intensity soil incorporation.

SUPPORTED BY U.S. Dept. of Agriculture

3.0059, WATER POLLUTION BY DAIRY FARM WASTES AS RELATED TO METHOD OF WASTE DISPOSAL
T.A. MCCASKEY, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

Initial work of this project will include an examination of existing waste disposal systems on Alabama dairy farms and the apparent correlation of the waste with water contamination. Immediately available for this phase of the study are four dairy farms of the Alabama Agricultural Experiment Station System

representing several soil and water conditions of the southeast. A number of large commercial dairies in the vicinity of Alabama cities will contribute to the study.

Field research will include studies of four systems of dairy farm waste disposal: 'dry' manure accumulation and periodic spreading with conventional equipment; semi-liquid manure collection in underground tanks and spreading on fields in liquid form using tractor-drawn equipment; liquid manure spreading via irrigation systems at frequent intervals; aerobic lagoons. Sampling sites will include: feedlots, croplands, pasture lands, streams or waterways, farm ponds, groundwater.

Laboratory studies will include the enumeration of the following groups of bacteria: fecal coliform and streptococci, salomonellae, shigellae, Clostridium perfringens. Chemical tests such as COD, pH, alkalinity, water hardness, nitrate and nitrite content, tannin and lignin, etc. will be made.

Field and laboratory data will be correlated with the view of developing guidelines on acceptable waste disposal systems for commercial dairy farms.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0060, WATER POLLUTION BY DAIRY FARM WASTES AS RELATED TO METHOD OF WASTE DISPOSAL
T.A. MCCASKEY, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-06-0110)

OBJECTIVE: Relate criteria of water runoff from dairy farms employing various methods of waste disposal. Study significance of health-related microbes in dairy farm-fed streams in relation to method of waste disposal. Develop guidelines for controlling water pollution and undesirable odors caused by dairy farm waste. Determine economics of dairy waste disposal systems.

APPROACH: Examine existing waste disposal systems on selected Alabama dairy farms and study four methods of waste disposal at Alabama Agricultural Experiment Substations. Disposal of waste by the conventional, tank wagon, irrigation, and by the lagoon methods will be evaluated by water and soil tests in view of developing guide lines on acceptable waste disposal systems for dairy farms.

PROGRESS: Dairy waste was applied at an equivalent rate of 20 tons 'dry' waste per acre to runoff plots to simulate conventional, irrigation, and slurry methods of waste disposal. Runoff from each of the disposal plots and a control plot were analyzed for manure pollutants. Runoff from liquid disposal plot contained more fecal organisms, nitrogen, ammonia, solids, and had higher BOD and COD values than runoff from the other plots. Pollutants decreased more rapidly in the runoff from liquid disposal plot than from the semi-liquid or 'dry' waste disposal plots. Number of fecal bacteria increased 87% in soil of the 'dry' waste plot, and 324 and 397%, in liquid and semi-liquid disposal plots. Nitrate-nitrite level in the soil of all waste disposal plots increased from 0.02 to about 0.35 mg per 10g soil 60 days after waste application. Application of waste to field plots by a semi-liquid system at 0.6 tons dry weight equivalent per application did not cause a substantial increase in manure pollutants in the soil. A slight increase occurred in number of fecal bacteria in the soil from the plot receiving weekly applications. Land disposal of waste at the present rate and frequency will not cause a significant increase in manure pollutants in soil.

SUPPORTED BY Alabama State Government

3.0061, DEVELOPMENT OF WASTE STABILIZATION LAGOONS FOR APPLICATION IN ALASKA
S.E. CLARK, U.S. Dept. of the Interior, Federal Water Quality Admin., *College, Alaska* 99701

The project objectives are to evaluate waste stabilization lagoon efficiencies while operating under Alaska's severe climatic conditions and to develop operation techniques which will assure adequate waste treatment throughout the year. A pilot plant located at Eielson Air Force Base is being placed in operation this winter utilizing the theory of storage of the winter's wastes with spring, summer and fall discharge. A polishing lagoon will be placed in operation during the warmer months of the year.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0062, SUBARCTIC AERATION LAGOON INVESTIGATIONS, BIOKINETIC REQUIREMENTS AND SEASONAL AND DURNAL EFFECTS ON NUTRIENT BALANCE
S.E. CLARK, U.S. Dept. of the Interior, Federal Water Quality Admin., *College, Alaska* 99701

The project objectives are to evaluate: a. To develop design and operational standards for artificially aerated waste stabilization lagoons under Alaskan conditions. b. To evaluate parameters contributing to effluent quality, power and maintenance costs, reliability under rapidly varying ambient conditions, and the effects on the receiving waters.

A pilot plant has been constructed and will be placed in operation at Eielson Air Force Base.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0063, COMPLETE MIX ACTIVATED SLUDGE UNIT PROCESS ADAPTION TO LOW TEMPERATURE
S.E. CLARK, U.S. Dept. of the Interior, Federal Water Quality Admin., *College, Alaska* 99701

The project objectives are to evaluate the influences of Alaska's severe climatic conditions upon the activated sludge process in the loading range between 0.02 and 0.40 no. 5-Day BOD per no. of MLVSS, and to develop techniques for minimizing the detrimental climatic influences. Laboratory scale pilot studies utilizing settled sewage are in progress to determine low temperature biokinetics including a major emphasis devoted to developing techniques of effective solids separation that will be feasible in the Alaska environment and under the Alaskan inflated economy. Large scale outdoor pilot facilities are planned.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0064, WATER AND WASTE MANAGEMENT (MUST)
H. PARTO, Garrett Corporation, *Phoenix, Arizona* 85034 (DADA17)

Technical Objective: This work is designed to reduce water resupply and waste disposal problems encountered in field operations of MUST hospitals. Haulage of fresh water over long distances is a continuing problem. The disposal of hospital wastes, which are often contaminated, is complicated by operations in extremely cold temperatures, when wastes cannot be buried, or in high water table areas where burial is likewise impractical.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0065, CHEMICAL REACTIONS OF WOODS AND BARKS
C.L. BRINK, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-FO-FPL-1834)

OBJECTIVE: Investigate known processes of wood pulping to determine their suitability for California wood species. Study the products of pulping reactions including liquor, solids, and gases and their potential for commercial utilization as fertilizers, papermaking fibers, hardboard, and industrial chemicals. Study the effect of chemicals on the constituents of wood and bark, namely, cellulose, lignin, and hemocellulose.

APPROACH: Recognizing that pulping offers an excellent means of utilizing residuals developed at California sawmills and other wood working plants as well as in the forests, pulping reactions will be studied to the end of producing high quality pulps, and minimizing to the greatest extent possible polution of water and air. The pulping liquor from the several processes studied will be investigated to determine the nature of the lignin and other constituents and their potential use. The problem of gas recovery in pulping operations will be investigated. Novel approaches to the problem of developing a pulping process suitable for the California scene will be tried.

PROGRESS: Organic Wastes Processing. Pyrolysis-Combustion. The two-stage, continuous (50-150 lb/hr dry solids, experimental unit designed for complete conversion of dissolved,

suspended or solid organic wastes to fuel gas by pyrolysis has been constructed and equipment shake-down is in progress. Provision has been made for combustion of the gas which in practice would be burned to produce energy. Inorganic and/or organic chemical recovery are optional. Analytical techniques were perfected for separating sulfur-containing from other organics, isolation of each compound, and determination of its structure. Wet Combustion study of organic wastes disposal by air oxidation of dissolved or suspended solids in an aqueous system using communited wood as a standard material was completed. Data reduction using computer programs was developed to provide energy and material balances for each reaction. Optimum conditions were indicated for organic chemical and/or energy recovery. Bleaching pulp using oxides of nitrogen appears technically feasible; economic study in progress. Water pollution reduced by burning organics solubilized. Alkaline nitrobenzene oxidation of wood study continued.

SUPPORTED BY California State Government - Sacramento

3.0066, COMPREHENSIVE STUDIES OF SOLID WASTES MANAGEMENT
C.G. GOLUEKE, Univ. of California, School of Engineering, *Berkeley, California* 94720

The objective of the project is to develop solutions to regional problems of solid waste management through a program of research which brings together the competence of specialists from such fields as planning, economics, administration, operations research, engineering, public health, and sociology or political science. Through participation of graduate students in such disciplines, it is also intended to orient personnel in a wide variety of fields to the problem of solid wastes which will confront them in professional practice. The research itself is concerned with developing an overall wastes generation and management model, establishing methodology for evaluating the waste generating potential of land dedicated to any plan of use; developing models and subsystems by which feasible alternative decisions can be evaluated from an economic and engineering viewpoint and fitted in with sociological and political realities, and developing new technologies. Finally, the objective is to relate research and real problems through a close association between researchers and practitioners in public works management.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0067, TRANSIENT LOADING EFFECTS IN THE ACTIVATED SLUDGE PROCESS
D.F. JENKINS, Univ. of California, School of Engineering, *Berkeley, California* 94720

The current and proposed research is investigating (a) the short- term transient behavior of activated sludge systems in the most significant practical situation in which they occur, i.e., in reactors such as contact stabilization units where deviation from completely mixed conditions exist, (b) the physical properties of activated sludge that influence its removal by sedimentation/clarification and the variation of these properties with organic loading and sludge growth rate, and (c) the chemical, biochemical, and microbiological properties of activated sludge in an attempt to provide a better representation of active solids than the measurement of VSS and to determine the reason for the deviations of activated sludge systems from a theoretical growth model.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0068, OCEANOGRAPHIC FACTORS IN THE FUNCTIONAL DESIGN OF WASTE DISPOSAL SYSTEMS
J.W. JOHNSON, Univ. of California, School of Engineering, *Berkeley, California* 94720

In the design of waste disposal systems, such as ocean sewer outfalls, cooling water waste lines from nuclear power plants, etc., a large variety of technical problems remain to be solved to place such sound design on a sound scientific basis. The three major areas of studies have been: 1. The mixing of a buoyant jet being discharged horizontally at the water surface. 2. The mixing of a series of buoyant jets being discharged horizontally from both sides of a manifold placed at the bottom of a tank. 3. The mixing caused by the mass transport associated with surface waves having a circular normal directional spectra.

The laboratory work done previously at UCB in regard to Item 1 was re-examined, and compared with the results of work done subsequently by other institutions. These results were then compared with the two sets of prototype data with which the investigators were aware: The Pacific Gas & Electric Plant at Morro Bay, California, and the discharge of the Columbia River into the North Pacific Ocean. The data compared favorably, on a gross basis. It became evident that the laboratory work should be extended to much smaller values of Froude number and that the statistical fluctuations of temperature and salinity in the mixing jet should be studied in detail.

In regard to Item 2, the results of the studies of single jets by a number of investigators were compared, and a preliminary report written on the findings. It was evident that no additional work need be done on the portion of a single jet between the bottom and surface, but that there is essentially no information on the interaction of multiple jets from a manifold. The laboratory equipment has been designed, constructed and tested, with preliminary tests made.

The results of a theoretical study of Item 3 have been negative, in the sense that there appears to be no mixing caused by the mass transport of waves with a circular normal distribution. However, the theoretical study was linear, and there may be some non linear mechanism that exists.

A 3-year study terminating 30 June 1970.

SUPPORTED BY University of California - Berkeley, Cal.

3.0069, LIVESTOCK ENVIRONMENTAL FACILITIES
T.E. BOND, U.S. Dept. of Agriculture, Agricultural Engineering Div., *Davis, California* 95616 (312-021-B216)

OBJECTIVE: Develop design criteria for structures and related equipment for providing optimum environments for livestock (principally beef cattle and swine) production.

APPROACH: In the laboratory, obtain basic bio-engineering data on relationships between environment and physiological responses--with principal emphasis on Southwest climatic conditions and heat and moisture transfer mechanisms. In the field, measure and map radiant fluxes from sky, ground, and surroundings. From the bio-engineering and radiant flux data develop and evaluate shelters, shades and related equipment for economically providing optimum production environments.

PROGRESS: The weight gains of pigs at 20 F above their maximum- growth air temperatures (89-92 F) were 0.76, 0.70 and 0.54 lb/day, respectively, with low, medium and high relative humidities; efficiency of feed use was 3.87, 4.06 and 4.72 lb feed/lb gain. Insulated trailer vans were modified for controlled-temperature animal studies. The first test with 8 individually-fed pigs per trailer at either 55 or 85 F was completed and there were no differences in production due to thiamin levels of 0.6, 0.85, 1.1 and 1.35 Mg/Kg. Animal waste disposal in desert climates was investigated using manure pits (anerobic) under slatted-floor pens for beef cattle, connected to adjacent lagoons (aerobic). Total solids, volatile solids, nitrogen and BOD are being measured; this study is still in progress. Solar reflectance values were determined for several colors of poultry, swine, sheep and cattle surfaces. In a study of the effect of wind, mud and rain on winter beef cattle production, cattle in concrete pens gained 25% less (7.04 lb feed/lb gain) when exposed to forced wind and 50% less (11.6 lb feed/lb gain) when artificial rain was added to wind; cattle in mud pens gained 10% less with wind; cattle in mud pens with shelter gained 30% less than on concrete but 40% less when forced wind was used. Tests of cooled drinking water for beef cattle and degree-hours tests with beef cattle at El Centro are still in progress.

SUPPORTED BY U.S. Dept. of Agriculture

3.0070, SOLID WASTE DISPOSAL AND BIRD HAZARD TO AIRCRAFT
H.L. COGSWELL, Calif. State College, School of Natural Sciences, *Hayward, California* 94542

Emphasis of this three year study is in the San Francisco Bay Region, California, where seven major and 13 smaller airports as well as 37 solid waste disposal sites are located on lowlands near bay shores. At 31 of the disposal sites many gulls (Larinae) of three to five species gather daily to feed. Many flight routes they follow to nighttime roosts and distant lakes transect the approach/takeoff zones of several airports where more than 1000 gulls often pass over 1000 feet in ten minutes. Baywide populations vary seasonally from 130,000 in October-December, to 5200 in June, 70 to 95 per cent being associated with disposal sites most of the day. Fifty seven of 236 gulls tagged have been subsequently identified individually. These and records here of more than 70 California Gulls marked in Wyoming, indicate considerable shifting of many gulls among disposal sites although population levels are rather consistent at each. Detailed analyses of populations and recurring movements are in progress.

Data are also being gathered on starlings and blackbirds, and applicability of Bay region findings elsewhere in the U.S.A. is being evaluated by visits to various airport-water disposal site combinations..

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0071, CHARACTERIZATION OF THE ACTIVATED SLUDGE PROCESS AT THE HYPERION TREATMENT PLANT

A.D. LEIPZIG, Los Angeles Bd. of Pub. Works, *Los Angeles, California* 90012

The objectives of the testing program to be carried out at the Hyperion Treatment Plant in Los Angeles can be divided conveniently into two parts. The first objective will be to develop a set of plant characteristics which will represent the average (24 hr. composite) performance of the plant.

The second objective (corresponding to Phase II) will be to study the time dependent or transient behavior of the plant by varying the influent stream in some predetermined way as a function of time and then making measurements of flow and concentration at various stations as a function of time (at one hour intervals). The purpose of Phase II will be to generate the necessary data to develop a dynamic or time dependent mathematical model for the activated sludge process.

The model will then be used to select the most practical method for controlling the plant to achieve improved plant performance and a more uniform water quality at the effluent weirs of the final settler.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

3.0072, STUDY OF WET GRINDING UNITS FOR HOSPITAL SOLID WASTE

B.S. WEINTRAUB, Los Angeles Co. Health Dept., *Los Angeles, California* (PH110-224-67)

The purpose of this contract is to determine if wet grinding units which discharge to a sewerage system are suitable and practical as a method of hospital solid wastes disposal.

In performance of this contract, the Contractor shall: Install wet grinding units in two hospitals served by a municipal sewerage system. One hospital must be over 200 beds in size and be located on a trunk sewer. The second hospital must be between 50 and 100 beds in size, and located in a suburban area and served by a secondary sewer. In one hospital, two units are to be installed; one at a central collection point, and one in a soiled work room. In the second hospital, the unit will be placed only at the central collection point. The contractor shall purchase the wet grinding units with the advice and consent of the local plumbing authority to assure compliance with applicable codes.

Summary of Final Report: The tremendous upsurge in the use of disposable materials, especially in modern health care facilities, particularly hospitals, has brough about a need for new methods of disposal. In an effort to discover methods for disposal of single use syringes, needles, paper and plastic products, Los Angeles County Health Department studied the use of wet grinding units to dispose of hospital solid wastes trhough the sanitary sewer. Results show that any such installation must be tailored to the individual hospital, and the staff must be instructed in the use of the system, but that grinding poses no insurmountable problems relating to sewer, or the water treatment facility.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0073, TECHNICAL AND ECONOMIC APPRAISAL OF PACKAGED SEWAGE TREATMENT SYSTEMS

R.E. DELARUE, Stanford Research Institute, *Menlo Park, California* 94025

The objectives of the research are to (1) analyze the technical characteristics of a patented sewage treatment system and compare its characteristics with other commercially available package treatment systems, (2) identify and evaluate the appropriate markets for this system, and (3) identify and analyze the criteria necessary for the company to compete successfully and profitably for these markets.

SUPPORTED BY No Formal Support Reported

3.0074, RECOVERY OF CHEMICALS AS A MEANS OF BRINE DISPOSAL

R.L. CLARK, Environmental Qual. Eng. Inc., *Oakland, California* 94610

Candidate products, processes, and sites will be identified for the recovery of chemicals from desalting plant effluents. Associated economic and process design data will be assembled, and environmental problems will be examined. Feasibility criteria for the potential of the process will be established. Based on this information and criteria, block flow diagrams will be developed for approximately eight products and sixteen processes. A preliminary market analysis will be performed on each product under consideration. The interrelation between chemical and desalting plants will be evaluated to include such factors as descaling, effluent brine concentration and composition, and changes in residual waste disposal resulting from chemical recovery.

Based on these exploratory studies, the most promising products, processes and sites will be selected for a preliminary engineering and economic analysis. This will include determination of the smallest plant size that will support chemical recovery. The results of this analysis will be used to (1) identify the most promising integrated facility for desalting-chemical recovery, and (2) determine research efforts necessary for advancement of chemical recovery methods for brine disposal.

SUPPORTED BY U.S. Dept. of Interior - Off. Saline Water

3.0075, TREATMENT OF MUNICIPAL SECONDARY EFFLUENT BY GRANULAR ACTIVATED CARBON

J.D. PARKHURST, Los Angeles Co. San. Dist. 21, *Pomona, California*

The objective of the project is to develop economic and design information on the application of granular activated carbon to removing the refractory organic materials from a municipal secondary effluent. The equipment consists of four 6-foot diameter, 10-ft. deep beds of 16 X 40 mesh carbon over which the secondary effluent is passed downflow at a Rate of 7 gpm/ft.2. The total flow is 200 gpm. The product COD is maintained between 3 and 12 ppm by thermal regeneration of the exhausted carbon in a 6-hearth Herreschoff furnace. The carbon exhaustion rate has been about 3500/mg. Carbon losses per cycle have been between 7-1/2 and 10% but it is believed that this would be reduced to 5% in a larger- scale operation. A cost estimate for a 10 mgd plant indicated that total costs would be about 8 cents/1,000 gal. Studies have shown that, between 4 and 10 gpm/ft2, contact time alone is controlling. Studies are underway to determine the effect of application rates below 4 gpm/ft.2 and to evaluate the effect of particle size and source of carbon.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0076, SOIL AND WATER MANAGEMENT SYSTEMS FOR DISPOSAL OF DAIRY AND POULTRY WASTES

S.A. DAVIS, Univ. of California, U.S.D.A. Soil & Wa. Cons. Div., *Riverside, California* 92507 (SWC-026-GRI-5)

OBJECTIVE: Develop adequate soil and water management practices to allow the disposal of dairy and poultry wastes on land while preventing pollution of soil and water and maintaining the yield and quality of crops.

3. SOLID WASTE MANAGEMENT

APPROACH: Laboratory, greenhouse, lysimeter, and field experiments will be conducted for maximizing disposal rates of dairy and poultry wastes while avoiding surface water and ground water pollution with excess nutrients or organic materials. Lysimeters will be used to study rates of nutrient and organic compound movement in soils of various textures and to determine optimum water table levels for a nitrification-denitrification sequence to dissipate nitrates. Soil and water management practices, such as methods of incorporating manure into the soil, frequency of irrigation and amounts of water applied, in combination with various rates and frequencies of manure application to soils, will be studied in the fields. Effects on quality and yield of crops and movement of nutrients and organic compounds into ground water will be evaluated. Greenhouse experiments will be used to study the potential for reducing yield and quality of crops with very high rates of manure and to identify the mode of action if detrimental effects are observed.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

3.0077, NITRATE POLLUTION FROM DISPOSAL OF DAIRY WASTE

P.F. PRATT, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (SWC-026-GRI-5X)

OBJECTIVE: Determine the capacity of various soils to oxidize dairy waste under various soil management practices while maintaining the yield and quality of crops and preventing contamination of drainage and ground waters with nitrates.

APPROACH: Laboratory, greenhouse, lysimeter and field experiments will be conducted with emphasis on application of existing knowledge of the N cycle to the development of management practices that will reduce pollution of water with nitrates. Lysimeters will be used to determine the optimum water table level for a nitrification-denitrification sequence in soils of various textures. Various rates and frequencies of manure will be applied to soils in the field to evaluate effects on crops and nitrates in ground water in relation to profile modification and irrigation management. Manure at rates up to 400 tons per acre will be applied in greenhouse experiments to determine effects on yields and quality of crops, and the leaching necessary to remove soluble salts.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

3.0078, PUBLIC CONTROL OF JUNKYARDS FOR HIGHWAY BEAUTIFICATION

S.F. MILLER, Real Estate Research Corp., *San Francisco, California*

Based on the assumption that compensation must be paid for the relocation, removal, or disposal of junkyards specified in the Highway Beautification Act of 1965, the legal research should include a review of all the decided cases discussing all the various elements of compensation involved.

Document provided by Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - Public Rds.

3.0079, A SOLID WASTES MANAGEMENT SYSTEM FOR THE BAY REGION

J.H. JACOBS, San Fran. Planning Association, *San Francisco, California*

Like most other American cities, San Francisco is running out of dumping sites for solid wastes. Experts estimate that the region will run out of disposal capacity by 1977. The problem is compounded by the obsolete technology of incineration and the multiplicity of refuse collections agencies-eighty-three in the Bay region.

Two years ago, consulting engineers recommended that San Francisco cart its refuse 200 miles out into the desert, over the Western Pacific Railroad tracks, where it would be buried. The outlying county was willing to take the garage - for a fee. In attempting to develop the solid wastes rail haul concept into a regional system, the investigators established six objectives allowing for a) no environmental impairment; b) emphasizing resource conservation; c) inclusion of all solid waste streams; d) flexibility to include future technological developments; e) region-wide organization; and f) least net cost.

Rail haul and burial did not satisfy most of the above objectives. Therefore, the regional system being developed envisions the use of composted solid wastes for rebuilding of agricultural soils while reclaiming metals and glass. The regional plan emphasizes barge haul of shredded, separated material to below-sea-level agricultural islands for compositing and land building. A demonstration program including six cities is now being developed.

SUPPORTED BY Ford Foundation - New York, N.Y.

3.0080, OPTIMIZATION OF SEWER SYSTEMS

S.A. MILES, Damas & Smith Limited, *Don Mills, Ontario, Canada*

Parameters in the layout, design and construction of storm and sanitary sewer systems are defined. These include water conditions, soil and rock strata surface topography and outlet conditions. Design algorithms for sanitary and storm systems by empirical and rigorous methods are programmed. An optimization procedure is developed using heuristic methods, to generate the sewer system design of minimum cost on the basis of a set of bid unit prices.

Document provided by Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - Public Rds.

3.0081, SEWER SYSTEM DESIGN, CONSTRUCTION AND MAINTENANCE PRACTICES AND EVALUATION

S.A. MILES, Damas & Smith Limited, *Don Mills, Ontario, Canada*

A survey of 36 municipalities in Ontario provides the basis of an evaluation of current sewer system design and operation. The data represents systems in various sizes of municipalities, and covers about 50 percent of the provincial population. A tabulation of results indicates an apparent wide range of design criteria and operating practices. An interpretive assessment of these findings in terms of costs and equivalent benefits for a model city is demonstrated. The annual cost savings by application of rigorous system design methods is estimated and compared with the increased engineering costs necessary for this type of design procedure.

Document provided by Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - Public Rds.

3.0082, APPLICATION OF DYNAMIC AND LINEAR PROGRAMMING TO URBAN DEVELOPMENT

R.W. SMITH, Damas & Smith Limited, *Don Mills, Ontario, Canada*

Urban development depends on the extension of distributive services - sanitary and storm sewers, watermains and streets. The optimal sequence of projects in each distributive service sector over a planning period is constrained by limiting service levels adopted, capital resources available and tax levels permitted. Capital and tax resources are related to the assessment of socio-economic activities serviced by the extended sewers, watermains and street systems. Dynamic programming in four dimensions, equivalent to successive 5 year programs over a 20 year macro-planning period, modified by a detailed initial 4 year program, is utilized to determine optimal sequence of projects. Output includes tax rates, capital resource use, and assessment formation. The procedures are applied to a small urban system of a town of 15,000 population.

Document provided by Highway Research Information Service.

SUPPORTED BY Damas & Smith Limited

3.0083, AERATED LAGOONS & ANAEROBIC REACTORS - A FIELD & LAB STUDY OF THEIR EFFICIENCIES & DESIGN PRINCIPLES IN SEWAGE TREATMENT
C.R. FORSBERG, Univ. of Saskatchewan, School of Engineering, *Saskatoon, Saskatchewan, Canada*

(a) Proposed Research: To study an aerated lagoon at Moose Jaw and an anaerobic reactor to be constructed in the University's temperature-controlled laboratory lagoon cabinet.

(b) Objective: To explore the possibility that the first compartment of two or more anaerobic cells in series may advantageously be converted to a mixed anaerobic reactor. Limitations in use from the health and nuisance standpoints would receive special attention.

SUPPORTED BY Canadian Government - Ottawa

3.0084, DEVELOPMENT OF A SIMULATION MODEL OF THE VANCOUVER REGION
M. GOLDBERG, Univ. of British Columbia, *Vancouver, British Columbia, Canada*

This grant will support the development of a simulation model of the Vancouver region that will analyze the economic, ecological, social, and political consequences of different development plans for use by city and regional officials.

The project is an outgrowth of a model developed by university faculty and students, under an earlier grant, that explored the effects of carrying development schemes on recreational land use of the Gulf Islands off the Vancouver coast. The city of Vancouver and the Vancouver Regional Planning Commission, along with the university, are also contributing funds to the project.

Drs. Michael Goldberg and C. S. Holling, co-directors of the study, will be aided by a group consisting of three university representatives, three from the city of Vancouver, one from the region, and two graduate students. Submodels on pollution, waste disposal, transportation, and recreation and open space will also be developed. The project has been endorsed by several Canadian agencies, including the Science Council of Canada which is particularly interested in the development of simulation models for urban environmental planning.

SUPPORTED BY Ford Foundation - New York, N.Y.

3.0085, ANAEROBIC TREATMENT OF ANIMAL WASTES
W.K. OLDHAM, Univ. of British Columbia, *Vancouver, British Columbia, Canada*

The purpose of the research is to determine, on a laboratory scale, the effects of various parameters on the treatment efficiency obtained during anaerobic decomposition of animal wastes. These parameters will include antibiotic concentrations in the waste, nutrient concentration in the waste, detention time, temperature, source and strength of waste, and effects of mixing. The need for controlled application of the anaerobic treatment process to decompose waste animal organics is becoming more important as the number of large-scale, concentrated, raising facilities increases.

SUPPORTED BY Canadian Government - Ottawa

3.0086, ANAEROBIC TREATMENT OF ANIMAL WASTES
W.K. OLDHAM, Univ. of British Columbia, *Vancouver, British Columbia, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

3.0087, TECHNIQUES FOR IMPROVING THE AMOUNT AND EFFICIENCY OF OXYGEN INCORPORATION INTO RAPID-RATE BIOLOGICAL WASTE TREATMENT SYSTEMS
C.C. WALDEN, Univ. of British Columbia, British Columbia Res. Council, *Vancouver, British Columbia, Canada*

This research will examine techniques for improving oxygen transfer into water and into biological oxidizing systems. Increasing the driving force for oxygen transfer by use of hydrocarbons with high oxygen solubility will be attempted and the effect of dispensing agents in reducing bulk viscosity will be evaluated. Possible effect of these agents on the rates of rapid oxidizing activated sludge systems will be examined. Oxygen transfer in present waste treatment systems is limiting; improved techniques will reduce operating costs and enhance efficiency.

SUPPORTED BY Canadian Government - Ottawa

3.0088, COMPUTER SIMULATION AND DESIGN OF TREATMENT INSTALLATIONS FOR DOMESTIC SEWAGE
P.L. SILVERSTON, Univ. of Waterloo, *Waterloo, Ontario, Canada*

Summary of Project: a) Derivation of mathematical models for waste treatment unit processes and operations, programming of the models in the framework of a process oriented executive program to yield a computer program which simulates the operation of a waste treatment plant or which provides design parameters for a treatment plant. b) The intent of the research is to develop a low cost, easy to use tool for optimum design of waste treatment facilities on the optimization of existing facilities. c) The relation to the health field is through the public health activity. Large amounts of money are spent annually on waste treatment facilities. Objective of research is to get maximum results from this expenditure.

SUPPORTED BY Canadian Government - Ottawa

3.0089, AERATED SEWAGE LAGOON INVESTIGATION - BOISSEVAIN
E.H. BALCHEN, Canadian Dept. of Natl. Health, *Winnipeg, Manitoba, Canada*

(a) The Proposed Research: To investigate operating efficiency of aerated sewage lagoon, followed by short-term detention lagoon.

(b) The Objectives, briefly: To determine the practicality of this new method of aeration.

(c) Relation to Health Field: To determine whether or not the proposed aeration system will be effective and safe for use as a general method of sewage treatment.

SUPPORTED BY Canadian Government - Ottawa

3.0090, EVALUATION OF THE APPLICABILITY OF AERATED LAGOONS FOR SEWAGE TREATMENT ON THE CANADIAN PRAIRIES
A.R. PICK, Metrop. Corp. of Gr. Winnipeg, *Winnipeg, Manitoba, Canada*

(a) The Proposed Research: To assess and compare with reference to conventional facultative lagoons and the activated sludge process, the effectiveness of three available methods of aeration of sewage in lagoon: (i) bubble tube diffusion (ii) surface aerators (iii) air gun aeration (iv) Parallel systems comprised of a conventional faculative lagoon, lagoons with bubble tube diffusion lagoon with surface aerators and an aerated lagoon with air gun diffusion will be placed in services for a period of two years.

(b) The Objectives, briefly: The efficiency of treatment and operating economics of three aeration systems for sewage lagoons will be defined. The results will be compared with those for an operating activated sludge plant and the conventional sewage lagoons. The appropriateness of the design criteria will be investigated.

(c) Relation to Health Field: To establish an efficient and economic treatment system to abate pollution.

SUPPORTED BY Canadian Government - Ottawa

3.0091, WASTE COMPOSTS AS CHELATING AGENTS IN PLANT NUTRITION
W.L. LINDSAY, Colorado State University, School of Agriculture, *Fort Collins, Colorado* 80521

3. SOLID WASTE MANAGEMENT

During decomposition of organic wastes in soils, chelating agents are found that increase the solubility and availability of certain plant nutrients. The beneficial effects of garbage composts and sewage sludge for correcting zinc and iron deficiencies have been well demonstrated. The purpose of the proposed study is to identify the soluble chelating agents that form from decomposing organic wastes in soils. Various organic wastes including sewage sludge and garbage composts will be incubated with soils. Water-soluble extracts will be removed periodically and fractionated by chromatographic methods by using Sephadex columns. Functional groups capable of forming metal complexes with iron and zinc will be labeled with 65Zn and 59Fe. Infrared adsorption and chemical analyses will be used to identify the functional groups responsible for the chelation of metal ions. Stability constants of the metal chelates will be measured and related to the beneficial role they play in plant nutrition. Hopefully the findings will provide direct evidence of how organic wastes aid in solubilizing and transporting insoluble nutrients to plant roots.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0092, CATTLE FEEDLOT WASTE AND AIR AND WATER POLLUTION

S.M. MORRISON, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00076)

OBJECTIVE: Determine basic factors involved in environmental pollution by cattle feedlots; feedlot design and operation for minimization of environmental contamination; modifications of manure decomposition; engineering procedures for handling large volume of animal waste; economical uses of animal manures.

APPROACH: The characterization of the microbial flora in manure at varying stages of decomposition will be done in the field and in laboratory. Attempts to modify the bio-degradation process by enrichment techniques (adjust C:N ratio, adding trace elements). By use of air sampling and vapor phase chromatography the volatiles most responsible for air borne 'contamination' will be classified. Bio- degradation modification will be followed in same manner. The hydrology of feedlot runoff and the factors controlling it, including the biological and chemical constituents of the runoff, will be studied. Modifications of the lot design and operations will be experimentally assessed. Ground water contamination will also be evaluated.

PROGRESS: Studies were conducted to define the role of feed supplement antibiotic residues in modifying the decomposition of feedlot wastes. Bioassays of fresh feedlot manure showed 14 mug chlortetracycline while after ageing in the pens there was 0.34 mug per gram of manure. Two groups of three animals each were used in a controlled experiment - one group only getting antibiotic feed supplement (70 mg/head/day). The antibiotic supplementation reduced the 5 day BOD by 28%, an effect on the microorganisms or on the manure constituents. There is indication that the microflora of manure and the manure constituents are modified and that antibiotic reduces the biodegradability of the animal wastes. Studies were completed on several aspects of feedlot runoff: five day and ultimate BOD values, temperature effects, COD, inorganic and organic constituents, redox potential, foaming coagulation characteristics, the modified dimensionless hydrograph of overland flow, surface storage, equilibrium runoff rates, concentrations of BOD, alkalinity, and conductivity; CO(2); settleable suspended solids; volatile solids (related to BOD); and inorganic dissolved solids.

SUPPORTED BY Colorado State Government

3.0093, MANAGEMENT OF ANIMAL WASTES AND FEEDLOTS TO AVOID SOIL AND WATER POLLUTION

F.G. VIETS, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Fort Collins, Colorado* 87101 (SWC-026-DFC-7)

OBJECTIVE: Discover chemical, microbiological, and physical principles, and engineer systems for the effective disposal of animal wastes and management of cattle feedlots so that the combination of manure, urine, and precipitation will not pollute or eutrophy surface ground water, and air.

APPROACH: Laboratory and field studies are conducted to determine: The relation of runoff, deep percolation, and evaporation to precipitation and water in excreta on different slopes, soil site conditions, and densities of animals; the kinds and rates of chemical transformations occurring between the surface and water table; the role of microorganisms in these transformations and the persistence of the common microbial pollution indicators under different management systems; develop systems for better control of the pollutional hazards of concentrated animal and poultry feeding operations.

PROGRESS: Two commercial feedlots have been instrumented to evaluate the various components of the hydrologic and chemical balance. Data collected from automatic vacuum lysimeters, runoff sampling equipment and a climatic station indicate that the weighted mean percolation below 40 inches was 1.3 cm. during a 156-day interval, or 0.008 cm. per day on a flat site. Percolate represented only 3.4 percent of the total water delivered to the lot. Percolation on the sloping site was much less than on the flat site, with only 0.011 equivalent (1.2 x 10 cm. per day). A total of 2.49 cm., or 19.2 percent of the precipitation left the site as surface runoff. Chemical analyses of the percolate samples showed a weighted mean NO(3)-N concentration of 865 p.p.m. at the sampling depth (40 inches) for the level site. Determinations were made on total organic carbon and on the carbohydrate content of soil profile segments from beneath feedlots and closely adjacent farmland. High organic carbon and carbohydrate contents were found in the surface inch or so of feedlot soils, but this material did not appear to move into the deeper profile. BOD determinations made on feedlot and cropland samples invariably gave low values of oxygen consumption, and they too failed to distinguish between subsoil core segments of feedlot and non-feedlot origin.

SUPPORTED BY U.S. Dept. of Agriculture

3.0094, DISPOSAL OF LIQUID INDUSTRIAL WASTE

C.A. JAWORSKI, James S. Minges & Associates, *Farmington, Connecticut* 06032

This project is funded under the auspices of the Connecticut Research Commission.

This project was initiated by the Research Commission at the request of industrial firms in Bristol, in order to determine the feasibility of a community-wide system for the disposal of liquid industrial waste. It was set up as a systems analysis of all alternatives, so that the results might also be useful to other industrial communities in the state, especially those having a large number of metal working firms.

The study was carried out with the full cooperation of the 23 firms in Bristol that produce liquid industrial waste. A separate survey was made of the problem of disposing of waste crankcase oil.

Three broad alternative approaches to the problem were selected for evaluation after a comprehensive review of all known methods of treating liquid wastes, oils and sludges. The alternates evaluated were: A. Centralized combined sanitary and industrial wastes treatment system. B. Centralized separate sanitary and industrial wastes treatment systems. C. Individual industrial waste treatment systems.

The recommended approach for Bristol is a variation of Alternate C in which the sludge from the individual waste treatment facilities would be dewatered in a centralized facility and waste oil would be incinerated in a centralized system. The effluent water from the individual treatment facilities and from the centralized sludge treatment facility would meet the requirements of the Water Resources Commission for flow into the Pequabuck River.

The report points out that different conditions in other communities might favor one of the other alternates.

Attention was given to the possibility of recovering valuable by- products from the waste disposal system. It was concluded that such recovery is best handled by each company as a production control function.

SUPPORTED BY Connecticut State Government

3.0095, DESIGN OF OPTIMAL REFUSE STORAGE DEPOSITORY SYSTEM FOR SERVICING MULTIPLE

DWELLING UNIT BUILDINGS IN ECONOMICALLY DISADVANTAGED AREAS

P.G. MEYERS, Meyers Electro Cooling Prod., *Manchester, Connecticut* 06040

The problem of handling refuse has become acute, especially in core-city areas. High population density, improper refuse storage facilities and lack of education in proper refuse handling compound the problem. Health hazards, neighborhood ugliness, resident agitation and considerable city budgets result.

The proposed investigation is to help solve the problem by formulation of an optimally designed refuse depository system for servicing multiple dwelling unit buildings in economically disadvantaged areas. The design should also result in substantial improvement in refuse collection.

Components of the project include interviews of users (building owners, custodians and tenants) to learn of their problems with refuse storage and collection, first hand.

SUPPORTED BY Connecticut State Government

3.0096, TREATMENT PROCESSES - WASTES PUMPED FROM SEPTIC TANKS

J.J. KOLEGA, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268

The first year of this study (1969-70) emphasized two categories: (1) The characterization of septage in terms of bacteriological, chemical, and physical parameters, and (2) An economic review of the systems under which septage is collected and treated.

The objectives of the second year of this study are: (1) To develop method(s)/systems for treatment of wastes pumped from septic tanks for small communities (i.e., areas in which conventional treatment plants are not available for disposal of these wastes), and to determine the best point(s) of waste introduction into existing sewage treatment plant processes and what, if any, preparatory treatment is desirable. (2) To develop recommendations for the handling and pre-treatment of septic tank wastes in areas where sewage treatment plant facilities are available.

Included in this study will be microbiological aspects and engineering-economic evaluations.

Project completion date: May 31, 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0097, DISPOSAL AND UTILIZATION OF DAIRY AND POULTRY MANURES BY LAND APPLICATION

J.J. KOLEGA, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONS00393)

OBJECTIVE: Develop and evaluate disposal and utilization systems for land application of treated and untreated dairy and poultry manure that will minimize pollution of water, soil, and air.

APPROACH: Field lysimeters will be used to study the effects of poultry manure slurry application rates on the levels of BOD/COD, solids, pH, nitrates, chlorides, and manganese. Crop response (corn) will also be evaluated. Three replications will be made of each treatment along with control plots. For part of the data collected, mathematical expressions will be developed for analog computer analysis to evaluate results that might be expected for other application rates not included in the experimental design.

PROGRESS: Three disturbed and three undisturbed lysimeters were constructed for soil conditions classified as fine sandy loam (Woodbridge) with hardpan layer depth at 20 to 30 inches. Lysimeter surface dimensions were approximately 8 x 8 feet. A tile drainage system was installed for each lysimeter along with a centralized sample collection pit. Two disturbed lysimeters 3 feet deep and 22 inches in diameter, were set up for the evaluation of percolate sampling devices developed.

SUPPORTED BY U.S. Dept. of Agriculture

3.0098, WASTE DISPOSAL IN RURAL AREAS

W.C. WHEELER, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONS00348)

OBJECTIVE: Measure and analyze thermodynamic, hydraulic, chemical and bacterial parameters prevalent in septic tank systems used for waste (excreta) disposal in rural Connecticut, with emphasis on temperature measurement and its interaction with the other parameters; design and test new septic systems.

APPROACH: Septic tank systems will be instrumented so that temperature patterns can be obtained for all phases of treatment process. Efforts will be made to determine quantity of influent and effluent without disturbing operation of systems. Bacteriological and chemical analysis will be made of influent, tank solution and effluent to determine effectiveness of treatment processes. Laboratory and field installations will be used. Physical properties of the disposal field will be analyzed and correlated to sewage stability and seepage rates. Effluent in draintile and separate tanks will be subjected to supplemental air and effect on aerobic digestive process will be studied. Modified septic systems will be designed, constructed and tested for more effective disposal of agricultural waste materials from poultry flocks, dairy herds and rural residences.

PROGRESS: An analysis of the hydraulic performance of an household waste disposal system was made. The study included both laboratory and field experimentation. Hydraulically speaking, the findings indicated that perhaps existing design recommendation figures could be reduced under certain field conditions; inadequacies in current installation practices for laying field tile and the type of field drain being used, and indicated a relationship of flood routing procedure to the short flow period of a septic tank system. Collection of temperature and water data at one field installation continued. Analysis of soil temperature data obtained from previous years and during the year reported for two 3-month periods showed a cyclic trend comparable to that of air temperatures. Theoretical evaluations were made of the use of heat for septic tank system operation. If emphasis were placed upon the handling of human body wastes, and waste water quantities were reduced, there may be certain instances where heat exchangers could be used at a reasonable cost if water pollution control were the prime concern.

SUPPORTED BY U.S. Dept. of Agriculture

3.0099, SPRAY SYSTEM FOR DAILY REMOVAL OF LIQUID COW MANURE

N.E. COLLINS, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00133)

OBJECTIVE: Develop equipment needed for daily disposal of liquid manure with a spray system; determine safe capacity of soil to assimilate liquid manure applied daily by a spray system.

APPROACH: The project includes grinding and pumping liquid manure to a field disposal area. Preliminary tests will be conducted to determine most efficient pump and grinder combination and to determine hydraulic characteristics of liquid manure. For field disposal liquid manure will be pumped 1000 feet to commercial sprinklers or other spreading device. Measurements of pollution, odor, insects, and microorganisms will be criteria for measuring effectiveness of disposal area.

PROGRESS: The first objective of the project was completed and a system developed, however, due to staff leaving the second objective was not completed. Since the start of this project a spray system for liquid manure was developed by a manufacturer. This system is sold today and a number of systems are working on farms. The system developed by the University of Delaware was similar to the commercial system. Therefore, it is felt this project should be terminated. Some of the specific results obtained were as follows: A system for spraying of liquid manure was developed. Pumps were capable of pumping a 1 to 1 manure to water mixture; however, a 3 to 10 mixture of manure to water worked best in the system. The 3 to 10 mixture could be moved through a grinder more easily and size reduction was more uniform with this 3 to 10 mixture. The system terminated with a standard 1/4" Rain Bird sprinkler. Metal nozzles will work but the fineness of grind is highly important as the particles will adhere to each other and again form a layer particle. It is advisable to use a rubber nozzle, thus permitting an expansion of the nozzle when it plugs and pressure in the system increases. The increase in the nozzle opening permits larger particles to pass. In all systems some means of removing stones and gravel should be provided. If this is not ac-

complished before the grinder and other equipment the stones will move through the system and damage the equipment.

SUPPORTED BY U.S. Dept. of Agriculture

3.0100, MASS TRANSFER AND CHEMICAL REACTION IN TWO-PHASE FLOW
F.W. RUSSELL, Univ. of Delaware, School of Engineering, *Newark, Delaware* 19711

The basic mechanism of mass transfer and chemical reaction in two phase (gas-liquid) horizontal pipes is to be investigated so that the possibility of using two-phase pipelines for treatment of raw sewage can be evaluated. A model of the process of chemical reaction and mass transfer has been developed and checked for two-phase flow in a horizontal pipe. Experimental work is proposed which will more fully verify the model and allow numerical determination of the key parameters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0101, OCEAN DISPOSAL OF INDUSTRIAL WASTES
L.L. FALK, E.I. Dupont De Nemours & Co., *Wilmington, Delaware* 19898

The proposed work for the disposal of an acid-iron waste at sea shall be directed: 1. To determine the physical, chemical and biological effects on a marine environment by the disposal of an acid-iron waste in a specified area. 2. To develop a mathematical model suitable for establishing the disposal characteristics of similar wastes in a similar environment. 3. To provide relative costs of various components of a waste barging operation.

Detail: 1. Design, plan, conduct, and evaluate a study project for the disposal of an acid-iron waste in coastal marine waters. 2. Determine and establish items listed in objective 1a and 1b of the proposal. 3. Compare costs with data available in the literature so that barging costs on a ton-mile or other basis can be extrapolated to other barging conditions. In particular, relative magnitudes of barging leasing, barge towing and shore waste storage facilities will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0102, IDENTIFICATION OF LIMITING FACTORS IN THE BIOLOGICAL TREATMENT OF SEWAGE
G.V. LEVIN, Biospherics Research Inc., *Washington, District of Columbia* 20011

The purpose of this contract is to explore the microbiological and biochemical wastewater literature to determine the intrinsic factors which limit the effectiveness of biological treatment of sewage. Comparisons of the fundamental microbial metabolic rates with those achieved in practice will be made. The information gained will be used to identify significant areas in which sewage treatment does not take full advantage of the biological processes. Once these areas are identified, laboratory and pilot plant research programs can be designed to develop improved treatment methods and practices. The information developed will be particularly useful in purifying the input to a mathematical model describing the activated sludge process which is being developed at the Cincinnati Water Research Laboratory.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0103, BIO-MASS DETERMINATION - A NEW TECHNIQUE FOR THE CONTROL OF AERATION SEWAGE TREATMENT PROCESS
G.V. LEVIN, Biospherics Research Inc., *Washington, District of Columbia* 20011

To examine a new method, conceived and developed by personnel of Biospherics Research, Inc. for the rapid determination of bio-mass and to assess the feasibility of applying this method in the control of sewage treatment processes. The proposed method is the firefly bioluminescent assay for microbial adenosinetriphosphate.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0104, ROADSIDE LITTER COMPOSITION
P.E. IRICK, Highway Research Board, *Washington, District of Columbia* 20037

An Ad Hoc Advisory Committee was formed that includes representatives of 29 participating state highway departments, the District of Columbia Division of Sanitation, the U.S. Bureau of Public Roads, the Research Triangle Institute of North Carolina, the Highway Research Board, and Keep America Beautiful, Inc. This committee was responsible for planning and general monitoring of the litter composition project. The general plan called for each participating state to make two litter pickups, 30 days apart, on each of the primary highway study sites selected at random. Using highway mileage data supplied by participating states, study sections were selected by Research Triangle Institute Staff, each study section was 0.2 miles long and covered the full width of the right-of-way. The study data came from a total of two miles of right-of-way in each state. Two forms were completed for each study section after each pickup (1) the section data form provided for the sections geographical.

Document provided by Highway Research Information Service.

SUPPORTED BY Keep American Beautiful Incorporated

3.0105, COMMUNITY ACTION PROGRAM FOR SOLID WASTES MANAGEMENT
UNKNOWN, Natl. Assn. of Counties, *Washington, District of Columbia* 20036

Ten community action guides pertaining to solid wastes management in in ten subject areas are to be developed. Action guides are to be reviewed and revised by representatives of federal, state and local government officials at a National Solid Wastes Workshop. Twenty regional Solid Wastes Management Institutes are to be organized and conducted for discussion and dissemination of the guides.

Document provided by Highway Research Information Service.

SUPPORTED BY National Association of Counties

3.0106, PERFORMANCE EVALUATION OF SOVENT SYSTEM
R.S. WYLY, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Technical Objective: Report findings as to the performance of the Sovent Single-Stack Plumbing System with loads up to approximately 50 bathrooms.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0107, REMOVING TRASH FROM MECHANICALLY HARVESTED SUGARCANE
H.D. WHITTEMORE, Everglades Agric. Expt. Sta., *Belle Glade, Florida* 33430 (308-041-C705)

OBJECTIVE: Develop methods of removing tops, leaf trash, soil, and other foreign material from mature sugarcane.

APPROACH: Experiment with methods of snapping the tops from the mature cane pieces. Develop systems for removing trash at every point in the harvesting and handling process that is feasible. If open field burning is prohibited, find ways to remove dry trash from the ground to improve operator visibility. Determine the best method of pneumatic cleaning and trash disposal. Devise methods of positively pulling green trash from mature cane pieces and disposing of the trash. Develop cleaning systems that might be incorporated in a harvester with a capacity of 30 to 60 tons per hour.

PROGRESS: No progress reported this period (new project).

SUPPORTED BY U.S. Dept. of Agriculture

3.0108, NEMATODES ASSOCIATED WITH SEWAGE TREATMENT AND THEIR SIGNIFICANCE
W.T. CALAWAY, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-EY-01323)

OBJECTIVE: Not Provided

APPROACH: Not Provided

PROGRESS: During the period of support investigations were carried on, research was done on the use of resin impregnation similar to that used for electron microscopy, sectioning, staining and examining visually. This was done to obtain histological information on structures after it was found that the usually parafin infiltration, sectioning and staining did not yield the information desired. Methods were developed for obtaining serial sections on portions of cover slips. These were than stained at temperatures in the neighborhood of 90 C. Several modifications of the basic fuchsin staining was tried as was regressive staining using gential violet. The publication of a description of Mononchoides changi by Goodrich, Hechler and Taylor has made it necessary to examine the Mononchoides species being described by us in order to find if differences between the two species exist. The species Mononchoides have been reviewed and a monograph discussing all the species known to have been included in this genus or in synonymous genera is in preparation. An amended, more concise description has been written and the members of all previous lists of Mononchoides have been compared with the amended description and with the original writers own diagnosis. This genus has been found to be the predominant diplogasterid in waste treatment.

SUPPORTED BY Florida State Government - Tallahassee

3.0109, ANTI-POLLUTION AND SEWAGE DISPOSAL FOR FLORIDA COMMUNITIES
T.D. FURMAN, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

This is a continuing study, renewable annually, of various methods of sewage treatment applicable to the semi-tropical climate of Florida. Special emphasis is directed toward modifications of design standards in order to take advantage of the warm climate and increased sunshine. The use of native filter materials is being investigated. Among the studies which have been conducted is an investigation of the efficiency and degree of treatment provided by intermittent sand filtration as influenced by size and depth of sand as well as the hydraulic and organic loading. A study of lagooning to determine the degree of treatment and efficiency of this method of sewage treatment, using both settled and unsettled domestic sewage at various hydraulic and organic loading rates has also been completed. The ecology of the flora and fauna instrumental in the treatment was investigated.

SUPPORTED BY University of Florida

3.0110, REACTION OF IRON AND ALUMINUM SALTS WITH PHOSPHATE
J.E. SINGLEY, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601

The proposed study would determine the effect of a number of variables on the reactions of iron and aluminum salts with the phosphate present in effluents from industrial and domestic waste treatment plants. The study would focus upon the determination of the competition of other anions with phosphate for coordination sites on the iron and aluminum ions in solution. The anions to be considered will be hydroxide, sulfate, chloride, nitrate and some organic anions. The kinetics, as well as the equilibria, will be studied.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0111, AEROBIC DISPOSAL OF ANIMAL WASTES WITH CONTINOUS WATER REUSE
R.E. SMITH, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO-03-0370)

OBJECTIVE: Study operating characteristics of system for decomposing animal wastes with continous aeration and mixing of wastes and use of effluent from system for dilution of low moisture animal wastes. Determine design parameters for system of influent waste dilution, feeding rate, detention time, 5-day BOD reduction, and rate of sludge build-up.

APPROACH: Effluent of a laboratory aerobic disposal units will be revised as the diluent of influent animal waste. Will determine if concentrations of any component of animal wastes will be detrimental to growth of requisite microbes. Information will be obtained about optimum input rates, dilution times, BOD reduction, and rates of sludge build-up.

PROGRESS: Research was conducted to determine the effects of a salts buildup on the biodegradation of poultry wastes in a recycling system. The inorganic products liberated upon complete digestion of the wastes was determined, including the specific ions released and the relative amounts of each. Then a graduation of solutions were synthesized by mixing chemicals to give the same constituents as the digested wastes. These synthetic solutions were used to dilute waste samples for aerobic digestion. The digestion rates were measured by periodic BOD tewts and expressed in mathematical form. The conclusion was reached that such systems would operate satisfactorily if sludge wasting is carried out to limit solids buildup.

SUPPORTED BY Georgia State Government

3.0112, PERFORMANCE OF THE INCLINED-PLANE TRICKLING FILTER FOR AEROBIC DISPOSAL OF ANIMAL WASTE
R.E. SMITH, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO-03-0467)

OBJECTIVE: Determine the biological reduction-rate constant as a function of contact time for the inclined-plane trickling filter. Correlate the inclined-plane slope and length and the hydraulic flow rate to contact time for the filter. Develop a mathematical model for the variables of the inclined plane.

APPROACH: Laboratory studies will be used with an inclined-plane trickling filter using diluted poultry waste as influent. Constants for the mathematical model will be evaluated from the operating data of the different plane positions and hydraulic flow rates. The form of the mathematical equation is: $L/L(o)0e$, where L is the remaining BOD in ppm, L(o) is the initial BOD, t is the residence time, and k is to be evaluated for the waste and the system.

PROGRESS:

SUPPORTED BY Georgia State Government

3.0113, DESIGN AND OPERATION CRITERIA FOR AN ANAEROBIC LAGOON FOR SWINE WASTE
R.E. SMITH, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO-03-0472)

OBJECTIVE: Design and construct an anaerobic lagoon for a new 400- animal swine facility at the College Experiment Station. Obtain operating data pertaining to: startup procedure, seepage losses, odor production, solids reduction and BOD reduction. Utilize the findings to construct and operate a field-scale lagoon for the conditions of the Piedmont region.

APPROACH: An anerobic lagoon will be designed to permit measurement of seepage losses and determine the role of sealing in anaerobic lagoon operations. A method of water reuse will be a part of the seepage studies. Data will be taken to study startup and operating procedures for the anaerobic lagoon.

PROGRESS:

SUPPORTED BY Georgia State Government

3.0114, EVALUATION OF TREATMENT PLANTS BY TRACER METHODS
G.G. EICHHOLZ, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332 (AT-(40-1)-4156)

Many of the processes used in treatment plants for municipal and industrial wastes can be studied by means of radiotracer methods. As the addition of radioactive tracers may be unac-

ceptable, post-sampling activation analysis with suitable non-toxic materials will be employed. The objectives of the proposed project are two-fold: 1) To select materials and develop methods for studying the mobility and characteristics of particulate tracers and the determination of the tracers, both in dissolved form and attached to very fine particles, that would be suitable for studying and measuring the operating parameters of waste treatment plants. This will involve laboratory tests on the behavior of the tracer materials in various mixing processes and on the competitive interactions in a medium containing finely divided material and agglomerates of varying characteristics. 2) To use these methods to investigate the operating conditions of selected treatment plants to establish the utility and practical limitations of the proposed procedures and to render practical advice and assistance to the plant operators.

SUPPORTED BY U.S. Atomic Energy Commission

3.0115, DIGESTION OF SLUDGES WITH SODIUM CHLORIDE AND SULFATE
R.S. INGOLS, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332

The primary objective of the projecct is the determination of the cause of sludge digestion failure in the presence of industrial wastes containing several salts at critical concentrations. If sodium chloride plus sodium sulfide are synergistically toxic then a search will be made to find as economical solution to the sludge disposal problem.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0116, SENSORS FOR CONTROLLING THE ACTIVATED SLUDGE PROCESS
R.S. INGOLS, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332

The project for developing sensors to control the activated sludge process of treating waste water has been funded (in the past) by a contract with the City of Atlanta and is currently supported by Georgia Institute of Technology. The city needs a new water pollution control facility using the Activated Sludge Process for the waste water from the Peachtree Creek drainage basin which will treat 4 cubic meters per second on the average.

The activated sludge process depends on microorganisms for its effectiveness in reducing the pollution load (effect) on the Chattahoochee River. The process which has several operating variables treats a waste water with variable characteristics. At times the effluent will have to be more highly treated than at other times. Because of (1) the large number of variables and (2) the time required to obtain laboratory data to assay the variables and (3) the added cost of operating the process at its maximum effectiveness and (4) the non- professional training of the available personnel and (5) the possible economy of using computers, the decision was made to provide computer control for the Peachtree Creek Plant. All the necessary sensors were not available for computer input and the electronic circuits are necessary to convert all the sensor circuits to digital form.

This project has developed two new sensors and the electronic conversion circuits for a digital printout device. The two new sensors include an oxygen uptake rate apparatus and a sludge concentration reader.

SUPPORTED BY Georgia Institute of Technology

3.0117, IMPROVED PROCESSING OF HAWAIIAN FRUITS
J.E. BREKKE, Univ. of Hawaii, U.S.D.A. Fruit Laboratory, *Honolulu, Hawaii* 96822 (W3-1-157)

OBJECTIVE: Develop new and improved processes for preparation of stable and high quality concentrated tropical fruit products.

APPROACH: Process Hawaiian fruits (guava, papaya, passion fruit, pineapple) into concentrates and dehydrated pieces and powders. Study best means to recover and add back volatile flavors. Determine composition of volatile components. Develop new juice blends, jams and jellies, and uses for dehydrated pieces. Develop methods for concentration, drying, or reuse of wastes. Investigate recovery of food or feed values from wastes.

PROGRESS: The stability of guava puree concentrate with added antimycotic agents was determined at 45 F.; no microbial spoilage but some quality deterioration was observed in 5 mos. storage. Heat inactivation of enzymes in guave puree for frozen storage did not appreciably enhance its stability. The carotenoid pigments in pink- fleshed guava were shown to be lycopene (096%), beta-carotene (2%), unidentified ( ). Non-volatile organic acids in papaya and guava were identified and determined quantitatively. A continuous-flow evaporator was used for production of high-quality concentrates of guava, papaya, pineapple and passion fruit juices and purees. Further exploratory work was done on evaluating quality of concentrates by dilution and sensory evaluation. Quality and stability of frozen mango slices were determined. Osmo-Vac dried bananas, various fruit beverage products, and samples of banana puree were prepared in cooperation with fruit processing companies to demonstrate new products.

SUPPORTED BY U.S. Dept. of Agriculture

3.0118, AEROBIC SECONDARY TREATMENT OF POTATO PROCESSING WASTES WITH MECHANICAL AERATION
W.M. SWANSON, R.T. French Company, *Shelly, Idaho*

The objective of this project is to demonstrate the aerobic biological treatment for potato processing wastes, to establish design criteria and to develop construction and operating costs. The following systems will be studied: 1. Extended aeration with sludge return; 2. Flow through aeration without sludge return, and 3. Intermittent aeration with intermittent effluent withdrawal.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0119, SORPTION ISOTHERMS OF PHENOL ON ION EXCHANGE RESINS
J.W. CHEN, Southern Illinois University, School of Engineering, *Carbondale, Illinois* 62901

Phenol is a troublesome pollutant from industrial wastes, it cannot be removed by biological treatment easily. Ion Exchange Resins are proposed as potential adsorbents to remove phenol because their selectivity and capacity.

Five different resins were screened. It was found that both IR 45 and IR 401 resins are excellent adsorbents for phenol. Sorption isotherms of these two resins at different pH and temperatures are investigated.

SUPPORTED BY Southern Illinois University

3.0120, NATIONAL CONFERENCE ON SOLID WASTES DISPOSAL SITES
L. WEAVER, Amer. Public Works Assn., *Chicago, Illinois* 60637

This application for a research grant is to support a Conference, nationwide in scope, to stimulate and assist State and local governments to formulate action programs which would lead to the acquisition, development, operation and maintenance of solid wastes disposal sites to meet their demonstrated needs, both immediate and on a long range basis, and consonant with overall community development requirements.

Research is proceeding on various fronts toward meeting the technological challenge of solid wastes disposal. The results of research on methods of managing solid wastes must be supplemented with research to develop workable abd acceptable programs to provide the answers to where wastes which are not salvaged or recycled can be processed and sequestered in a manner harmonious to environmental requirements. Solid wastes disposal encompasses elements that have an effect on the total environment. These include economic, social and political considerations associated with air and water pollution and other environmental health concerns. The multiplicity of governmental jurisdictions in urban areas responsible for the continued operation of thousands of sub-standard disposal facilities and sites makes it imperative that a comprehensive, workable program of action be developed to stimulate and guide the application of this research.

It is proposed that a National Conference be held in the spring of 1971 involving personnel from local, State and the Federal government, universities and private enterprise. The objective is the development of a series of recommendations which State, local, and Federal officials can utilize to formulate action programs. A Proceedings of the Conference will be published.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0121, A METHOD OF MANURE DISPOSAL FOR A BEEF PACKING OPERATION

W. WILCOX, Illinois Packing Company, *Chicago, Illinois* 60609

It is proposed to engineer, construct and install a fluidized solids incinerator plant in the plant of Illinois Packing Company, a beef slaughter house in Chicago, to demonstrate an efficient disposal proces for paunch manure from the live cattle.

The plant will have the capacity to handle five tons of feed per day. The incineration process consists of a feed bin, a concentrating conveyor and a fluidized solids incinerator tower operating at approximately 1400 degrees F. The heat of combustion of the process is sufficiently utilized to minimize fuel costs.

The discharge streams from the plant consists of water condensate, oxides of combustion ad sterile ash. It is expected to conclusively demonstrate that the process is a sound approach to this industrial waste disposal problem.

The operation of the plant will contribute valuable operating information and experience in the area of animal solids waste disposal.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

3.0122, DECISION MAKING AND SOLID WASTE DISPOSAL

J.R. SHEAFFER, Univ. of Chicago, Graduate School, *Chicago, Illinois* 60637

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0123, WATER AND SEWERAGE FACILITIES REPORT

UNKNOWN, East West Gateway Coord. Coun., *East Saint Louis, Illinois* 62201 (003072)

The council is in the process of formulating a series of developmental roports for long-range water and sewerage development. These reports will effectively outline the region's capacity for continuing growth. The objectives of this report are: (1) to give a general background for existing water and sewerage facilities and to indicate the extent that these services have been developed; (2) to analyze the existing conditions in light of the projected needs for future services so that areas of high priority can be recognized; (3) to indicate the anitcipated expenditures from both the public and private sectors associated with water and sewerage facilty development based on current trends; and (4) to state the goal and general policies for improving and expanding the existing water and sewerage facilities so that the specific policies and programs that are established will provide a realistic set of guidelines for the solution of these regional problems.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Housing & Urban Development

3.0124, DEVELOPMENT OF A MATHEMATICAL MODEL FOR SEPARATION, COAGULATION AND SEDIMENTATION PROCESS USING ADDITION OF CHEMICALS

W.A. JASIONOWSKI, General American Trans Corp., *Niles, Illinois* 60648

The contractor shall develop a mathematical model for coagulation and sedimentation of activated sludge process effluent using lime or alum as an additive. The emphasis shall be placed, first, on establishing the current state of design procedures for predicting the performance of existing equipment such as the Infilco Densator or Accelator. Next, limitations of current design procedure should be delineated by comparison with data from existing installations.

The limitations of existing design procedures should then be used as a basis for developing improved design procedures or, if necessary, recommending additional experimental programs.

The model shall consist of a set of preliminary design relationships for computing the size of the equipment required, the amount of chemicals and power required, and estimates of both capital and operating and maintenance cost. The performance of the process is expressed by the volume flow and concentration of all important species in the effluent streams from the process as a function of the characteristics of the influent stream and the operating and design conditions should be expressed in mathematical terms.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

3.0125, DEVELOPMENT OF MATHEMATICAL MODEL OF SEWAGE SLUDGE FLUIDIZED BED INCINERATORS

J.D. ZEFF, General American Trans Corp., *Niles, Illinois* 60648

To develop a mathematical model of the incineration of sewage sludge in a fluidized bed furnace. The model will be written in FORTRAN language applicable to an IBM 360/65 computer.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

3.0126, ACTIVATED SLUDGE - BIO-DISC TREATMENT OF DISTILLERY WASTES

J.O. NACK, Amer. Distilling Company Inc., *Pekin, Illinois* 61554

This project involves construction of two biological waste treatment process lines, one utilizing activated sludge treatment, and the other a Bio-Disc system. The Bio-Disc system will be designed to handle 25 percent of the design hydraulic and organic waste load from the American Distilling Plant. An equalization tank will precede the Bio-Disc unit for tempering of pH and temperature peaks. Individual clarifiers will be provided following each biological system. Sludge thickening and dewatering on drying beds are proposed prior to ultimate disposal in a landfill operation.

Significant operational flexibility has been incorporated into the preliminary layout of the treatment facility. Basic investigations will be conducted on a parallel flow pattern. Within this operational framework, a number of factors will be evaluated including effect of ambient temperature; effect of wastewater temperature and pH extremes; effect of the extended periods of zero flow; effect of varying nutrient feed levels; and effect of varying organic and hydraulic loading.

Evaluation of a series flow pattern is also anticipated. In this arrangement, the Bio-Disc system will serve as a roughing biological process, followed by activated sludge polishing treatment.

A complete sampling and analytical program will be conducted to evaluate system performance and economics.

Results of the research program will be compiled in a suitable format for utilization in establishing design and operational parameters for use throughout the industry.

This project was started in June 1970 and will be completed in June 1972.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0127, BIOPOLYMERS AND POLYMER-PRODUCING MICROORGANISMS IN ACTIVATED SLUDGE

L.L. WALLEN, U.S. Dept. of Agriculture, Northern Utilization Res. Div., *Peoria, Illinois* 61604 (N1-1-355)

OBJECTIVE: Investigate biopolymers in activated sludge, determine types of microorganisms responsible for their production, and establish practical conditions for their recovery as a means of improving economics of cereal waste treatment.

APPROACH: Analyze sludge from cereal and municipal waste treatment plants for content of polysaccharides and other polymeric material. Quantitate and characterize other microbial products and components of sludge. Test selected products for possible uses and biological activity. Establish optimum conditions for economic and complete recovery of products with

potential commercial value. Study slime formation by sludge microorganisms in pure culture, and compare polysaccharides thus obtained with those isolated from sludge. Determine optimal conditions for growth of slime-producing microorganisms and for slime production; determine types of bacteria responsible for slime or polysaccharide formation; and determine whether other potentially useful products are formed.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

3.0128, UTILIZATION OF FLORIDA PHOSPHATE SLIMES

S. VASAN, Internat. Min. & Chem. Corp., *Skokie, Illinois* 60076

Very finely divided wastes are suspended in water during the processing of phosphate rock matrix. These wastes, termed 'slimes', tie up huge quantities of water in slime pond reservoirs. Because of the colloidal nature of the slime it is very difficult to dry the ponded wastes. The water pollution problems which can occur because of this method of phosphate processing and waste disposal are: 1) fouling of fresh water due to seepage from ponds, 2) lowering of the water table due to high water requirements, and 3) sea water encroachment due to a lowering water table. There is also a large and wasteful use of land in the impoundment of these wastes.

The solution consists of using the slimes to produce a large volume product of ceramic materials. Preliminary market studies indicate a substantial demand for structural clay products. Experimentation by the IIT Research Institute has shown that clay-type bodies may be made from slimes using standard kiln techniques. Such bodies, such as brick & ceramic tile, have considerable potential in areas such as Florida which have shown trends toward accelerated building & construction in the nex few years. This test coupled with the results of previous experiments involving the use of phosphate slimes, indicates the potential for utilizing large volumes of waste materials. If this market can be realized, considerable water may be released from the slime ponds for reuse as well as minimizing the pollution aspects of processing phosphate ore.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0129, CHLORINATION OF SEWAGE EFFLUENTS

R.L. EVANS, State Water Survey, *Urbana, Illinois* 61801

As part of an investigation to relate chlorine dosage, bacterial kill, and chlorine demand with the chemistry of various types of sewage effluent, the use of chlorine gas versus hypochlorite will be explored. Efforts will also be directed toward defining the major chlorine reducing substances in sewage effluents, the rates of reaction, and the relative lethal activity of definable chloramines. A principal adjunct to the investigation will be an effort to use MF techniques that produce comparable coliform counts with the MPN method.

SUPPORTED BY Illinois State Government - Springfield

3.0130, CHLORINE CONTACT TANK DESIGN

V. KOTHANDARAMAN, State Water Survey, *Urbana, Illinois* 61801

The current methods of designing chlorine contact tanks for the partial disinfection of sewage effluents have many shortcomings. Field experience suggest short circuiting, solids accumulation, and maintenance problems all resulting in inefficient and, consequently, ineffective operation. A study, employing a hydraulic model, is being undertaken to develop a rational design for chlorine contact tanks using some of the techniques developed in sewage treatment technology. Tracer studies using Rhodamine B dye in a hydraulic flume will be used for positioning and evaluating control appurtenances. Once design criteria have been selected the efficacy of the concept will be tested using fuller's earth; finally it is planned to test the model in the field with an on-line sewage treatment facility.

SUPPORTED BY Illinois State Government - Springfield

3.0131, BIOLOGICAL METHANE FORMATION

M.P. BRYANT, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-35-0364)

OBJECTIVE: Obtain fundamental ecological, nutritional, and biochemical information on the methanogenic bacteria that can be applied to a general understanding of the process of the anaerobic degradation of organic matter in important systems such as sewage and rumen fermentations.

APPROACH: The quantitatively significant methanogenic bacteria will be enumerated, isolated and characterized. The biochemistry of methane formation will be further elucidated.

PROGRESS: We previously showed that ethanol oxidizing methane bacterial species are in fact symbiotic associations of two species. One is an H(2)-utilizing methane bacterium (M) which reduces CO(2) to methane and the other is an organism such as S organism which ferments ethanol to acetate and H(2) but grows poorly unless M is present to maintain a low partial pressure of H(2). Extracts of S show that it oxidizes ethanol to acetaldehyde via an NAD-linked alcohol dehydrogenase (ADH), and acetate and H(2) is produced via a ferredoxin (Fd)-linked aldehyde dehydrogenase. Extracts contain Fd which is essential for NAD reduction by H(2). The results suggest that S grows in the presence of the methane bacteria since the reoxidation of NADH derived from the ADH reaction requires a low partial pressure of H(2). S contains a formate hydrogenlyase system which requires both NAD and Fd for H(2) formation. The presence of S in an environment allows methane formation from formate by H(2)-utilizing methane bacteria which may not metabolize formate. Attempts to isolate species of bacteria responsible for oxidation of butyrate to acetate coupled with reduction of CO(2) to methane has continued unsuccessful but isolation of two new species of methane bacteria that utilize H(2) but not butyrate from butyrate enrichments of rumen contents and sludge suggests that methane formation from butyrate requires a symbiotic association of two species as shown in ethanol fermentation. Attempts to isolate butyrate oxidizing bacteria on anaerobic agar media containing heavy lawns of H(2)- utilizing methane bacteria are under way.

SUPPORTED BY Illinois State Government - Springfield

3.0132, ANIMAL WASTE MANAGEMENT WITH POLLUTION CONTROL

D.L. DAY, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-10-0375)

OBJECTIVE: Further develop animal waste management systems to (1) collect, transport, manage; (2) treat and condition, (3) utilize and dispose of wastes; and (4) analyze and integrate systems from 1, 2, and 3 in a manner that minimizes pollution of air, water and soil and is compatible with efficient agricultural production.

APPROACH: Will use in-the-building oxidation ditch for waste treatment. Designs for floors and pens will be refined to eliminate buildup of waste and to reduce odors and gases. Tolerance levels will be determined by testing pigs in small chambers in which atmospheric components can be controlled and varied over desired ranges.

PROGRESS: The in-the-building oxidation ditch eliminates objectionable odors from manure pits and reduces pollutional value of waste by about 90 percent.

SUPPORTED BY U.S. Dept. of Agriculture

3.0133, HYDROGEOLOGY OF SOLID WASTE DISPOSAL SITES

G.M. HUGHES, Univ. of Illinois, Graduate School, *Urbana, Illinois* 61801

The objectives of this project are to investigate hydrogeologic environments in northeastern Illinois that are being used for shallow solid-waste disposal, and to evaluate the factors that control ground- water movement of refuse leachate in these environments. Criteria are sought to judge the suitability of proposed disposal sites not only in glaciated areas, such as northeastern Illinois, but in many other areas as well.

Existing landfills are being studied, and the investigation is proceeding by: (1) drilling by wash boring or with hollow-stem augers to determine the character and sequence of deposits; (2) installation of piezometers to define fluid potential distribution and the ground- water flow system; (3) sampling of the ground water for chemical analysis; and (4) a monitoring program of the piezometers to determine seasonal variations of the flow system.

SUPPORTED BY University of Illinois

3.0134, LIVESTOCK WASTE MANAGEMENT

W.H. LUCKMAN, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-12-0316)

OBJECTIVE: Develop procedures for the removal, reduction or de- toxification of pesticide residues and conversion products in agricultural commodities. Develop or improve methods for determining pesticide residues in agricultural commodities in marketing channels.

APPROACH: Modifications of present processing techniques to removal or reduce toxicity of chemical residues in food products (with emphasis on soybeans). Development of new chemical or non chemical detection methods. Improved instrumentation for analysis of chemical residues. Analysis of food samples to evaluate techniques.

PROGRESS: The outstanding achievement reported at the last NCM-37 meeting was the development of a method for partitioning extracts on a 2" x 8' strip of glass microfiber for final cleanup before analysis. Acetonitrile extracts or other extracts are applied in a one-half inch band across the width of the fiber strip and partitioning solvents such as pure acetonitrile is allowed is allowed to move by capillarity over the treated zone. Botanicals, synergists, and pesticides move with the solvent front away from the fat, oils, or waxy residue. The portion above the residue band is cut off and extracted with hexane or some other appropriate solvent. Meat, milk, or vegetable material contaminated with .01 ppm organophosphates, carbamates, pyrethrins, piperonyl butoxide, and others have been processed in this way for analysis with high recovery values (80-95%). This will be a valuable method of cleanup in research on the isolation of many organic compounds. The study of aldrin and heptachlor residues in Ill. soybeans has been discontinued since our work has to a considerable extent brought about the needed federal action in regulating the use of these pesticides. Initial studies with furadan have shown that its toxic glucaronate can be found in most plant parts when soybeans, radishes, and turnips are grown on soil treated at a dosage of 20 lb. per acre. We have no future plans for this project because of the June termination date. Certain aspects of this project, particularly methodology, can be utilized within the scope of the NC-85 project.

SUPPORTED BY U.S. Dept. of Agriculture

3.0135, DEVELOPMENT OF A DEVICE FOR DISCHARGE MEASUREMENT WITHIN A SEWER PIPE

H.G. WENZEL, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

The objective of the research is to develop a device which is capable of measuring unsteady discharge within a sewer pipe under both open channel and full flow conditions. The increasing need for drainage data in urban areas points out the need for such a device.

The funding will permit analytical studies to determine the optimum geometry and theoretical rating curves for the device. Various flow conditions will be considered. A laboratoy demonstration model will be constructed and tested to verify the computations and to illustrate the operation of the device under various flow conditions.

SUPPORTED BY University of Illinois

3.0136, USE OF ALGAE, ALGAE-PROTOZOA, AND ALGAE-BACTERIA CULTURES IN SEWAGE TREATMENT

S.V. GANAPATI, Univ. of Baroda, *Baroda, India* (908-034-B703)

OBJECTIVE: Reduce cost of rural community sewage treatment and disposal through optimum algal-protozoal and algal-bacterial symbiotic balances.

APPROACH: Evaluate various species of photosynethetic algae from sewage in and around Baroda and Ahmedabad for oxygen liberating capacity and resistance to zoo-plankton predators. Select most suitable species and determine optimum conditions for growth and development. Treat selected species to develop mutants and evaluate with respect to oxygen liberation and sewage purification. Grow selected algae species with Vorticella Epistylis and other protozoa. Vary environmental conditions to determine optimum. Make similar studies of algal-bacterial symbiosis. Further evaluate promising laboratory results in outdoor tank pilot plant.

PROGRESS: Several types of bacteria were found to utilize the soluble organic and other nutrient substances in sewage by oxidative assimilation in 4-7 days. Chlorella vulgaris, Oscillatoria obscura and Oscillatoria chalybea carry on antagonistic symbiosis while Scenedesmus quadri cauda, Nostoc pyriformis and Aulosira fertilisima carry on mutualistic symbiosis. Final purification takes place and results in a considerable reduction in turbidity, BOD (corresponds to relative stability), organic matter, ammonia nitrogen and phosphates during 7-28 days as a result of endogenous respiration. Chlorella vulgaris is a very fast-growing algae in sewage producing a comparatively high level of chlorophyll, dissolved oxygen and a phenolpthalein alkalinity. As a result of the latter, almost all of the ortho-phosphates and ammonia nitrogen are removed from the medium.

SUPPORTED BY U.S. Dept. of Agriculture

3.0137, EFFECT OF IRRADIATION ON THE MICROECOSYSTEM OF SEWAGE

C. RAMSKRISHNAN, Univ. of Baroda, *Baroda, India*

Effect of irradiation on the microecosystem of sewage (part of a coordinated programme of research on the study and environment of biosphere resources).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

3.0138, LIFE CYCLE DAIRY HOUSING, MANAGEMENT AND BEHAVIOR

J.L. ALBRIGHT, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01407)

OBJECTIVE: Investigate least-cost rations for cattle and ascertain the effect of different types of housing, materials handling and milking schemes upon sanitation, health, cow behavior, production levels and economic returns.

APPROACH: With the cooperation of interested groups, data will be collected, analyzed and forms developed for electronic computers. Through the use of forage analysis combined with linear programming techniques, least-cost rations that are acceptable, palatable and economical for cattle will be determined. Various housing, manure handling and disposal, and feed handling systems will be evaluated at three locations in Indiana that are under the direct management of Purdue personnel. Field studies in conjunction with regulatory agencies to determine sanitation, labor efficiency and economics will be studied. Males, representing a large and often unwanted by-product of the dairy industry, will be fed various rations ranging from predominately forage to all-grain. Attempts will be made to alter the color of the meat from certain traditional dairy breeds. Carcass evaluation will be done under project 1312 (NC58).

PROGRESS: Dairy herd management research needs were categorized into 10 important areas. Studies on methods of handling dairy manure continued. A deep (20 ft.) lagoon with a capacity of 175,000 cu ft. has been excavated. To reduce the cost of bedding and its removal, various permanent and minimum bedding materials were used in free stalls. Under winter conditions, pit-run gravel and either sawdust or chopped corn stover was satisfactory for yearling heifers. Blacktop was superior to wood. With permanent bedding (rubber mats or Tartan 3M indoor track mats) there was an increase in udder irritation and mastitis in first calf heifers. Type of housing, free stalls or stanchion barn, was not related to incidence or severity of mastitis. Dipping teats for 18 months in an iodine solution after milking was associated with a small decrease in udder irritation and no difference in clinical mastitis as compared to not dipping after milking.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY Indiana State Government

3.0139, WASTE TREATMENT FOR AN INDIVIDUAL HOME WITH REUSE OF THE WATER

D.E. BLOODGOOD, Purdue University, School of Civil Engin., *Lafayette, Indiana* 47907

A system consists of a 300 gallon spherical fiber glass tank with nylon bag occupying about 2/3 of the tank volume. Aeration of the bag contents is continuous. Water from the tank is put under pressure, passed through an activated carbon filter and used to supply a conventional flush toilet.

SUPPORTED BY Purdue University - Lafayette, Ind.

3.0140, CONTROL OF FLIES AND OTHER INSECTS ASSOCIATED WITH SWINE PRODUCTION WITHOUT INSECTICIDE

A.C. DALE, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (033201670115)

OBJECTIVE: Measure relative effectiveness of four systems of swine housing and waste disposal for control of fly and other insect propagation without insecticides.

APPROACH: Compare the following four systems of swine housing and waste disposal. Type (A) is an open-front, shed-type with concrete floored front, types (B) and (C) are encolsed houses with partially slotted floors over pits, but with different methods of waste disposal, and type (D) is an enclosed house with total floor slotted over lagoon. In the type(A) house, the manure and bedding is removed weekly; in the type(B) house, the waste is discharged into a septic tank and lagoon; in the type (C) house, the waste is discharged into a holding tank and subsequently spread on adjacent land; and in the type (D) house, the waste is discharged into a lagoon which extends outside the house.

PROGRESS: Four types of swine housing and waste disposal were studied. Type (A) an open-front, shed-type house with concrete floored front, types (B) and (C) enclosed houses with partially slotted floors over pits, but with different methods of waste disposal, and type (D) an enclosed house with total floor slotted over lagoon. In the type (A) house, the manure and bedding were removed weekly; in the type (B) house, the waste was discharged into a septic tank and lagoon; in the type (C) house, the waste was discharged into a holding tank and subsequently spread on adjacent land; and in the type (D) house, the waste was discharged into a lagoon which extends outside the house. Fly populations in type (B) and (C) houses were slightly lower than those in type (D) and substantially lower than in the type (A) house. Mosquito larvae were found in the unscreened lagoons of the type (D) house, but no larvae survived in the septic tank lagoon of the type (B) house.

SUPPORTED BY U.S. Dept. of Agriculture

3.0141, LIVESTOCK WASTE TREATMENT AND DISPOSAL

A.C. DALE, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01631)

OBJECTIVE: Determine effect of aeration on odors and decomposition of wastes. Evaluate disposal of wastes by aerated lagoons and irrigation. Observe effects of oxidation ditches on wastes. Determine the decomposition of wastes by anaerobic and aerobic treatment.

APPROACH: Laboratory studies will be made to find the effect of temperature, time, size of particle, loading rates and aeration on decomposition of wastes. A field trial of an aerated lagoon and irrigation system will be set up to evaluate this method for returning wastes to land. Oxidation ditches at the Purdue Swine and Dairy farms will be monitored to evaluate feasibility for treating and disposing of wastes. Set up a laboratory study using an anaerobic chamber followed by an aerobic chamber to find how completely solids in livestock wastes can be decomposed.

PROGRESS: The effect of 4 loading rates at 24 C and 4 C was determined on aerobic decomposition of dairy cattle manure. These loading rates were 9, 12, 15, and 18 grams of dry matter to 4 liters of untreated ground water in aerated chambers. Relations of temperatures 35 F, 45 F, 55 F, 65 F and 75 F to the rate of decomposition of volatile solids in dairy cattle manure was determined. A 74-day experiment was conducted at these temperatures. A reduction of over 70% of the volatile solids was obtained in highest temperature chambers. Settling characteristics of the aerated manure were also determined during the experiment. Other phases on the decomposition of dairy cattle manure are: effect of particle size on decomposition rates, effect of antibiotics on decomposition of dairy cattle manure, control of foam and foaming in treatment processes.

SUPPORTED BY U.S. Dept. of Agriculture

3.0142, INVESTIGATIONS OF BIOLOGY, ECOLOGY AND CONTROL OF INSECT PESTS OF INDIANA LIVESTOCK

R.C. DOBSON, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01585)

OBJECTIVE: Determine the occurrence of livestock insects in Indiana and to assess their importance. Study the ecology, biology and population dynamics of Indiana livestock pests. Initiate, develop and perfect more effective techniques for reducing the ravages and annoyances of livestock pests.

APPROACH: A program of continuous evaluation of changing populations of these pests and the resulting impact on livestock is designed to serve as a bench mark for determining study needs. Attention will be directed toward singling out vulnerable factors for manipulation. The effectiveness of some of the presently recommended control materials and procedures will be studied under Indiana conditions. Changes in procedures and practices will be investigated and incorporated as they prove effective. Attention will be given to new insecticides, new application techniques, the use of sex attractants, quantitative hormone adjustment, environmental disruption, and waste disposal.

PROGRESS: Work continued studying systemic insecticides in water for cattle grub control. Two additional materials were tried with variable results. Ecological studies of insects in natural bovine manure were carried on as well as in insecticidally-treated feces. At the present time it appears that the ecological succession of insects is not only changed but may cease entirely in treated feces. The break- down of chemicals in manure appears to be slower than originally thought, which may lead to serious pollution problems. Determinations of residues picked up by swine in treated corn fields were made and attempts at clearing contaminate swine were started this fall.

SUPPORTED BY U.S. Dept. of Agriculture

3.0143, FARM ANIMAL WASTE DISPOSAL

T.E. HAZEN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01433)

OBJECTIVE: Characterize physical, chemical and biological properties of livestock and poultry wastes; improve management systems with regard to handling, treatment and disposition of wastes.

APPROACH: Qualitative and quantitative measurements of physical, chemical and biological properties of swine, poultry and cattle wastes from confinement production units will be taken. Methods of manure treatment and disposal presently under consideration are one- and two- cell lagoons, oxidation ditch and sludge digestion. Effect of waste management in a hog confinement unit will be studied to evaluate ventilation and structural design requirements in confinement rearing.

PROGRESS: Experimentation continues on waste handling system for the I.S.U. swine finishing unit. Manure is hydraulically removed from building by a flowing gutter and discharged to an anaerobic lagoon. Lagoon effluent is pumped to an oxidation ditch. Oxidation ditch effluent is pumped to flush tanks in upper end of finishing unit and reused for manure transport. Equipment modifications are underway for year-round operation. BOD of the returned water was between 50 and 100 mg/l, a reduction of over 98%. No coliform were detected. Further monitoring of treatment and animal performance are to be done. Work was completed on the activated sludge treatment of anaerobic swine lagoon effluent. A predictive design equation was developed and

verified. An activated sludge system may be used effectively with an anaerobic lagoon as the complete treatment of liquid swine wastes. A laboratory investigation was conducted to determine suitability of an activated sludge system alone for the treatment of raw swine wastes. Study was discontinued when it was shown that an excessive sludge build-up was taking place, the oxygen demand of the system was excessive and the effluent produced was not of desired quality. System was modified to a mixed anaerobic digester preceeding an aeration vessel. This unit appears to partially overcome the previous disadvantages.

SUPPORTED BY U.S. Dept. of Agriculture

3.0144, DEMONSTRATION OF A RECIRCULATING SWINE WASTE TREATMENT SYSTEM USING A ROTATING BIOLOGICAL CONTRACTOR
J.R. MINER, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010

The overall objective of this project is to demonstrate the feasibility of using treated waste water from a confinement hog production unit for waste removal within the facilities. The specific objectives are as follows: (1) Demonstrate the effectiveness of a flushing gutter system for handling manure from a hog finishing building. (2) Demonstrate the effectiveness of the Rotating Biological Contractor (RBC) system in treating overflow from an anaerobic lagoon receiving liquid hog manure. (3) Demonstrate the suitability of using treated waste water as the flushing medium for hog finishing building. (4) Determine the operating costs and management skills required to operate this waste management system.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0145, FARM ANIMAL WASTE DISPOSAL
J.R. MINER, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01730)

OBJECTIVE: Improve farm animal waste management systems with regard to handling, treatment, utilization, and disposition of the wastes.

APPROACH: Treat the liquid waste to such an extent to allow recirculating the liquid effluent. Anaerobic digestion systems of increased efficiency would appear possible for animal waste treatment. These systems, which involve temperature control and mixing, will be investigated first on a laboratory scale then in operating size units. This would reduce both the water requirement of the system and the water pollution potential of the discharge. The system has definite management, environmental and animal health implications to be evaluated. To be considered successful, this manure handling system should not have adverse effects on animal performance nor should it result in the spread of disease among animals within the unit. Parameters influencing the physical performance of the hydraulic transport system must be measured and similarly the influence of these variable on the physical, chemical, and social environment within the building.

PROGRESS: Study of a recirculating hydraulic manure transport system operated in a building housing 700 finishing swine was continued. The animals deposit manure in two shallow gutters and hourly 125 gallons of treated effluent is flushed down each gutter, transporting the manure to an anaerobic lagoon. Effluent is further treated in a covered oxidation ditch and then returned and used as flushing water. Results this year have been a building which operates with a minimum of odor, without need for pen cleaning, without hauling of manure, and without discharge of pollutants. Decreased performance of the animals which come into contact with the flushing water has not been observed. Work continued in the application of lagoon effluent to cropland. More than thirty inches of effluent containing over two thousand pounds of nitrogen equivalent per acre per year have been applied. Discharge reaching drain tile lines was colorless, free of organic matter and significantly reduced in nutrient concentration. An alternative means of nutrient removal, a hydroponic system utilizing water hyacinths, was initiated. These plants, of semi-tropical origin, grew well under Iowa conditions and showed potential of nutrient removal from partially treated liquid animal wastes.

SUPPORTED BY Iowa State Government - Des Moines

3.0146, OPTIMIZATION TECHNIQUES FOR AGRICULTURAL PROBLEMS
L.T. FAN, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00737)

OBJECTIVE: Apply systems analysis and systems optimization to agricultural problems. Simulation, optimal design, and optimal control techniques will be developed and demonstrated by application to important agricultural problems. Emphasis will be placed on agricultural problems. Emphasis will be placed on food processes and environmental systems.

APPROACH: Although the approach to be used in this work differs somewhat from problem to problem, it usually involves the following steps: Definition of a performance criterion or objective for the processing system. Development of a mathematical model to describe the processing system. Application of optimization techniques to develop optimal solutions. Analysis of results.

PROGRESS: A mathematical model for the continuously operated bioreactor system which can be used to represent a biological waste water treatment process as well as various types of fermentation processes has been developed. The analysis of steady states if investigated thoroughly. One purpose of this work is to investigate the critical flow rates which will cause washout to occur. The effects of macromixing, micromixing and cell recycle on the critical flow rates which will cause washout are examined. In this work several different mathematical models are presented, such as the single CSTR model which is usually used to model the chemostat, the N CSTRs in series model, the PFR model and the diffusion model. Furthermore mathematical models are obtained which describe batch growth in fermentations with two liquid phases present. Simulation was carried out using CSMP language on an IBM 360 computer.

SUPPORTED BY Kansas State Government - Topeka

3.0147, FARM ANIMAL WASTE DISPOSAL
G.H. LARSON, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00666)

OBJECTIVE: Characterization of physical, chemical and biological properties of livestock and poultry wastes. Improvement in management systems with regard to handling, treatment and disposition of wastes.

APPROACH: Make a field study of existing waste disposal systems. Representative samples of various animal manures will be collected over a short period of time and will be analyzed. Existing practices for disposal of municipal and industrial wastes will be evaluated in light of information obtained on nature of animal wastes. Based on information obtained, and if possible, a new system will be designed and tested for economic feasibility for disposal of animal wastes.

PROGRESS: Previous work on characterization of runoff from test feedlots for beef cattle with water applied by sprinklers pointed to much slower sedimentation rates than appear to be occurring in field installations. In a period of higher than normal natural rainfall, suspended solids in runoff when feedlot surfaces had been tramped into a slurry ran almost double the highest previously recorded values. With lot surfaces saturated at onset of 3 inches of rain in 8 hours, suspended solids at 2.5 hours were 13,820 and 25,950 mg/l respectively for dirt and concrete lots and at 7 hours the values were 21,750 and 26,520. Population was 200 head per acre. With 400 head per acre corresponding values were: 26,850 and 44,400 at 2.5 hours and 45,200 and 48,600 at 7 hours. Feedlot runoff with 600 micromhos/cm and 50% exchangeable sodium was applied to 3 soils in soil columns. Piezometers showed some decrease in hydraulic conductivity with a sandy soil and a Hastings silty clay loam but results were erratic. Crete silty clay would not let water through the column. Field plots irrigated with feedlot runoff showed no apparent decrease in water intake rate and corn yields were the same for plots irrigated with runoff and others irrigated with well water and fertilized according to standard recommendations. Tests in plant growth chambers showed that very heavy applications of feedlot

manure to land can very seriously retard early growth of corn though germination was not greatly reduced.

SUPPORTED BY U.S. Dept. of Agriculture

3.0148. FARM ANIMAL WASTE DISPOSAL

G.H. LARSON, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN-05-835)

OBJECTIVE: Not Provided

APPROACH: Not Provided

PROGRESS: When population density of cattle in test feedlots was doubled (400 head per acre vs. 200), the pollution potential of simulated stormwater runoff was increased by 25%. Extended wetting of lots until a manure slurry was created on the surface produced contamination in runoff that greatly exceeded values found by the previously developed prediction equation. Work with out-door infiltration plots and with laboratory soil columns to study the effect of feedlot runoff water on hydraulic conductivity of soils encountered difficulty with techniques. Further attempts to get meaningful results are being made. A trailer was built for transporting the fluidized bed incinerator. In field tests, corn plots were irrigated with feedlot runoff from a detention lagoon. Yields equaled those from plots treated with commercial fertilizer and well water. Water intake rate did not seem to be affected. Application for a large grant has been completed, revised and submitted a second time to the FWPCA. The application outlines studies of land disposal of solid wastes and runoff from feedlots.

SUPPORTED BY Kansas State Government - Topeka

3.0149. DEMONSTRATION AND DEVELOPMENT OF FACILITIES FOR THE TREATMENT AND ULTIMATE DISPOSAL OF CATTLE FEEDLOT WASTES

H.L. MANGES, Kansas State University, School of Engineering, *Manhattan, Kansas* 66502

Manure generated in feedlots and stormwater runoff from the feedlots are sources of pollution to streams, groundwater, and land. This research is based on the hypothesis that pollution can be minimized by the orderly disposal of these wastes onto agricultural lands.

The objectives are: (a) to characterize stormwater from the feedlot, (b) to characterize manure generated in the feedlot, (c) to determine the effect of storage in an anaerobic lagoon on quality of feedlot runoff water, (d) to determine the influence of lagoon water loading rates and manure loading rates on the soil, on the soil leachate, on stormwater runoff from the waste disposal area, on removal of nutrient elements from the soil by cropping and on corn yields, (e) to determine the most economical loading of lagoon water and manure onto cropland compatible with pollution control, and (f) to determine the health hazards when feedlot runoff waters are spread onto land through a sprinkler irrigation system.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0150. PRODUCTION EFFICIENCY IN CAGE EQUIPPED LAYING HOUSES AS INFLUENCED BY LABOR PRACTICES

W.M. INSKO, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY01017)

OBJECTIVE: Determine standard times for performing different tasks in a caged laying systems, establish economic feasibility of using different types and levels of mechanization, and observe and attempt to solve problems associated with waste disposal, disease prevention, odors and fly control.

APPROACH: A job analysis of work methods indicating time requirements and cost of equipment as a substitute for labor will be made for all operations and sub operations with cages placed in various arrangements including two to six cages per row. Operations timed will indlude feeding, egg collection, cleaning waters and cleaning dropping boards. Project will include work methods and items of equipemnt to cover various levles of mechanization in each of afore metioned operations. With information obtained it will be possible to compute and establish economics of using different types of management and different levels of mechanization in various sized cage laying installations.

PROGRESS: This report covers 47 weeks of management of caged layers with different degrees of mechanization. In 5 of 6 labor categories, manual care of a fourth deck took the most time per dozen eggs or was tied for the most time. The one exception was pit cleaning under stacked cages. Mechanization resulted in lower labor requirements. In cleaning manure pits, manual or semi-mechanical cleaning varied from .20 to .28 man-minutes per dozen eggs, while mechanical cleaning, including clean-up of equipment, took only .08 man- minutes per dozen. Mechanical feeding took .03 man-minutes per dozen eggs, while manual feeding took from .15 to .31 man-minutes. No significant differences were found among groups in either mortality or egg production.

SUPPORTED BY U.S. Dept. of Agriculture

3.0151. TREATMENT AND DISPOSAL OF LOW-LEVEL SLUDGES BY SOLAR EVAPORATION

S.S. KIM, Korean Off. of Atomic Energy, *Seoul, Korea*

Treatment of low-level sludges by solar evaporation is a continuation of the previous research contract No. 566 which was directed to the development of the application of local clays for treatment of low-active liquid effluents. The project involves a study of meteorogical conditions, development of evaporation pan and economical evaluations of the solar evaporation and the whole waste treatment scheme. The first year's programme includes: Selection of the methods of measurement of the evaporation rates and continuous measurement of the evaporation rate during the seasons. Design and construction of experimental evaporation pan and devices for handling of final product. Measurement of evaporation rate of the sludge in the experimental evaporation pan. Determination of evaporating pan capable of handling the yearly sludge production.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

3.0152. LAGOONS FOR DISPOSAL OF BARN YARD WASTES

H.T. BARR, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01081)

OBJECTIVE: Determine feasibility of disposing of animal waste by lagoon method under La. Climatic conditions: determine if lagoon method can be used for Milking parlor & milk room, Feeding floors for dairy, beef, hogs and chickens, determine what size should be used in order to get satisfactory sedimentation, elimination of odors and to meet the demands of the State Board of Health.

APPROACH: Collect data on efficiency of operation on lagoons now in use. Help install additional lagoons and obtain accurate data for 2-3 year period during operation. Summarize data and calculate correct size and operation for future recommendations on lagoons in Louisiana.

PROGRESS: Further evaluations of a lagoon for poultry were made. The lagoon was used for 1392 laying hens and the production was compared with that of conventionally caged hens. These results are summarized in the following: Feed*** BodyWt., (lbs), No Birds, Egg*, Egg Wt., Mort., Haugh**, Shell, Efficiency, Treatment, Start, End, In Expt., Prod.(%), Oz/Doz., (%), Units, Thick(in.), (lbs.), Lagoon, 2.49, 3.69, 1392, 54.45, 25.30, 20.47, 85.76, 0.0130, 4.42; Control, 2.51, 3.71, 1368, 58.63, 25.50, 11.91, 85.07, 0.0129, 4.62; * 330 Day Production Period ** Measure of Interior Quality, *** Pounds of Feed per Dozen Eggs. Although the difference in feed efficiency results are not statistically significant, it is obvious that the lagoon is performing well. Observations were made on the two swine lagoons and there was a definite accumulation of sludge at a higher rate in the lagoon based on 35 sq. ft. of surface per 100 lbs. of swine as compared with 45 sq. ft. These results are tabulated and reported in a bulletin listed below.

SUPPORTED BY U.S. Dept. of Agriculture

3.0153, DEVELOPMENT OF DIET RATIONS FOR CULTIVATION OF SHRIMP AND CRAWFISH

S.P. MEYERS, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01507)

OBJECTIVE: Utilization of fish protein concentrate (FPC) and single cell protein (SCP) for aquacultural purposes. Development and testing of various complete rations under controlled aquarial conditions.

APPROACH: Aquaculture is rapidly becoming a large potential source of fish and protein, with considerable economic implications on a world-wide basis. Shrimp cultivation is a major area for exploitation by many food-based and other industries. A big stumbling block is the development of an economical and reproducible food. Similarly, the relatively small, but important, crawfish industry in Louisiana would benefit greatly by development of methodology for artifical cultivation using an efficient low-cost ration to support and accelerate animal growth. The proposed formulation of diets utilizing marine or fish protein, microbial protein (such as yeast cells-SCP) and crude fiber has real practical significance. This is especially evident in currently designed food and fiber waste disposal systems engineered for ultimate microbial conversion of end product into single-cell protein, the latter for use in animal feed supplement, including aquacultural vertebrate and invertebrate crops.

PROGRESS: Cultivation of aquatic and marine invertebrate crops is a significant aspect of a rapidly expanding aquacultural industry. A major stumbling block with invertebrates is development of economical, reproducible, rations for proper growth and nutrition of the animal. Basic diets have been formulated utilizing fish protein concentrate (FPC) and single cell protein (SCP-Torula yeast) as the sole protein supplement, and rice bran at 30-45% as the primary carbohydrate addition. Pellets designed for maximal utilization by the juvenile animals are small (1/8" diameter x 1/2" long) with good 'sinkability' for bottom-feeding specimens. Feeding tests with juvenile shrimp and crawfish show ready utilization of the FPC- and SCP-based rations. Growth rate increments are noted, i.e., doubling in weight in initial two weeks feeding period. Pellet durability index (PDI), using Masonex (hemicellulose) as a binder, requires improvement for maximal utilization efficiency. Pellet 'systems' are under evaluation to effect maximal PDI, controlled nutrient release, and attractability to the animal.

SUPPORTED BY Louisiana State Government

3.0154, BEDDING AND INFILTRATION STUDIES OF SANITARY SEWERS IN THE GULF COAST AREA

F.W. MACDONALD, Tulane University of Louisiana, School of Engineering, *New Orleans, Louisiana* 70118

The purpose of this project is to determine the best types of bedding arrangements and the most suitable materials to be used in laying sewer pipes in the Gulf Coast areas, including studies on manholes, and other appurtenances of sewer systems. A major portion of the project will be infiltration studies using various materials of construction. Some of the studies will be with a testing frame in the University laboratory, while other studies will include field studies of sewer lines in the area.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0155, NEW FOOD PRODUCTS AND SERVICE

M.E. HIGHLANDS, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME03059)

OBJECTIVE: Processing problems, new developments and services to the food industry on processing.

APPROACH: Among items that have been encountered are: lye peeling of squach, evaluation of new apple varieties for canning, evaluation of new dry bean varieties for canned baked beans, evaluation of Maine canned tuna. Service problems on various analytical methods and development of simplified techniques for quality control have been worked out. Work in the area of processing plant waste disposal has also been done. Work along the above lines will be continued.

PROGRESS: Work on the relation of holding time at 30-32 F to sensory panel preference for texture and flavor of Maine shrimp was investigated. Results indicate a tendency for increased preference for shrimp held four to five days at 30-32 F with regard to flavor and texture as opposed to shrimp held one to three days under the same conditions. Sanitary surveys of three shrimp processing operations including one canning plant, one prepeeled freezing operation, and one precooked, non-peeled chilled operation were examined. Evidence of improved sanitation requirements were observed in the canning operation and suggestions for correction were made. Examination of cultures from shrimp processing operations are continuing with the view of establishing sanitary improvement and possible significance of these organisms in consumer utilized shrimp products. Service research and development work was carried out on processing of battered breaded fried, frozen poultry products, resulting in improvement of these products and selection of proper battering materials. Microbiological examinations of processed and non-processed poultry products were made in connection with establishing the sanitary integrity of the finished processed product. Recommendations with regard to sanitation and handling of the processed products were made and when applied resulted in products of acceptable sanitary condition and quality.

SUPPORTED BY Maine State Government

3.0156, DISPOSAL AND UTILIZATION OF DAIRY AND POULTRY MANURES BY LAND APPLICATION

A.F. KLINGE, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00222)

OBJECTIVE: Develop and evaluate disposal and utilization systems for land application of treated and untreated dairy and poultry manure that will minimize the pollution of water, soil, and air.

APPROACH: Relationships among temperature, moisture, air flow and drying rates of fresh poultry manure under various environmental conditions will be determined. Drying will take place in an insulated bin. Mathematical relationships among temperature, relative humidity, air flow rate and moisture content will be determined for the drying process. Pollution effects of the dehydrated poultry manure when applied to soil will be evaluating using rainfall simulators producing up to 5.0 inches per hour. Surface runoff will be measured and percolate analyses will include COD, NO(3), Na, NH(4), PO(4), NO(2), at three depths in the soil.

PROGRESS: Poultry manure from pits was dried by blowing heated air over the surface of the manure as it was being stirred in an insulated chamber. Average initial conditions of the manure were: moisture content, 65%; total nitrogen 1.15%; nitrogen from ammonia, 0.54%; and potassium, 1.40%. Average conditions after drying were: moisture content, 12%; total nitrogen, 6.18%; nitrogen from NH(4), 0.51%; and potassium 2.43%. Volume reduction during drying out was about 50%. The dried manure was applied to 10' x 20' plots on Caribou loam at rates of 0, 7, and 28 tons per acre and disced in lightly just prior to the application of 1.25 inches of water in approximately 50 minutes by rainfall simulator. Surface runoff from the plots was collected and analyzed with the following average results: control plots, 7.54 ft of runoff containing 1.19 ppm NO(3) and 0.21 ppm NH(4); 7 tons per acre plots, 8.96 ft. of runoff containing 2.76 ppm NO(3) and 8.72 ppm NH(4); 28 tons per acre plots, 4.94 ft. of runoff containing 4.01 ppm NO(3) and 23.56 ppm NH(4). One month later, water was again applied in a like manner with the following average results: control plots, 14.32 ft. of runoff containing 3.82 ppm NO(3) and no NH(4); 7 tons per acre plots, 13.36 ft. of runoff containing 7.88 ppm NO(3) and 2.38 ppm NH(4); 28 tons per acre plots, 5.35 ft. of runoff containing 7.89 ppm NO(3) and 11.37 ppm NH(4).

SUPPORTED BY U.S. Dept. of Agriculture

3.0157, DESIGNING AND TESTING HYDRAULIC HANDLING SYSTEMS FOR POTATOES, SUGAR BEETS AND OTHER CROPS

N. SMITH, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (TF1-094A)

3. SOLID WASTE MANAGEMENT

OBJECTIVE: Design and test hydraulic (fluming) systems for handling potatoes, sugar beets, and other crops which will reduce operating costs without impairing market quality of product being handled

APPROACH: Engineering studies to evaluate principles of various systems for hydraulic handling of crops, including open and closed, above and below floor level, fixed and portable systems; lateral and main flume layouts and configurations evaluated; auxiliary items including pumps, sumps, and sump clean out and disposal systems will be developed. Product damage and deterioration studied. Prepare complete set design criteria and operating procedure. Engineering-economic cost comparison with other typical handling systems.

PROGRESS: Further tests were conducted with the closed pipeline system after adjusting initial instrumentation. Stored Katahdin potatoes were run through the system to obtain water headloss figures and to evaluate potato damage. Small potatoes showed negligible damage and only very slight skinning at all conveying velocities (up to 10 ft. per sec.) while large potatoes showed minor cuts and light skinning at conveying velocities above 7 f.p.s. No severe damage found. Potatoes passed through the system 50 times per hr. for 6 hours still retained over 50 percent of their skin, indicating potential for economical, high-speed movements in smooth pipes. Damage tests were also continued with Russet and Kennebec potatoes. Flume intersection angles of 90 , 60 , and 45 were designed and fabricated as well as the remainder of the other equipment needed for trials in 10-inch trapezoidal flumes. Fluming tests were run to evaluate the effects of flume intersection angles on flow profiles and bruise damage using three rates of potato supply and two rates of water supply. Design calculations were made for circular flume sections. Data obtained from previous trials with rectangular flumes were processed. Mechanical and hydraulic methods for sump cleanout were analyzed. Data from tests conducted over a three- year period were summarized and partially analyzed.

SUPPORTED BY U.S. Dept. of Agriculture

3.0158, LITTERLESS HIGH-DENSITY BROILER PRODUCTION SYSTEM

R.B. WILLIAMS, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00212)

OBJECTIVE: Evaluate various non-litter materials in respect to their use as broiler flooring. Determine methods of removing waste materials from this flooring on a continuous complete disposal basis; determine extent of carcass defects occurring during growing, handling and transporting operations while utilizing the flooring; use this information for development of a litterless, high density, controlled growing and handling system for broilers.

APPROACH: Broilers will be raised on a number of non-litter flooring materials to find a satisfactory alternative to litter. Carcass quality and production efficiencies will be determined. A method of removal and disposal of waste will be developed and a growing- handling container for use in the litterless fully mechanized production system will be developed.

PROGRESS: The broiler growing and handling cage unit has been redesigned to include direct transport of the growing cage to the processing plant. These units are now under construction and will include several new selfcleaning flooring designs. Uniform grading of test birds for carcass quality was a problem in the past due to high speed of the processing line. A system of handling has now been established with one of the local commercial processors to allow greater detail in carcass grading.

SUPPORTED BY U.S. Dept. of Agriculture

3.0159, SLUDGE DISPOSAL AND MATERIAL RECOVERY SYSTEM FOR MANUFACTURERS OF COATED AND/OR FILLED PAPERS

R.P. LABRECQUE, Scott Paper Company, *Westbrook, Maine* 04092

A proposal has been made to incinerate dewatered primary treatment sludge by using a rotary kiln incineration process. Since the sludge in question contains a very high amount of paper making pigment and consequently is not amenable to conventional sludge incineration processes, an incineration process has been developed which will allow economical recovery of the pigment so that it can be reused as a replacement for virgin filler pigment during the paper making operations.

Extensive laboratory and field trials have shown that, through careful control of incineration temperature and retention time in the incineration system, a pigment product which is equal to or superior to most paper making pigments can be recovered from the waste sludge as the ash resulting from the incineration process.

The project has been divided into two phases. The project in question, Phase I, will consist of a large scale mill trial during which ten tons of sludge will be processed. Phase III, which may follow Phase I, will consist of the construction and trial operation and evaluation of a full size recovery system composed of a 250 ft. rotary kiln, four pigment pulverizers and a pigment storage-distribution system.

Phase I of the project will begin in May, 1970 and will end in April, 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0160, ACCELERATED BIODEGRADATION OF SANITARY WASTE SOLIDS

W. VANHEES, U.S. Navy, Ship Research & Dev. Lab., *Annapolis, Maryland* 21402

Technical Objective: Development of information necessary for rapid microbial solubilization and digestion of cellulose and similar solids in sanitary waste, applicable to prospective use in designing shipboard waste treatment systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0161, CHEMICAL AND PHYSICAL TREATMENTS OF CATTLE EXCRETA FOR REDUCING ENVIRONMENTAL POLLUTION

L.W. SMITH, U.S. Dept. of Agriculture, Animal Science Research Div., *Beltsville, Maryland* 20705 (033107090121)

OBJECTIVE: Reduce the pollution potential of cow feces by chemical and physical treatment and evaluate the feed value of treated fecal fractions.

APPROACH: Feces of dairy cattle and sheep will be fractionated into water soluble and non-water soluble portions. Whole feces and water soluble portions will be treated with heat, cold and chemicals to reduce solubility of constituents. Isolated insoluble fractions will be treated with delignifying agents to increase the availability of cellulose. These treated materials will be added to rations of experimental animals.

PROGRESS: Laboratory chemical treatments of total fecal dry matter or isolated fecal cell walls has been completed. Sodium hydroxide was found to be the most economical chemical for solubilizing cell walls and for enhancing in vitro digestion of fecal fiber. Additional intake and digestion trials have been conducted using sheep fed rations containing 85% ground or pelleted dehydrated manure which was nearly free of bedding. Digestibilities of DM were 43, 52, 55 and 53% for untreated, NaC10(2), Ca(C10)(2) and NaOH treated ground dairy cattle manure. Digestibilities were lower when the rations were fed pelleted (37, 46, 47 and 57, respectively) except for the NaOH treated which increased. These digestibilities are higher than those observed on saw-dust containing manure. Consumption of the untreated manure pellets was highest (3.5% of body weight per day). A growth trial is in progress with 15 dairy heifers on rations composed of Manure:corn meal at ratios of 1:1, 2:1 or 3:1. Consumptions exceeding 2.0% BW are being observed.

SUPPORTED BY U.S. Dept. of Agriculture

3.0162, NEW HAMPSHIRE, MASSACHUSETTS COOP (NEWBURYPORT W AND E)

L.R. PAGE, U.S. Dept. of the Interior, Geological Survey, *Beltsville, Maryland* 20705

State(s) to which the work listed herein pertains: Massachusetts, New Hampshire.

Bedrock mapping of the two quadrangles in elucidating faults of regional significance and should closely define the location and potential of a belt of lead-silver deposits.

In depicting the diverse elements of glacial, fluvial, and marine origin, which make up the surficial deposits, special emphasis is given to cataloguing construction materials, defining foundation characteristics of the deposits and classifying various terrains to permit recognition of some of the pressing problems of waste disposal and pollution.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

3.0163, REFINING OF MOLTEN FERROUS SCRAP

H.V. MAKAR, U.S. Dept. of the Interior, Bureau of Mines, *College Park, Maryland* 20740

Project objective is to develop an economical method of copper removal from molten ferrous scrap.

Research in progress includes: A. Rate studies on slag metal reactions between molten iron and alkali slags; effect of carbon content of the iron on copper removal; removal of other impurities; and feasibility of spent slag recycling. B. Development of special processing techniques, such as lance injection and counter-flow operations, to improve efficiency of slag-metal reactions.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0164, ANIMAL WASTE COMPOSTING EQUIPMENT FOR THE NORTHEAST

J.W. HUMMEL, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (901-031-B610)

OBJECTIVE: Develop methods for disposal of livestock and poultry production and processing wastes.

APPROACH: Create new concepts of design criteria and prototype machines for composting animal wastes by studies of: use of hydroponic techniques to remove plant food elements; longitudinal flow; air entrainment requirements and techniques; transport and mixing; confining platforms and channel shapes and sizes; precompost treatment requirements; the use of chemical and biological additives to facilitate and/or accelerate the composting process; capacities in relation to production unit size; and impact on livestock and poultry production systems.

PROGRESS: Plans were developed for the channel to be used for the composting mechanization system. Material was obtained and a test section constructed. Length of the test section was approximately one- third of the anticipated prototype model. Cross-sectional area was full-scale. Plans were drawn up and a first-generation model of the elevating and mixing mechanism was constructed. The unit was designed to elevate at different pitches and rates of flight movement. Torque measurements were made to evaluate power requirements for the unit. Preliminary tests indicated some modifications were required. Modifications were made and additional tests conducted. A means of propelling the unit forward was designed. Combinations of wet sawdust and other additives to simulate animal waste were tried. Dye material to color the sawdust was investigated. The dyed sawdust will be used to determine mixing capabilities of the elevating an mixing mechanism.

SUPPORTED BY U.S. Dept. of Agriculture

3.0165, USING WASTE FORMED IN VEGETABLE AND CHEESE PRODUCTION

A. KRAMER, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-Q-085-A)

OBJECTIVE: Study the chemical, nutritional, microbiological composition of waste materials occurring during the manufacture of processed tomatoes, cottage cheese, and other fruits, vegetables and cheeses; investigate the possibility of utilizing these waste products as food or feed, for men, animals, plants or soils; and manipulate such wastes by means of drying and ensiling, and where possible, use of chemicals, additives and solvents to yield additional uses for the raw materials.

APPROACH: First work will be directed to determining the chemical, nutritional and microbiological composition of tomato and cottage cheese waste materials. Work on other product wastes will follow. Feeding and plant growth studies will be used to determine possibilities for feeding ruminants or in crop production.

PROGRESS: A process of utilizing tomato cannery waste was developed where press-cake containing 2/3 of total solids, 10% protein is usable as cattle feed, and 1/3 of solids, 60% protein is precipitated as a Tomato Protein Concentrate. This concentrate can be extracted with acetone to form an 85% protein isolate, and a tomato flavor and pigment residue may be obtained during the acetone recovery. Significant phytotoxic effects are limited to ripe tomato fruit components. When properly processed by HTST pasteurization, cheese whey can be used up to 50% in place of milk for the manufacture of sherbet and ice cream, and mixed with tomato or fruit juices as a 'breakfast' drink.

SUPPORTED BY Maryland State Government

3.0166, DISPOSAL OF WASTES FROM SWINE FEEDING FLOORS TO MINIMIZE STREAM POLLUTION

W.F. SCHWIESOW, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-R-029)

OBJECTIVE: Investigate methods for disposing of waste from swine feeding facilities. Develop guide lines for design of systems to minimize water pollution by swine wastes.

APPROACH: Use of a sedimentation tank, sprinkler system, tile distribution field, and field spreading in several combinations are to be investigated. Waste products coming from the swine production unit will be analyzed to determine the liquid-solids ratio, available nutrients--N, P, K, BOD and COD. The waste will be run through a sedimentation. Liquid waste, measured by a flow meter at the tank outlet, will be pumped to an adjacent field and distributed by sprinkler or under ground tile system. Solid wastes will be drawn from the sedimentation tank by a vacuum type spreader and placed on a field. Immediate and delayed coverage will be practiced.

PROGRESS: The basic installation has been completed. A lysimeter 200' long, 2' wide and 4' to 7' deep was constructed. Twenty-six test plots were built. Each plot having a 10' x 10' test area. Solid wastes were applied at rates of 25, 50, 75 and 100 tons per acre to 12 plots on one side of the lysimeter. Grass did not become established this year. Effluent was applied to 12 plots on the other side of the lysimeter. Application rates were 1, 2, 3 and 4 inches per week for nine weeks this year. Two untreated check plots are maintained--one on each side of the lysimeter. Soil samples were taken before treatment began. Samples were taken of the effluent before application and of water percolating through the soil. Percolating water was collected by slotted plastic chains installed at 6', 12', 24' and 72' levels were permitted by lysimeter depth. Sampling of the percolate water continues. These samples are now being analyzed for nitrogen, phosphorous, calcium, sodium and chlorides. Effluent application is to be resumed next year.

SUPPORTED BY Maryland State Government

3.0167, FARM ANIMAL WASTES MANAGEMENT

G.B. WILLSON, Univ. of Maryland, U.S.D.A. Agric. Engin. Div., *College Park, Maryland* 20742 (901-031-B603)

OBJECTIVE: Develop methods and facilities for handling, reclaiming and/or disposing of farm animal wastes economically and without environmental pollution hazard or aesthetic nuisance.

APPROACH: Conduct studies to design, test and evaluate methods and facilities for handling, holding, transporting, disposal and/or utilization of farm animal wastes. Studies will be included to develop technology for the use of composting as a method for reducing the volume of wastes and transforming them into an innocuous material for disposal or utilization. These studies will include an evaluation of physical, chemical and biological characteristics that will influence the design and operational methods used in the composting process. Studies will be made of the use of filters and other methods of removing odors and dusts from the exhaust air from poultry houses.

PROGRESS: A new laboratory facility for farm animal waste management research was constructed by the University of Maryland. This facility is the site for cooperative research on the composting process for treating farm animal wastes. Although the facility was not completely ready for use until December, some exploratory work was initiated in the fall. Studies of the compost

process have shown that dairy cow manure and bedding in approximately halfston batches can be digested to a relatively odorless material. The process reduces total dry matter 60% and could with drying reduce the weight by 85%. The volume is reduced about 30% in the loose state and could be reduced further by compaction or pelleting. Temperatures achieved (150 -170 F.) were adequate to kill pathogenic organisms and weed seeds are digested in the process. Aeration has reduced process time about 50%. Studies of the use of filters to clean poultry house exhaust air have shown that baffle impingement filters reduce the dust emission 1/2 to 2/3. A fog nozzle between the exhaust fan and the filter increases the efficiency, particularly for the smaller size particles. A marked reduction in odor strength was observed under both operating conditions, with wet operation being more effective.

SUPPORTED BY U.S. Dept. of Agriculture

3.0168, CLOSED SYSTEMS FOR ANIMAL SEWAGE TREATMENT

J.T. CLAYTON, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01002

The specific objectives of the proposed research are: (1) To develop a waste stabilization system that will minimize the polluting strength of manure and other dairy farm wastes; and (2) to clarify, by digestion and subsequent treatment, the liquid (or liquifiable) parts of dairy farm wastes so that the system effluent can be safely disposed of or used as the agent for subsequent cleanings of the dairy facility.

Two experimental sewage processing systems will be used. The first will consist of primary settlement of the influent with secondary aerobic digestion. In the second system aerobic digestion will precede settlement. Effluent quality and the fate of indicator organisms, will be the principal criteria of performance.

Microbiological determinations will be made in order to obtain the following information: (a) the activities in the various stages of the process; (b) the public health hazards associated with the final sludge and effluent; and (c) to determine the degree of disinfection necessary before discharge.

Later experiments will include the use of coagulants, coagulant aids, and chemical treatments. Dosage and effectiveness of ion exchange minerals and resins will be investigated with special emphasis on odor and color effects. Chemical treatments for microorganism control and small organic particle removal will be studied.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0169, THE CONSTRUCTION OF THE STORM DETENTION AND CHLORINATION STATION

H. WHITMORE, Metrop. District Commission, *Boston, Massachusetts* 02108

The storm detention and chlorination station is being constructed for the treatment of storm water overflows from the combined sewage system of the cities and towns bordering on the Charles River Basin. The proposed installation will be capable of handling a maximum of 230 million gallons per day of excess flow from the new and old sewerage systems. Consisting of screening and pumping facilities, chlorine dosing and detention facilities and skimming and flushing facilities, this installation will be fully automatic and will become an integral component of the overall sewage control program for Metropolitan Boston. A comprehensive sanitary survey of the Basin is now underway and will be followed up by correlation of operation data with rainfall; frequency and extent of overflows; physical, chemical and bacteriological analyses of influent and effluent; regrowth of coliforms; effectiveness of chlorination and solids removal with measurements of solids returnto sewer; effectiveness of the double-sided overflow weirs in relief conduits; effectiveness of effluent diffusers into Basin and overall unit cost studies relating to operation, utilization and performance of the installation. Scheduled to be under construction in the Fall of 1967, the facility will be in preliminary operation in the Fall of 1969.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0170, EFFECTS OF HEAVY METALS ON ALGAL GROWTH AND ORGANIC REMOVAL EFFICIENCY IN STABILIZATION PONDS

W.R. DOMEY, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

Many heavy metals are present in industrial wastes which may be discharged into stabilization ponds for muncipal waste treatment. This study will determine the effects these metals have on oxygenation capacity and on growth of algae. The effect that these metals have on the efficiency of the waste treatment facility will also be determined.

SUPPORTED BY Northeastern University

3.0171, KINETICS OF SEWAGE DEGRADATION IN SEA WATER

W.R. DOMEY, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

Ocean disposal of sewage wastewaters usually is predicated on the dispersal capacity of the sea. This study will generate data for the degradation of the waste as opposed to the dispersal phenomena, which must have some eventual limitations.

SUPPORTED BY Northeastern University

3.0172, MICROBIAL CONTAMINATION OF AIR NEAR OPEN WASTE TREATMENT FACILITIES

C.J. GREGORY, Northeastern University, School of Engineering, *Boston, Massachusetts* 02115

Bacteria are emitted from agitated waste treatment facilities such as aeration tanks and, depending on environmental factors (wind, temperature and humidity), may constitute a health hazard to treatment plant operators and nearby residents. The significance of such emissions is under study at an existing activated sludge waste treatment facility.

SUPPORTED BY Northeastern University

3.0173, ENVIRONMENTAL SYSTEMS PROGRAM

H.A. THOMAS, Harvard University, School of Engineering, *Cambridge, Massachusetts* 02138

Drawing on the disciplines of engineering, applied mathematics, economics, political science, and city and regional planning the Environmental Systems Program will conduct research on the technical, economic, social, and political aspects of problems of environmental quality. Major aims are to train graduate students and post-doctoral fellows in the successful conduct of interdisciplinary research.

The research program involves the cooperation of the School of Public Health, the Graduate School of Design, and the John F. Kennedy School of Government and includes analysis of environmental management institutions; economic analysis of individual decision units; studies of municipal financing of environmental control systems; expansion of current studies of solid waste disposal; and studies of the epidemiology of urban fires. The research program will involve graduate students and post-doctoral fellows in order to develop the talent required for intelligent management of environmental quality management.

SUPPORTED BY U.S. National Science Foundation

3.0174, OPTIMAL DESIGN OF SEWER AND DRAINAGE SYSTEMS

R.T. MCLAUGHLIN, Mass. Inst. of Technology, School of Engineering, *Cambridge, Massachusetts* 02139

Unsteady flow in systems of open channels is being analyzed numerically using a digital computer and dynamic programming is being applied to the optimal design of such systems.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0175, INVESTIGATION OF NEW WASTE DISPOSAL/SANITATION TECHNIQUES FOR GARRISON FOOD SERVICE
D.B. CORNFIELD, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Technical Objective: To determine the feasibility of an automated scullery operation and to investigate techniques of waste disposal.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0176, URBAN WASTE DISPOSAL IN THE SLUM DISTRICTS OF SOUTH BOSTON AND ROXBURY
W.R. JOHNSON, New England Comm. Dev. Corp., *Roxbury, Massachusetts* 02119

The grant in Boston will carry forward research begun in 1969 on urban waste disposal in the slum districts of South Boston and Roxbury. A group including Harvard faculty, the Triton Foundation, and the Organization for Social and Technical Innovation will design demonstration projects and work with the Boston Model Cities Project and other organizations to determine the best ways to dispose of solid wastes in city neighborhoods. Work to date has found, for example, that the system of waste management in Boston is too rigid. Any deviation results in a littered neighborhood--e.g., if waste is put in bags instead of cans, or if cans are too far from the curb, it is not picked up.

SUPPORTED BY Ford Foundation - New York, N.Y.

3.0177, THE ELECTRO-OXIDATION OF AMMONIA IN SEWAGE TO NITROGEN
D.L. BROWN, Ionics Incorporated, *Watertown, Massachusetts* 02172 (14-12-432)

Semiconducting electrodes will be studied with the object of finding an electrode for the electro-oxidation of ammonia to nitrogen in wastewater. A large number of materials will be screened under a variety of operating conditions. Tests will be run on a simulated sewage effluent containing ammonia levels in the range of 10 to 30 ppm. Candidate electrode materials will be evaluated by a three step procedure: (1) conduct potential sweep tests; (2) prepare stepped potential curves for materials that look promising; and (3) for the most promising materials, place them in an electro-chemical cell and run a sufficient time to obtain reliable analytical data.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

3.0178, FLOWING BIOLOGICAL SYSTEM IN AQUACULTURE, SEWAGE TREATMENT AND POLLUTION ASSAY
J.H. RYTHER, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

The primary objective of this research is to design procedures and techniques by which various uses of waste effluent may be made compatible. It combines sewage treatment with aquaculture, thus concentrating two essential uses of the coastal zone in one confined area (food production and waste disposal), leaving contiguous waters free and unaffected by these uses for recreational or esthetic purposes.

SUPPORTED BY U.S. National Science Foundation

3.0179, ENGINEERING PROPERTIES OF COMPACTED ASH FILLS
D.H. GRAY, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

The annual projection of fly ash or ash produced from the incineration of sewage wastes poses a serious disposal problem. An effective solution would be to compact this material and use it as a structural fill or construction material. This might include such potential applications as lightweight backfills, highway embankments, and road subbases.

In order to use these ashes successfully for such purposes their chemical, physical, and engineering properties must be determined. It is also important to investigate possible health or environmental hazards posed by such usage.

The research is presently aimed at determining the compaction characteristics of various ashes, strength and compressibility of the ash after compaction, frost susceptibility, age hardening properties, and response to various stabilization treatments. In addition, such chemical properties as COD, aggressiveness of the ash towards metals and vegetation are also being measured.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0180, ELECTRICAL STIMULATION OF MICROBIAL WASTE TREATMENT
J.S. SCHULTZ, Univ. of Michigan, School of Engineering, *Ann Arbor, Michigan* 48106

Project objectives are to establish operating conditions for stimulating microbial growth and metabolism by electrical techniques and to ascertain design methods for the use of electrically stimulated cultures in bioregenerative waste handling systems.

The program is planned to delineate the effects on microorganisms of various types of electrical stimuli, such as AC, DC, and pulsed; to determine the efficacy of electrical stimuli for increasing the rate of microbial growth and waste handling capability; and to investigate the mechanism of the stimulatory effects.

Electrical effects will be tested in both batch and continuous culture of microorganisms. Electrical effects will be evaluated in terms of microbial growth, rate of substrate utilization, and permeability of the cells to specific metabolites.

This project was initiated on June 1, 1967 and will terminate on April 30, 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0181, FARM ANIMAL WASTE DISPOSAL
J.S. BOYD, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL01021)

OBJECTIVE: Characterization of physical, chemical, and biological properties of livestock, animal and poultry waste, and improvement in management systems with regard to handling, treatment and disposition of waste.

APPROACH: Animal wastes will be dried to provide a material which can be stored and spread under optimum field conditions. Two high temperature dryers are available. The work on electro-osmosis as a means of reducing moisture will be continued. Several lagoons will be studied from the standpoint of management and operation, of which two are on the MSU campus. Aeration may be incorporated in the lagoon to improve the efficiency of operation. Plans will be developed for use of an aerobic digester for animal solid wastes.

PROGRESS: Results of tests were presented to groups to get their reaction to the practice of drying animal manure. One of the problems was capacity of the dryer. This would be used on large farms of 100 dairy cows, 600 steers, or 20,000 hens. One company in Michigan now has made a prototype of dryer which has two times the capacity which would be good enough for 50 dairy cows. A system of collecting manure in free stall dairy barns is also being investigated. This has been used successfully in Sweden and Finland. DeLaval is interested in selling it in the U.S.A. Initial contacts have been made to install the first one on a Michigan farm in Shiawassee County. Mr. Gail is presently constructing a new 60-cow barn and has used a size which will fit this type of manure collector. During the coming year this building should be completed and hopefully a unit operating. Then cost studies and time studies will be made.

SUPPORTED BY U.S. Dept. of Agriculture

3.0182, CLOSED SYSTEM WASTE MANAGEMENT FOR LIVESTOCK
M.L. ESMAY, Michigan State University, School of Agriculture, *East Lansing, Michigan* 48823

3. SOLID WASTE MANAGEMENT

It is the broad objective of this research to determine the design parameters of a self-contained, automated animal waste management scheme.

The specific objective is the development of a liquid manure processing system which is capable of fractionating animal waste into its liquid and solid components, neither of which would cause aesthetic or pollutional problems after processing.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0183, SWINE HOUSING ENVIRONMENT

M.L. ESMAY, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00981)

OBJECTIVE: Develop and verify design criteria for control of the thermal environment for swine production.

APPROACH: Develop adequate information for prediction of air flow patterns, jet stream velocities, air entrainment, thermal mixing, air stratification, moisture diffusion and air management in general for design of precise ventilation systems. Air flow patterns will be studied in a 1/4 scale model and full scale buildings. Air flow rates and slot inlet design and location will be varied. Both theoretical and empirical approaches to the problem will be made.

PROGRESS: Functional planning and structural designs were completed for a swine farrowing house and a nursery-finishing house. Plans were developed for these two buildings for distribution through the M.S.U. Agricultural Engineering Extension Plan Service. Both houses included the design details for slatted floors and liquid handling of animal wastes. Plans for an Animal Waste Laboratory and an experiment swine finishing building were developed and construction was started. Two research studies pertaining to ventilation air flow and temperature patterns in livestock and poultry buildings were made.

SUPPORTED BY U.S. Dept. of Agriculture

3.0184, FARM ANIMAL WASTE DISPOSAL

C.J. FLEGAL, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00928)

OBJECTIVE: Characterization of physical, chemical, and biological properties of livestock and poultry wastes; improvement in management systems with regard to handling, treatment and disposition of the wastes.

APPROACH: Electro-osmosis principle of drying animal and poultry manure will be investigated. Amount of electrical current and design of a material used in electrodes will be studied. Time required to dry material and amount of moisture remaining in material when system stops operating will be determined. Water removed and residue will be analyzed. Bulk density of manures and orientation of electrodes will be investigated. Use of air, mechanical agitation, and pumping (circulating) will be accomplished investigated as a means of increasing aerobic digestion. This will be accomplished in small tanks with controlled amounts of manure added daily. In addition one or more full scale tanks in pens with a high density population will be used.

PROGRESS: A pilot study was conducted to determine the feasibility of nutrient recycling of dehydrated poultry waste utilizing laying hens. Egg production was lowered when 40% dehydrated poultry waste was incorporated in the diet. All levels tested (10, 20 and 40%) resulted in reduced shell thickness. No carryover of taste was determined in scrambled or hard-cooked eggs. Hen day production in those birds receiving 10 or 20 percent dehydrated poultry feces was similar to the production of the birds on the control diet. Feed efficiency was similar for the birds on the control diet when compared to the birds receiving the 10 percent level of dehydrated poultry waste, however, the other levels tested resulted in poorer feed efficiency when compared to the birds receiving the control diet.

SUPPORTED BY U.S. Dept. of Agriculture

3.0185, SYSTEMS APPLICATIONS IN AGRICULTURE

J.B. HOLTMAN, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL01028)

OBJECTIVE: Development and execution of programs for the solution of particular agricultural problems will be investigated which include: dynamical farmstead modeling; control and design of woods harvesting operations; determination of optimum systems for assembling, storing, and distributing cash grains in the Great Lakes region; systems aspects of animal waste management and utilization.

APPROACH: Several different types of farming systems will be considered. Existing data will be compiled and additional requirements determined and collected. The data will be analyzed statistically and models will be formulated on the basis of statistical tests and feasibility of subsequent analysis. Simulations will be designed for woods harvesting systems. The compatability with respect to work scheduling and of various equipment will be studied. The flow of cash grain from producer to terminal operations will be studied which involves mathematical modeling of cash grain flow and the subsequent analysis of the results for improvement of current operations. The movement and utilization of animal wae will be analyzed from a systems approach. A working model will be simulated and studied for possible improvements and performance.

PROGRESS: Much developmental work has been accomplished on the problem of dynamical farmstead modeling. A long range model structure has been established. Many of the hydrolical and biological component models are complete at this time.

SUPPORTED BY U.S. Dept. of Agriculture

3.0186, ELECTRO-OSMOSIS

C.J. MACKSON, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00788)

OBJECTIVE: Determine effect of electro-osmosis on living plants, determine the effect of electro-osmosis of the removal of water from chicken excrement.

APPROACH: Subject small trees to electro-osmotic process to determine potential difference needed to force water through the tree and to determine the effect of the additional water. It is also planned to use the process on cut flowers and other plants after the technique has been determined. Use various DC voltages to determine the possibility of removing moisture from wet poultry manure.

PROGRESS: The concept of electro-osmotic flow in plants was examined. After a review of fundamental bases of plant anatomy and physiology a model of xylem vessels was developed. The energy flow through this model was analyzed mathematically. The energy balance equation was solved for dissipated energy, considered the source of generated electric energy. This relationship was examied by forcing water through a pad of cellulose filter papers. Water head varied and voltage, current and flow rate were measured. The results showed the source of electric energy may not be an 'intrinsic constant quantity' of the material and the liquid, as is assumed in the zeta potential concept, and rather may be a product of the flow process itself. A theory - 'The Electron Accumulation Theory' was developed to reflect this finding. Physiological processes of plants which may be explained by this theory include the negative charge on root hairs and, when combined with the high observed, tensile stress of xylem sap, may cause this sap to act as a communication system along tHe whole height of the plant. Application of the results to the plant irdicate that electro osomsis as defined does not play a role in sap movement in xylem vessels.

SUPPORTED BY Michigan State Government

3.0187, LABOR EFFICIENCY AS AFFECTED BY DAIRY HOUSING FACILITIES

J.A. SPEICHER, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00796)

OBJECTIVE: A study is to be made of 16 dairy housing units. Eight are conventional free-stall housing, and eight are covered free-stall housing systems. Four of each system use liquid manure storage and handling.

APPROACH: The detailed study will be made of the general arrangement of the building and the farmstead, labor requirements for the major dairy chores associated with the dairy operation, efficiency in the case of labor force, methods of handling

forage and manure, investment and other phases of these dairy systems.

PROGRESS: Differences in labor efficiency between open-lot and covered free stall dairy housing was compared. Eight dairy farms of each of the two types of free stall housing were selected for comparison. Units selected were relatively new and of comparable size. Liquid manure was included in 5 of the covered units and 3 open lot units. One complete day per month was spent on each farm measuring the time required to perform the various chores, in addition the operators maintained records on specified tasks. Seventy percent of the total chore time spent on the cow herd was devoted to milking and cleaning equipment. The most efficient milking parlors were herringbone parlors with 4 units per man. Chore time was affected by type of housing, kind of roughage, and method of handling manure. Covered units gained markedly in efficiency when dry hay was eliminated from the ration. Liquid manure increased labor efficiency in covered systems but not in open lot systems. The study showed dairy housing systems of covered free stalls, liquid manure handling and silage feeding to be more efficient than any other system studied.

SUPPORTED BY Michigan State Government

3.0188, THERMOPHILIC METABOLISM IN SOLID SUBSTRATES

M.E. STEPHENSON, Michigan State University, School of Engineering, *East Lansing, Michigan* 48823

With the continued increase in the generation of urban solid wastes, it is imperative that detailed methodology and basic information regarding disposal technology be developed. The sanitary landfill is one of the two generally accepted methods of refuse disposal. To date, research on this system has been conducted almost exclusively through field studies with little definitive laboratory investigation involved. Published field investigations have not provided quantitative information regarding the full extent and composition of the products of decomposing refuse or the generalized kinetics of conversion to a stable condition. Recent field studies indicate that a rapid rate of approach to stability may be obtainnd under aerobic, thermophilic conditions.

Thus, it is the objective of this study to develop a valid laboratory model of the reacting system and to measure both the macro- and micro-components of the products of the decomposition process. As an ancillary objective, this study has resulted in the modification and development of analytical techniques necessary for the determination of the physical and chemical constituents related to the decomposing mass. Practical parameters of stability have been proposed on the basis of this investigation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0189, STORAGE AND DISPOSAL OF WASTES RESULTING FROM THE CONCENTRATION OF LOW GRADE IRON ORE

C.R. BAILLOD, Michigan Technological Univ., School of Engineering, *Houghton, Michigan* 49931

The overall project objective is to improve the applied technology related to the storage, disposal and reuse of water resulting from beneficiation of low grade iron ore. Specifically, the project will: (1) develop basin design and management criteria which recognize the influence of tailings settleability and the effects of hydrological phenomena on pond effluent quality; (2) investigate the physical and transportation characteristics of the supra-collodial particles contained in the tailings basin discharge; and (3) investigate alternative tertiary treatment methods for eliminating the fine particulate materials from the basin discharge with a view toward development of a tertiary treatment system for subsequent demonstrations. The project stems from a current study of mines operated by Cleveland Cliffs Iron Company and associated companies in the Michigan Upper Peninsula. This project will begin in July, 1970, and be completed in October, 1971

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0190, FEASIBILITY OF REGIONAL UTILITIES FOR MANAGEMENT OF INDUSTRIAL AND MUNICIPAL WASTES

B.M. CONBOY, State Dept. of Commerce, *Lansing, Michigan*

The proposed research plan deals with the economic and institutional feasibility of using regional waste services 'utilities' that would assist industry and municipalities in meeting environmental control standards. The utilities would sell waste management services to industry and municipalities for a fee and use revenue bonds for capital expenditures. The political, institutional and technical factors associated with the design and implementations of a utility approach will be investigated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0191, ANIMAL WASTE MANAGEMENT STUDY

E.C. MILLER, Univ. of Minnesota, Agricultural Experiment Sta., *Crookston, Minnesota* 56716

To study flow characteristics of unbedded cow manure in below ground storage tank under various temperature conditions. To study temperature gradients in and around the above system. To study agitation techniques for removal of manure from the tank. To study nuisance level of liquid manure systems with respect to fly control, odor, and safety. To study land disposal application using systems which include liquid spreader tanks and sprinkler irrigation. Observe biological and physical changes of stored liquid manure.

SUPPORTED BY University of Minnesota - Minneapolis

3.0192, STUDY OF ECONOMICS OF HOSPITAL SOLID WASTE SYSTEMS

R.G. BOND, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

Current studies of solid waste handling practices in hospitals have demonstrated a need for a thorough analysis of the economics of such practices. Whereas cost benefit studies in hospitals usually follow the departmental structure of the hospital, solid wastes involve activity in almost every department; therefore, a problem oriented hospital wide study is needed. This study is concerned with the identification, quantificatiom, and evaluation of economic and environmental sanitation constraints of solid waste systems in selected medium size general hospitals.

Present systems involve a large labor force applied to relatively inefficient operation with resulting high costs. Through industrial engineering evaluation techniques efforts will be made to develop more efficient operations - also to determine the critical size of institutions where mechanization, in part at least, is economically feasible and provides an improved system with respect to the sanitation and safety conditions in the hospital.

The study will also attempt to identify the feasibility and benefits of a centralized waste processing system for a cluster of hospitals - just as other hospital operations have benefited from such centralization.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0193, EFFECT OF PHYSICAL ENVIRONMENT UPON MANAGEMENT PRACTICES

R.W. BERG, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-16-034)

OBJECTIVE: Investigate variable factors listed below with regard to achieving satisfactory growth and reproduction in turkeys. Variation of floor condition such as the use of wood shavings litter versus slat floors and other possible techniques for the handling of excrement with its attending problems. Effect of bird density upon floor and/or litter conditions as well as upon growth and reproductive characteristics. Relationship of air movement and temperature control upon efficiency of production with variable bird density and floor conditions.

APPROACH: Broad White turkeys will be reared in confinement with automatically controlled light, temperature and humidity to minimize experimental error due to prior environmental

conditioning. Estimates of air movement required relative to various temperatures and bird density in given pens will be made from which experimental variables will be planned for treatment of the birds.

PROGRESS: Turkey breeder hens were housed on three different methods of floor management, - litter floors, slat floors, and cages, - the same as the previous year except one replicate was rotated in an attempt to control broodiness. Rotation did not solve our broodiness problem but produced an indication that the lower hatchability of fertile eggs was present only for the birds held in cages during the holding period. Turkeys moved from cages to litter the hatchability increased 5 percent or almost as high as the controls. This indicates that something in cage management causes a depression in hatchability that is quickly corrected by a transfer to litter. This must be re- checked. Turkeys held either on litter and slats prior to rotation showed no change in hatchability.

SUPPORTED BY U.S. Dept. of Agriculture

3.0195, LABOR REQUIREMENTS FOR PERFORMING FARMSTEAD WORK ELEMENTS

R.E. LARSON, Univ. of Minnesota, U.S.D.A. Agric. Engin. Div., *Saint Paul, Minnesota* 55101 (313-012-B211)

OBJECTIVE: Develop standard times for farmstead labor and operational elements and develop procedures, equipments and structures that will provide optimum labor use in the farmstead operations.

APPROACH: Identify work elements and establish standard times for existing as well as new operational concepts in livestock production. Establish standard times for work elements by time and motion studies on actual farms, on simulated work elements in the laboratory or in pilot type studies or by adaptation from other systems. These standards will be established as part of an ultimate complete system suitable for analysis of any part, or all, of the farmstead operations. The studies will be conducted in conjunction with waste management research and will be directed to the establishment of efficient procedures for handling of feeds, animals, and wastes in livestock production systems, particularly in the area of beef and dairy cattle housing.

PROGRESS: Studies were conducted to evaluate 3 beef production systems. The systems are: (1) conventional open feedlot, (2) confined slatted-floor unit bunk-fed daily, and (3) confined slatted-floor unit self-fed. The two confinement units are over an experimental oxidation ditch. The labor requirements for the open feedlot tend to be higher for inspection of animals and for animal waste handling. The labor requirements between the slatted floor units show little difference as they require the same labor for filling the feed hoppers or storage bins and the time required for feeding daily in the one unit can be utilized for inspection of the animals on essentially the same basis as is required for the similar duty in the self-fed unit. Less labor is required for loading and for hauling wastes from the oxidation ditch under the slatted floor units. However, this will have to be evaluated with other construction and operation costs of the ditch. Labor for inspecting, cleaning, and servicing waterers can be significant with inadequate design. Gain efficiencies of the three systems are indicated by daily gains of 2.95, 2.65, and 3.07 0/day for the three respective units. The feed conversion rates were 794, 799, and 702 pounds/100 0 of grain respectively for the three systems.

SUPPORTED BY U.S. Dept. of Agriculture

3.0196, EVALUATION OF WASTE HANDLING SYSTEMS FOR HOUSED LARGE ANIMALS IN THE NORTH CENTRAL REGION

R.E. LARSON, Univ. of Minnesota, U.S.D.A. Agric. Engin. Div., *Saint Paul, Minnesota* 55101 (901-031-B613)

OBJECTIVE: Develop technology for efficient handling, storing, utilization and disposal of cattle wastes produced in confinement production systems.

APPROACH: Evaluate systems of handling wastes that include storage during cold weather periods when land disposal is not suitable. The investigations will include studies of oxidation ditches. Rotor design, flowspeed, volume ratio and shape are factors to be evaluated. Investigations will be made of means of separating the solids and liquids for separate handling, storage and treatment. The methods studied will include mechanical separation, thermal dehydration, and structural design to provide separation at the point of deposition. Studies will also be made of the confinement structure and equipment to determine design specifications which will minimize the quantity of bedding added to the wastes.

PROGRESS: The use of an oxidation ditch for waste from beef cattle confinement systems has provided odor-free storage with partial treatment. In a trial conducted October 13, 1969 to April 14, 1970, the dissolved oxygen level was above 1 mg/1 throughout the test, so that aerobic conditions were maintained. The trial was started at a loading rate of one animal per 50 cu.ft. of water. The loading rate at the end of 150 days was one animal per 92 cu.ft., leaving a net waste accumulation of approximately .3 cu.ft. per animal per day. The waste production by animals weighing 600-1100 pounds and fed a ration of 90% rolled corn, 7.5% ground hay, and 2.5% supplement averaged 5.1 pounds of dry solids per day per animal. A measurement of the solids in the ditch on the 148th day of the trial indicated the total solids put into the ditch in that period had been reduced 34%. The BOD of the wastes varied within a range of 900 to 2500 mg/1. The COD increased steadily and reached a maximum of 64,000 mg/1. Foam was not a problem in this study as it was permitted to float around the ditch to return to the rotor where it was physically dissipated by the beating action of the rotor.

SUPPORTED BY U.S. Dept. of Agriculture

3.0197, FARM ANIMAL WASTE DISPOSAL

J.A. MOORE, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-12-060)

OBJECTIVE: Evaluate, under Minnesota conditions, the effectiveness of the Pasveer Oxidation Ditch as a means for treatment and partial digestion of beef animal manures.

APPROACH: Beef animals will be confined on slatted floors under cold conditions. The manure wastes from such animals will enter the Pasveer Ditch located directly beneath the animal confinement areas. The rotor of the ditch will be operated on a continuous basis and measurements made on changes in BOD, pH, dissolved oxygen, temperature, suspended solids, volatile solids, nutrient levels and volumes of influent and effluent. Studies will also be made to determine the reduction in solids volume as a result of treatment within the ditch. Such data are needed to determine practical facility size and time intervals between pumping to field soils for final disposal. Construction for the physical facility needed for conducting the above research is completed.

PROGRESS: Research efforts were directed to the study of manure management of beef cattle housed in solid and slatted floor units. An oxidation ditch was used as the treatment storage method. In November, 18 herefords (690 lbs) were placed on each of the following three units: conventional open lot; insulated structure with solid concrete floor (22 sq.ft./animal); and another identical unit with a concrete slat floor. Waste from both confinement units plus water was put into the ditch to provide a loading rate of 1 animal/38 cu.ft. of liquid. After 223 days, the slurry had a total solids concentration of 11.3% and was too viscous for adequate reaeration and circulation. During this test a liquid volume increase had changed the loading rate to 1 animal per 80 cu ft. Results indicate that the batch oxidation ditch system can treat and store cattle manure through a Minnesota winter. Major foaming problems have been eliminated. Studies are presently being continued at a loading of 1 animal/50 cu.ft. Models are being used to study some of the engineering parameters of the system and the fate of pathogens shed with the cattle waste into the oxidation ditch. Handling and storage of waste from 60 dairy cattle is being studied in a 90'x30'x8' concrete tank in Northern Minnesota.

SUPPORTED BY Minnesota State Government - Saint Paul

3.0198, MATERIALS HANDLING SYSTEMS FOR NORTH CENTRAL FARMS

J.H. POMROY, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-12-078)

OBJECTIVE: Establish design criteria of elements for handling agricultural materials.

APPROACH: Three types of housing will be considered: (1) confinement on concrete slab, (2) confinement on concrete slats, (3) open housing with minimal shelter. Twenty head of beef type calves will be fed to market weight under each type of management. Two methods of manure handling within the structure will be considered, (1) soil floor, no bedding, semi-liquid, sloping gutter, and (2) slat floor over an oxidation ditch. Observations will be made of (1) the effectiveness of the oxidation ditch under severe condtions, (2) the conditions on the slats and on the solid floor, and (3) the effect of the oxidation ditch on the environmental conditions, (relative humidity, odor and temperature in particular), in the structure above and on the health of the animals.

PROGRESS: Four trials have been conducted in the pilot-sized units for the study of materials handling and labor requirements of beef cattle under three systems of management, (1) conventional (2) slatted floor total confinement, (3) solid floor, total confinement, slatted gutters. Labor for feeding is limited to that required to fill feeding hoppers every 10-13 days. No labor required for waste handling from the slatted floor. Automated hydraulic flushing of gutter eliminates labor for cleaning solid floor slatted gutter unit. However, flushing water comes directly from the oxidation ditch and contains too much solid material. A holding tank or settling basin is needed to separate solids from liquid for flushing. With the same uniform width slats, 1 1/2' slat spacing stays cleaner than 1 1/4' slat spacing.

SUPPORTED BY U.S. Dept. of Agriculture

3.0199, CROP RESIDUE DISPOSAL

R.F. COLWICK, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-1-200-0308)

OBJECTIVE: Establish design criteria for crop residue disposal machines with primary emphasis on cotton.

APPROACH: Research will be conducted in several phases in order to best utilize funds and personnel available. First phase will be concerned with determining maximum size stalk and root pieces that can be tolerated without disturbing precision and timeliness of planting and weed control equipment in light and heavy soils. Second phase will determine relationship of particle size to rate of decomposition so that size of shredded material in the fall can be related to that remaining at planting time. Third phase will be a study of physical properties of cotton plant and their relationship to disposal forces. This will include such variables as time of shreeding, soil physical condition, mositure of stalk, strength of stalk, root extraction forces, soil tenacity, and angle of root extraction.

PROGRESS: Analysis of data on the 1968 test to determine the influence of length, size, and depth burial on the decomposition rate of cotton stalks was completed. Residue leaf on the surface decayed least, and there was a tendency for better decomposition at the four inch depth of burial than at two inches and six inches, but there were no differences in decayed strength due to length of pieces or soil type. Root sections decomposed slower than any other plant sections, and after decomposition exhibited greater strength than any other plant section for a common diameter. The tendency of residue to interfere with planting accuracy was measured in the field this year by measuring the uniformity of planting depth with several sizes of crop residue. Agreeing with previous soil-bin tests, the 3 inch and 6 inch length residue caused less interference than the 9 inch. Differences in planting depth were harder to detect in the field, but uniformity and rapidity of seedling emergence indicated less interference from the shorter-cut residue. Loosening the surface of the seedbed immediately ahead of planting tended to reduce interference of residue with seed covering. Based on these tests, design criteria for disposal equipment should include provisions for reducing the root and main stem sections to range of 3 inches to 6 inches in length and burial depth of 2 to 4 inches.

SUPPORTED BY Mississippi State Government

3.0200, SOURCES OF TRASH IN COTTON HARVESTING

G.L. BARKER, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUM-0004)

OBJECTIVE: Determine sources of contamination of seed cotton and means for reducing trash in mechanical picking; investigate methods of removing trash during picking operation.

APPROACH: Determine soruces of contamination of cotton lint by using highspeed movies, field tests, and other tracers. Design means of eliminating this trash from the picked sample.

PROGRESS: Laboratory picker investigations have shown considerable trash floating freely or loosely attached to the seed-cotton in the picking zone. Experimental fingers and an air blast system were designed to fit between the picking and the doffing zones in a regular tapered-spindle picker. The fingers and air blast system showed considerable promise in the laboratory but did not work well in the field. In studying the effectiveness of picker basket grates, seven different experiment designs were compared with standard grates. These different designs consisted of rear-ranged expanded metal strips, 1/8' x 1/2' flat strips, 1/4' round stock, and different sizes of expanded metal. The grate made of 1/2 x 1' flat expanded metal, with the diamond turned perpendicular to the flow of cotton proved superior with respect to trash buildup and cleaning ability. A seedcotton cleaning attachment for a tapered spindle cotton picker was developed, using an adaptation of the USDA-developed stick remover in cotton gins. From a mechanical standpoint, the cleaner worked very well and required only slight modifications in the intake and exhaust areas. The total trash content of the seed cotton that had passed through the cleaner was 20 percent less than the trash content of cotton which bypassed the cleaner.

SUPPORTED BY Mississippi State Government

3.0201, DEVELOPMENT OF EQUIPMENT AND TECHNIQUES FOR CROP RESIDUES

J.R WILLFORD, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUM-0006)

OBJECTIVE: Develop, test, and improve equipment and techniques for crop residue disposal.

APPROACH: New shredding devices offered by farm machinery manufacturers will be field tested and an evaluation of their efficiency in total destruction of the old crop will be made. Modifications of present machines will be made and combinations of soil-working equipment and stalk shredding devices will be used in an attempt to incorporate crop disposal operation with primary tillage.

PROGRESS: Further progress was made in developing a low-cost method of removing cotton stalk roots simultaneously with stalk shredding operations. Performance of the 16-inch high-lift sweep used in previous studies was increased by mounting the sweeps on a two-row heavy-duty rotary cutter equipped with three-point hitch. A coulter was also added to reduce lateral movement of the sweeps and aid in centering the machine over the row. Maximum efficiency in removing root stubble was achieved when the sweeps were set to operate at a depth of approximately 3 inches. The machine performed satisfactorily in both dry and moist soil. Over 96 percent of the stubble was removed in field tests on Bosket fine sandy loam. The use of this machine will eliminate one operation with a disk harrow and may help reduce insect populations in cotton fields.

SUPPORTED BY Mississippi State Government

3.0202, CONDITIONING AND CLEANING MID-SOUTH COTTON VARIETIES

V.P. MOORE, U.S. Dept. of Agriculture, Cotton Ginning Research Lab., *Stoneville, Mississippi* 38756 (308-035-C104)

OBJECTIVE: Develop, test, and evaluate methods, practices, and systems for better preserving the inherent quality of cotton during drying, humidifying, and trash removal operations incident to ginning.

APPROACH: Evaluate existing cleaning and newly developed conditioning methods as to their efficiency and effect on cotton quality. Based on these observations and data, investigate new principles which show promise for more effective trash removal and reduce quality degradation. Evaluate under commercial conditions these methods and practices which prove of value in the laboratory prior to making recommendations to the industry.

PROGRESS: Split versus series lint cleaning gave similar grades for each treatment at normal and low moisture levels with no differences in span length and yarn tenacity. Increased clean-

ing efficiency of split stream over single stage lint cleaning is due to reduced loading and not increased combing ratio. Increasing lint cleaner feed rate decreased cleaning efficiency,waste removed, and bale value. Strobe photos show that lint cleaner saws are not loaded uniformly. A linear relationship exists between log of electrical resistance and log of equilibrium moisture regain for lint. A partial vacuum drier proved to be impractical for commercial use but should be useful as a research tool. One 6 cylinder cleaner plus doublestick machines gave best overhead cleaning results. Seed cotton cleaning efficiency decreased as feed rate increased. Picker twists cause grade reduction. Current design of a self-cleaning magnetic separator proved to be unsatisfactory.

SUPPORTED BY U.S. Dept. of Agriculture

3.0203, IMPROVE METHODS, EQUIPMENT & FACILITIES FOR HANDLING WASTE MATERIAL FROM LIVESTOCK MARKETS & FEEDLOT

H.F. MAYES, Univ. of Missouri, U.S.D.A. Transp. & Facil. Div., *Columbia, Missouri* 65201 (TF2-159A)

OBJECTIVE: Develop improved methods, equipment, devices and facilities for handling the waste materials from livestock markets and commercial feedlots.

APPROACH: Conduct engineering studies on livestock markets and commercial feedlots to determine current handling methods and labor and equipment requirements and costs. Evaluate adequacy of handling and disposal of waste materials concerning such problems as odor control, air and water pollution, and meeting Federal, State and local sanitation regulations. Develop operating criteria for more efficient handling of waste materials at reasonable costs.

PROGRESS: On this project, approved during the fiscal year, progress was limited to determining how the livestock marketing industry is disposing of its animal waste materials, current problems in disposing of this waste material, and current problems associated with runoff from holding pens and other uncovered areas. Some of the current disposal methods include dehydration, landfill, spreading on land, and lagooning. In dehydration, some of the existing problems are air pollution, handling required to stockpile and turn, runoff from stockpiles, operation of dehydrators, and excessive power requirements of dehydrators. Landfilling problems include handling of waste material, possible pollution of underground water, and odor. Spreading on land is not practical in some areas because livestock producers are afraid of disease organisms, and because grain producers are concerned with noxious weeds. Where spreading on land is practiced, because the waste material is spread only in late fall and during the spring means the waste material must be stockpiled. Hauling and spreading involves the use of large trucks which can traverse the land only when it is dry enough to support the trucks. Runoff from non-covered pens and other non-covered facilities is entering natural waterways and streams. This runoff is considered a pollutant by many State water pollution boards. The amount of the various pollutants in this runoff must be determined if methods of disposal are to be developed.

SUPPORTED BY U.S. Dept. of Agriculture

3.0204, EFFECT OF PRESYNTHESIZED BIOLOGICAL INTERMEDIATES ON SUBSTRATE UTILIZATION RATES

J.T. NOVAK, Univ. of Missouri, School of Engineering, *Columbia, Missouri* 65202

The proposed research plan involves an investigation into the free energy utilization and substrate removal rates in an anaerobic biological treatment units. In this study, presynthesized biological intermediates will be added to the unit to determine their effect on biological growth rates.

In the first phase of the study, micro quantities of selected amino and fatty acids will be added to methane bacteria to determine if these materials can be assimilated directly by the cells as building blocks for new cells.

The second phase of the study will be to demonstrate the practical application of this technique to field units. Effluent biomass will be destroyed by sonication and the fragmented cell parts recirculated to provide necessary cellular materials for growth stimulation.

Results from this study will be used to demonstrate the fundamental difference between pure substrate laboratory studies and field units receiving mixed organic materials; and may serve as a basis for upgrading present biological waste treatment design criteria.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0205, ENGINEERING GEOLOGY IN COUNTY PLANNING

J.H. WILLIAMS, State Geol. Survey & Wa. Reso., *Rolla, Missouri* 65401

Maps and description of soil and bedrock outline major surface features that could effect urban growth, including waste disposal and lake development.

Completion of soil and geology map data, supplemented by field work.

SUPPORTED BY Missouri State Government

3.0206, RECOVERY OF MINERAL MATERIALS FROM SELECTED PROCESSING WASTES

A.A. COCHRAN, U.S. Dept. of the Interior, Bureau of Mines, *Rolla, Missouri* 65401

To develop economical processes for recovery and reutilization of metals and minerals from liquid or slurry wastes generated by metal processing and electroplating industries.

Initiate research on extraction and recovery of nickel, chromium, vanadium, cobalt, and other valuable metals from wastes such as stainless steel pickling sludges.

Conclude research on recovery of vanadium, indium, silver, and molybdenum from vanadium extraction plant wastes.

Conclude research on the recovery of metal from cyanide and nitric acid electroplating wastes. Continue investigations on recovery of metals from spent silver electroplating baths, chromic acid etching solutions, and other industrial electroplating wastes. Major emphasis will be on treatment of alkaline, organic-cyanide rack-stripping and etching wastes, followed by the recovery of chromium, nickel, copper, and an aqueous effluent that can be safely discarded to streams.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0207, MICROBIOLOGY OF SLUDGE - DNA ANALYSIS AND N2 REMOVAL

R.L. IRGENS, Southwest Missouri State Coll., Graduate School, *Springfield, Missouri* 65802

We are in the process of developing a method whereby DNA may be extracted from activated sludge floc. Having perfected this method, the possibility of using DNA concentration as an estimate of the viable bacterial population of activated sludge floc will be determined. The relationship between the quantity of DNA, the oxygen uptake and the concentration of volatile solids will be investigated.

We are presently comparing denitrification by activated sludge floc at two temperatures, 23 degrees C and 45 degrees C.

Future projects involve the investigation of nitrogen removal in waste treatment at near zero temperatures and the relationship between oxygen tension and denitrification at these temperatures.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0208, FEED AND WASTE REMOVAL STRUCTURES FOR LIVESTOCK

C.M. MILNE, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715 (MONB00106)

OBJECTIVE: Develop feeding facilities for feeding livestock in a confined area, and to store liquid manure or waste at low temperatures.

APPROACH: Develop feeding facilities for beef cattle using free stall open housing and slotted floors. Assemble necessary equipment to pump liquid manure and to spread liquid manure in the field. Make an economical study of the entire system.

PROGRESS: During the 1968-69 winter feeding period, a stationary chopper was incorporated into the system at the outdoor slotted-floor feed lot. This effort was undertaken as a final

attempt to evaluate the practicability of outdoor slotted floors for beef cattle fattening under severe winter conditions. The 1968-69 winter feeding period was particularly severe with heavy snow and temperatures reaching the -40 F range. During the particularly severe weather, the slot openings plugged up, resulting in manure buildup approximately equal to that in the adjacent solid-floor pens. Despite the severe conditions imposed by the large amounts of bedding and hay in the manure pit, no great difficulty was encountered in cleaning the pit. Techniques have now been developed so that the pit can be satisfactorily emptied using commercially available equipment. Due to the belief of animal scientists that cattle could not tolerate a no-bedding condition under local winter-time conditions, all tests run during the project have incorporated relatively large amounts of bedding. Considerable time and effort was spent in evaluating manure-handling systems in feedlots throughout Montana, preparatory to a major project revision to be proposed in the near future.

SUPPORTED BY Montana State Government

3.0209, EVALUATION OF MEAT ANIMAL HOUSING SYSTEMS IN RELATION TO POLLUTION

T.E. BOND, U.S. Dept. of Agriculture, Agricultural Engin. Res. Div., *Clay Center, Nebraska* 68933 (901-031-B614)

OBJECTIVE. Abate pollution through improved design of meat animal housing systems.

APPROACH. Systems of housing and management will be developed to reduce the pollution potential of livestock production, and increase the efficiency of animal waste handling and disposal. The influence of such factors as surface materials, floor slope, degree of shelter enclosure, animal space, feeds, feeding methods, ventilation, and climate will be investigated in systems ranging from open feedlots to completely enclosed confinement housing. Evaluation will be measured by the amounts of dust odors, insect pests, runoff and subsurface water pollution, and by animal health and productivity.

PROGRESS.

SUPPORTED BY U.S. Dept. of Agriculture

3.0210, DAIRY HERD MANAGEMENT

R.D. APPLEMAN, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-13-035)

OBJECTIVE. Develop supplemental record-keeping programs to complement current DHIA programs. Compare systems of livestock housing and feeding, including waste disposal and disease prevention. Study impact of mechanization on labor utilization.

APPROACH. Evaluate devices for milk weighing, sampling and testing which may meet present DHIA standards. Each device will be tested on two consecutive milkings of at least 25 cows. The project leader will work closely with one or more commercial DHIA computing centers in the development of a suitable mechanized record-keeping systems encompassing the health and reproductive status of both the young and producing stock. Daily milk weights and weekly milk composition data will be obtained. Individual calf shelters for raising calves outdoors will be compared to conventional calf-raising systems utilizing individual pens in a controlled indoor environment. Various feeding programs, methods of disease control and economic consideration will be included. Milking vacuum level, milking vacuum stability, type of liner used, length of liner life, pre-milking sanitation practices, and teat-dipping after milking will be investigated.

PROGRESS. Three different milk metering and sampling devices (Milk-O-Meter, Tru-Test, Waikato) were evaluated. The observed accuracy of two Tru-Test meters, expressed as a percentage of true scale weight, averaged 99.5 and 100.0% and were recommended for approval. Weekly milk weight milk fat data were collected from fresh cows in three different herds to determine the influence of time from freshening to first test on the accuracy of DHIA records. Herd differences are apparent, with positive errors in estimated fat production occurring in all herds when cows are first sampled within 25 days of freshening. Radiographs of the teat streak canals of 105 lactating cows were obtained to determine the factors influencing anatomical changes of the teat-end and its importance in the incidence of mastitis. Increasing age and advancing stage of lactation resulted in dilated teats. The correlation of these traits to either rate of milk flow or udder health was low. Studies indicate that early weaned calves can be successfully fed once daily with milk replacer or with cold milk. Colostrum was superior to whole milk.

SUPPORTED BY U.S. Dept. of Agriculture

3.0211, INFLUENCE OF CERTAIN HOUSING AND MANAGEMENT REGIMES ON CONFINEMENT REARING OF GROWING FINISHING PIGS

R.D. FRITSCHEN, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-42-001)

OBJECTIVE. Compare the effects of open versus closed growing- finishing buildings in a one-and-two-unit production system; determine the amount of slotted floor required for optimum performance; determine optimum pen size and shape; evaluate economically the implications of several confinement systems; observe and study manure disposal procedures; evaluate ventilation systems.

APPROACH. Insulated, environmentally regulated buildings are compared with uninsulated, semi-open front buildings. Four buildings are of concrete block and two are precast concrete panel construction. Three replications of pens with 25, 50, 75 and 100 percent of total pen floor area slotted are compared. Environment (temperature, humidity, air flow) in each unit will be measured by sensing equipment. Economic components (i.e. electricity, gas, labor) will be measured per unit. Carcass data including bone breaking strength are measured.

PROGRESS. The completion of four additional growing-finishing (G/F) research production units and utility building in May 1969 brought the building total to seven six research units plus utility building. A test including 480 G/F swine (Aug. 8-Dec. 12, 1969) indicated that swine grown in an environmentally regulated (ER) unit do not have a greater rate of gain expression than those in an unheated, uninsulated modified open-front (MOF) unit. However, pigs grown in an ER environment had a 6.2 percent improvement in feed efficiency. No difference was noted between pigs grown to 100 lbs. to market wt. swine grown in semi-exposed confinement gained slower (8.1 %) and required more feed (12.3 %) than those in an ER unit. The decreased response in performance is largely thought to be due to more severe ambient weather. The slat to solid floor types studied revealed a slight linear response in favor of less slatted area in the open and modified open front units. Tissue studies indicate that stomach tissues do undergo unfavorable changes such as ulcers when grown under the described conditions. Lung and metatarsal bones are also being used as response criteria.

SUPPORTED BY Nebraska State Government

3.0212, WASTE MANAGEMENT, CONTROL, AND DISPOSAL IN MIDWEST BEEF FEEDLOTS

C.B. GILBERTSON, Univ. of Nebraska, U.S.D.A. Agric. Eng. Res. Div., *Lincoln, Nebraska* 68503 (901-031-B608)

OBJECTIVE. Develop beef feedlot criteria for design for economical waste management and disposal with effective pollution control.

APPROACH. Investigate systems of animal waste disposal that can be adapted to existing feedlots to prevent contamination of water by the run-off. The investigations will include studies of hydraulic settling channels or basins from which solids can be removed frequently, basins of larger area and longer retention to allow settling out of suspended solids for more infrequent removal and with the liquids siphoned to an evaporation pond. Studies will be made of the use of reverse slope dirt lots with feed bunks and apron located on the low side. In this type layout the apron will serve as a collection and clean out area and will be connected to a liquid control system. The method and equipment necessary for mechanical management of the wastes during dry periods will be also included in these studies.

PROGRESS. Solids Accumulation on Outdoor Feedlots: Dry matter cleaned from outdoor feedlots averaged 1.42 and 2.26 tons per acre-day for lots with animal densities of 200 and 100 sq. ft. per animal, respectively. About 34% of the dry matter was volatile. Total N averaged 29 lb. per ton dry matter. Runoff

Quantity and quality of runoff appeared to be more dependent on rainfall than feedlot slope or animal densities. An estimating equation based on all treatments was Runoff 0 0.531 (Precipitation) - 0.135. Winter thaw runoff concentrations were about 10 times the rainfall-runoff concentrations. Rainfall-runoff transported an average of 1.6 tons dry matter per ac-in. About 50% of the transported material was volatile. N and P transported averaged 100 and 13 lb. per ac-in., respectively.

SUPPORTED BY U.S. Dept. of Agriculture

3.0213, MANAGEMENT OF CATTLE FEEDLOTS AND ANIMAL WASTES FOR CONTROL OF SOIL WATER AND AIR POLLUTION

T.M. MCCALLA, Univ. of Nebraska, U.S.D.A. Soil & Wa. Cons. Div., *Lincoln, Nebraska* 68503 (SWC-026-DLI-2)

OBJECTIVE. Measure the magnitude of soil, water and air pollution from existing systems of cattle feedlot management and develop scientific principles and engineering designs for the effective control of pollution by runoff and deep percolation of water, and volatilization into the air, and the efficient disposal of animal wastes on agricultural land.

APPROACH. Laboratory and field investigations, often on a small watershed basis, will be conducted to determine the extent of pollution of runoff and ground water by organic substances, phosphate, nitrate, and harmful organisms on the range of site and feedlot management conditions now used. New systems will be designed and tested for more effective control of runoff and management of the water balance of the feedlot for on-site disposal. Field studies will be conducted to determine how much and when animal wastes can be applied to soils to effectively use the waste as a resource for crop production without contaminating soils and runoff and underground water.

PROGRESS. Four commercial cattle feedyards in eastern Nebraska have been completely instrumented to measure precipitation and runoff. Vacuum lysimeters and access cylinders have been installed to measure quantity and chemical quality of percolate. One feedyard was bench- terraced to evaluate the practice for retention of runoff. At Gretna, on a 5% slope, about 0.5 inch of rain is needed to initiate any runoff, but 1 inch is needed if the surface is very dry. Most of the turbidity and offensive odor and taste of runoff can be eliminated by treatment with alum and a cationic polyelectrolyte. On a flat, uncleaned feedlot no percolation of nitrate into the shallow water table apparently occurs. High methane and CO(2) concentrations occur in the soil air under the feedlot, but not under cultivated fields at the same depth. Preliminary data show that ammonia, amines and organic acids volatilize from feedlot surfaces. Comprehensive data on composition of feedlot runoff from different management systems were obtained.

SUPPORTED BY U.S. Dept. of Agriculture

3.0214, UTILITIES IN PERMAFROST FOR MILITARY INSTALLATIONS

S.C. REED, U.S. Army, Cold Reg. Res. & Engin. Lab., *Hanover, New Hampshire* 03755

Technical Objective. To develop new and improved criteria for design and construction of utilities for military installations in permafrost areas, including water, fuel and electric supply, fire protection and waste treatment and disposal systems.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0215, EXPERIMENTS TO DETERMINE THE EFFECTIVENESS OF PHOSPHATE REMOVAL BY MEANS OF THE MOVING BED FILTER

G.R. BELL, Johns Manville Corporation, *Manville, New Jersey* 08835

The effectiveness of the Moving Bed Filter will be determined for the removal of suspended solids and phosphate removal as compared to conventional methods. The Moving Bed Filter (15,000 gpd) will be installed at a typical waste treatment plant to optimize the flocculation and filtration procedures for phosphate and solids removal. Design and engineering data will be developed for a fullscale installation. Estimates of the capital and operating costs for various sizes of plants also will be made.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

3.0216, VOLUME REDUCTION AND STABILIZATION OF WASTES FROM SWINE

H.E. BESLEY, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (901-031-B615(CA))

OBJECTIVE. Develop technology for the use of composting methods for volume reduction and stabilization of wastes.

APPROACH. Determine characteristics of the wastes from the animals, incidental bedding, and feed. Characteristics will include moisture content, plastic materials, metals, glass, bacteria, molds, fungi, BOD, nitrogen and others as necessary. Studies will be made of the biological and chemical changes occurring in the process as influenced by various characteristics. Evaluations of handling methods for both the raw wastes and the processed material will be made in a search for technology for reducing the potential of the wastes to pollute the surrounding air and water. Utilization and/or disposal of the processed materials will be the aim of studies of its use for lawn or field application or of its disposal in sanitary landfill.

PROGRESS. A Roto-Shredder was obtained and tests started August 18, 1969 with two windrows of swine waste 12 feet wide, 6 1/2 feet high and 120 feet long. This trial was designed to develop the techniques of composting hog wastes and to become familiar with the operation of the machinery. Windrows were turned twice a week for the first two weeks, then once a week through December 30. The original material was high in moisture content. Temperatures were slow to rise during this period. Heating occurred in all parts of the windrows through the third and fourth weeks, rising to 150 F. This temperature persisted until turning was stopped December 30 (17 weeks). Characteristics of bacteria, fungi, etc., were not observed during this trial; analyses of these characteristics are planned for the next trial. The odor of the original material was quite offensive. This changed afterthe fourth and fifth week to a musty odor. Later in the process the material took on a dark brown color with an earth-like odor. When turning was stopped (after 21 weeks), the windrows were 9 feet wide, 2 1/2 feet high and 120 feet long, showing a reduction in volume. The nonbiodegradable materials, such as plastics, still create a problem and a means of screening and disposing of them must be determined.

SUPPORTED BY U.S. Dept. of Agriculture

3.0217, POULTRY MANURE DISPOSAL BY PLOW FURROW COVER

H.E. BESLEY, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00903)

OBJECTIVE. Explore the limitations of the plow-furrow-cover method of disposal of poultry manure and to investigate the pollutional effects upon the ground water and the soil.

APPROACH. Present equipment used in the plow-furrow-cover method will be reelevaluated and modified or new equipment developed for use in this project. The amounts, frequency of application, and length of time that poultry manure may be disposed of in the soil will be disposed of in the soil will be determined and the chemical, physical and biological changes occurring in the soil will be measured. Factors which limit the prolonged use of soil as the disposal medium will be evaluated and the performance of soil as disposal media will be correlated with loading regime and soil characteristics.

PROGRESS. The plow-furrow-cover (PFC) method of waste disposal is a technique for incorporating slurries and semi-solid wastes into the aerobic layer of the soil in a relatively odor-free and pest-free manner. To apply wastes by the PFC method, various components of equipment have been developed and demonstrated. Poultry manure was PFC applied to test plots of Freehold loamy sand in amounts equivalent to 0, 15, 30 and 45 tons of dry solids per acre. The soil was not cropped. An analysis of lysimeter samples showed downward movement of elements of 36 and 48 inch depths without high concentrations in 4 to 7 months. However, 12 to 15 months after the application some high nitrate,

sulfate and TOC concentrations were measured down to the 48 inch depth. In a laboratory examination of poultry manure samples obtained from commercial farms it was observed that approximately 30% of the samples contained Salmonella.

SUPPORTED BY New Jersey State Government - Trenton

3.0218. REMOVAL OF PHOSPHATE FROM WATER BY ALUMINUM AND IRON

P.H. HSU, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00085)

OBJECTIVE: Study the reaction mechanism between phosphate and aluminum or iron, and define the optimum conditions for removal of phosphate from water.

APPROACH: Using wet chemical and diffraction techniques, studies will be made of the nature of the phosphate-removing cations (Al or Fe), their concentration, the concentration of phosphate, ratios among these, various sources of cations, the presence of other components, and additional factors.

PROGRESS: The ultimate objective of this project is to develop an effective and economic process for removing phosphate from water and sewage by aluminum or iron. The research activity was started from a study of several simple systems containing AlCl(3), NaH(2)PO(4) and NaOH only, with an objective to understand the fundamental reaction mechanism between aluminum and phosphate. Experimental results indicate that positively charged hydroxy-aluminum polymers are the species accounting for the precipitation of phosphate. Phosphate was effectively and immediately precipitated from solution when the polymers were completely neutralized of their positive charges by phosphate ions, but the precipitation of phosphate was much less effective either prior to or after this point. On the basis of the information, the dosage of aluminum must be critically controlled in any practical process of phosphate removal. This trouble, however, can be overcome by the addition of sulfate or kaolinite as coagulation aid. Montmorillonite can also be used as coagulation aid, but it is difficult to reduce the final phosphate concentration to lower than 2 ppm. Fluoride, on the other hand, indicates detrimental effects.

SUPPORTED BY New Jersey State Government - Trenton

3.0219. SOLID AND LIQUID WASTES

A.J. KAPLOVSKY, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00531)

OBJECTIVE: Characterize and identify the microorganisms that initiate floc formation during an activated sludge start-up period.

APPROACH: Study to establish the chemistry of colorimetric reaction between phenolic compounds and 4-aminoantipyrine.

PROGRESS: Study indicated that activated carbon adsorption data from wastewater and plant effluents do not fit either Freundlich or Langmuir isotherms but data allowed for interpretation by semi-log method. Influent organics are more efficiently removed than effluent organics, and reduced organics more readily removed than oxidized organics. The role of flow rate on benthal oxygen demand was investigated and found to be a complex relationship between oxygen supply effects, detention time, and turbulence. Composting will be carried out in continuous steady state, bench composter. Will monitor and measure temperature, air flow, oxygen utilization, carbon dioxide evolution and substrate feeding rates. At steady-state microbial population study will be made. Gravitational electrodialysis extended to industrial wastewaters. Technique did not result in detailed information but technique used in conjunction with adsorption, chemical treatment with lime, ion exchange and reverse osmosis can provide picture of wastewater characteristics. Work underway to determine effect of wastewater treatment processes on molecular weight distribution of wastewater soluble organics by Sephadex filtration.

SUPPORTED BY New Jersey State Government - Trenton

3.0220. SOLID AND LIQUID WASTES - TREATMENT

A.J. KAPLOVSKY, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00532)

OBJECTIVE: Determine chemical composition of substrate in bulking of activated sludge; biodegradability of commercial and experimental detergents and effects of same on operation and efficiency of sewage treatment process and plant; evaluate principles of simultaneous enzymic adaptation and induction and repression of enzymes in mixed bacterial populations involved in waste treatment process.

APPROACH: This work will be performed in model systems in laboratory and in nearby municipal waste treatment plants.

PROGRESS: Disc system exploits activities of attached biological growths on closely spaced rotating discs alternately submerged in wastewater and exposed to air for high degree removal of organic matter and oxidation of NH(3)-N. BOD and SS reductions exceed 90% after 1 hour contact time. Chlorine demands low (1 mg/1) after 10 stages. Surfactants 1 mg/1 after 8 stages. Die-off studies reveal importance of moisture and temperature in relationship to persistence of Salmonella in poultry manure. Pathogen isolated from dried excreta after 148 days but not found in wet excreta at 30 C after 8.6 days. Changes induced by ionizing radiation will be evaluated for enhancing subsequent solids waste handling processes. Sludge digestion - analysis system designed, constructed and tested. Studied factors affecting persistence of Salmonella in avian residues from poultry operations. Initial increase in organisms observed upon addition. Die-off curves show organisms supported longer in turkey and duck excreta as compared to chickens. Aerated manure slurries studies through sludge age, sludge volume index and volumetric loading. Only volumetric parameter of cu.ft. of aeration tank capacity/0 BOD applied was responsive to operational changes. Long term poultry manure soil decomposition followed through nitrogen transformations. Data showed 60% nitrogen loss after 214 days. No nitrite or nitrate in soil observed. N(2) loss most likely gaseous.

SUPPORTED BY U.S. Dept. of Agriculture

3.0221. HANDLING AND DISPOSAL OF POULTRY MANURE

C.H. REED, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00568)

OBJECTIVE: Determine a practical and economical method of disposing of poultry manure by using soil as active stablizing agent.

APPROACH: One of the first methods to be investigated will be a sanitary land-fill method, or perhaps modifying it to some type of soil covering technique.

PROGRESS: During the last 5 years the testing and modification of 5 prototypes of tank trailers have established the performance requirements and many of the detailed specifications for farm equipment for the plow-furrow-cover method of waste disposal. Farm tractors are the power source for these two-wheel tank trailers, plow being mounted on either the trailer or tractor. Each of the tank trailers has limitations on the solids content of the liquid manure which it can load or unload. The most versatile unit for unloading is not equipped to self-load. Field testing was continued this year and specifications are nearly completed for this type of equipment. Plans have been initiated for a self-propelled highway transport with interchangeable components which will function as follows: 1) Load or unload any biodegradeable slurry or semi-solid waste with up to 30% solids; i.e. poultry or animal manures with bedding, municipal sewage sludge, or industrial waste sludge. 2) Plow-furrow-cover. 3) Inject beneath sod. 4) Spread on the land surface. It is hoped that this new component can be integrated with many waste disposal systems in which waste is stabilized in the soil and utilized in plant growth cycles.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY New Jersey State Government - Trenton

3.0222, CIRCULAR DAIRY BARN

M.E. SINGLEY, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00570)

OBJECTIVE: Construct and study in operation a self-feeder silo- milk production center for 40 animals, study performance of dairy animals when self-fed from silo containing a specification feed, and study the nature of forage production and supplementation required for specification feeds.

APPROACH: Construct milk production center with 18-foot diameter silo, 60 feet tall; a 6-foot wide feeding platform; a 7-foot wide manure alley and free stalls 7 feet long contained in a circular building 60 feet in diameter. Records will be maintained on labor requirements in the center, power requirements and bedding requirements. Manure disposal system will be constantly evaluated. Feed consumption will be recorded daily and related to milk production. Yield of forage crops will be recorded and analysis of the forage will be made prior to storage and supplements added as necessary to meet feed specification. When fed, each forage will be again analysed to determine feed value losses.

PROGRESS: The barn was occupied on January 9, 1969. Most systems have worked well. Operation of the self-feeder silo has not been completely satisfactory. Very short cut alfalfa haylage with a high rate of corn meal additive cannot be supported. Corn silage has performed fairly well. Adjustments of the length of cut of the material and of the support elements are being made to resolve these problems. Measurements of the loads on these elements are being made. Several techniques of flushing the liquid manure have been tried. This system has been improved by increasing the height of the gates from 12 to 18 inches. Keeping the trench full to an 18-inch depth with water and allowing manure to float off over the top seems to work well. The storage tank has been emptied several times and the emptying system seems satisfactory. The ventilation system has performed well. Temperatures are being monitored. Condensation only occurs when the animals return to a cold barn. In the summer months, ambient temperatures in the barn are maintained within 2 F. of outside air temperature. The air conditioning has not been installed.

SUPPORTED BY U.S. Dept. of Agriculture

3.0223, DISPOSAL AND UTILIZATION OF DAIRY AND POULTRY MANURES BY LAND APPLICATION

J.E. STECKEL, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00064)

OBJECTIVE: Develop and evaluate disposal and utilization systems for land application of treated and untreated dairy and poultry manure that will minimize the pollution of water, soil and air.

APPROACH: Study the application of liquid poultry manure by plow- furrow-cover and sub-sod injection methods; analyze soil samples for mobility of Ca, Mg, Na, K, NH(4), Cl, NO(2), SO(4), PO(4) and carbon thru the soil profile; determine changes in soil physical conditions; determine the decomposition rates under various loading and different temperatures; and determine the survival of salmonella in soil and seek information to minimize the dissemination of this organism through disposal by land application.

PROGRESS: Poultry manure was PFC applied 6 to 7 inches into Freehold loamy sand soil (20% clay in the B horizon). The soil was not cropped. Soil-water was sampled with suction lysimeters. Samples collected on 10/24/68 (131 days and 17 inches of rain after PFC) show a downward movement of K, Ca, Mg, Na, NO(3) NO(2)-N, Cl, and SO(4). Increased concentrations of these elements were found at 36 inches soil depth but not at 48 inches. Subsequent soil-water samples taken on 7/1/69 (391 days and 50 inches after PFC) show considerable increase in concentrations at 36 and 48 inches. NO(3) NO(2)-N concentrations on the zero, 15, 30, and 45-ton water-free poultry manure treatments were 1, 90, 290, and 700 ppm at 36 inches and 10, 250, 590, and 450 ppm at 48 inches respectively. The amount of element dissolved in the soil water in an acre for 5 soil depths has been calculated and summed for the 9 to 48-inch soil depth. For the 7/1/69 sampling, the sums of 25, 215, 590, and 1090 pounds of nitrogen (as NO(3) NO(2)/acre) were found dissolved in the soil water in the 0, 15, 30 and 45-ton PM treatments respectively. Similar trends exist for K, Ca, Mg, Na, Cl, and SO(4). Disposal of large amounts of poultry manure into soil by PFC has caused large increases in the concentrations of elements in the soil water. Soil-water samples will be taken next year to determine when or if the element concentration reaches a maximum and starts to decrease.

SUPPORTED BY U.S. Dept. of Agriculture

3.0224, REMOVAL OF BOD AND NUTRIENTS BY BIOLOGICAL SLIMES

W.N. TORPEY, Rutgers the State University, Graduate School, *New Brunswick, New Jersey* 08903

The objective of this proposal is to exploit the activities of attached biological growths on closely spaced rotating disks alternately submerged in sewage and exposed to air for high degree removal of organic matter, nitrogen and phosphorus. It is proposed to utilize a series of such units for sequential specialized populations. It is expected that neither artificial aeration nor secondary sedimentation will be necessary by virtue of the fact that the biological growths will not be allowed to accumulate to great thickness and will, therefore, not slough off but instead they will be removed at will after they have reached the logarithmic stage of growth.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0225, WEST COXSACKIE PROJECT - HIGH-PERFORMANCE BIO-TREATMENT OF MUNICIPAL SEWAGE

C. BEER, State Dept. of Env. Conserv., *Albany, New York* 12205

The following process concepts will be investigated: aerated surge tank ahead of plant, two-stage activated sludge, including an up-flow intermediate settler, two-stage final settling, shallow multiple-tray settling, a batch process of aerobic sludge stabilization, chemical oxidation (by chlorine) of primary sludge, biochemical precipitation of phosphates within the activated sludge system.

The project will be conducted in an experimental sewage treatment plant of 120,000 GPD capacity using domestic sewage from a state penal institution. The project was started in 1967 and should continue through 1974. The site of the project is West Coxsackie, New York.

SUPPORTED BY New York State Government - Albany

3.0226, A PRESSURE SEWER SYSTEM DEMONSTRATION

J.G. CARCICH, State Dept. of Env. Conserv., *Albany, New York* 12205

The major purpose of this project is to demonstrate the feasibility of a pressure sewer system. Previous work by the American Society of Civil Engineers under a Federal Water Pollution Control Contract has been devoted to the development of design criteria, construction methodology, installation techniques, and a grinder-storage-pump unit. This work has been completed and a demonstration of the entire system is now necessary.

The demonstration will consist of having pump-storage-grinders fabricated and installed in twelve homes located in close proximity one to the other and connected to a common pressure sewer line. At a point downstream of the test area, the pressure line would discharge into a gravity system. By the end of June 1970, the installation will be completed, the system will be operated for a one year period to observe its feasibility. If the system proves feasible, it will be possible to sewer many other areas at a reduced cost and to sewer some areas which were previously unsewerable.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0227, CHEMICAL-PHYSICAL WASTE TREATMENT PLANT DEMONSTRATION

L.J. HETLING, State Dept. of Env. Conserv., *Albany, New York* 12205

A new chemical-physical process to treat wastewater, remove phosphorus and produce a reuseable water will be demonstrated. A 7 gpm trailer mounted pilot plant of the process will be constructed and tested by Ecolotech, Inc. for the New York State Department of Health. The pilot plant will employ lime coagulation of raw wastewater, CO sub 2 neutralization, activated carbon adsorption and sand filtration. The pilot plant will be used to obtain design data for a full scale 1.7 MGD chemical physical waste treatment plant which is anticipated to be built in Waterford, N. Y. The pilot plant may be moved to various municipalities for testing on their wastes. Several experimental methods to remove nitrogen will also be tried.

The contract for the pilot plant with Ecolotech, Inc. was initiated in April, 1969. The first phase of operation of pilot plant should begin in September, 1969 at New Rochelle, N. Y. and at Waterford, N. Y. by June, 1970.

SUPPORTED BY New York State Government - Albany

3.0228, THE BIOCHEMISTRY OF ANAEROBIC DIGESTION

J.S. JERIS, Manhattan College, School of Engineering, *Bronx, New York* 10471

Investigations in anaerobic digestion have shown that the process has great potential for treatment of concentrated complex wastes. Yet, the process is not being used to its maximum potential because of a lack of fundamental knowledge of its microbiology and biochemistry.

The general objective of this proposal is to explore further the basic biochemistry in order to determine the general pathways involved in the anaerobic microbiological breakdown of various pure organic compounds which are constituents of complex wastes. Some of the compounds under study include propionic acid, lactic acid, succinic acid, glutamic acid, glycine, and oleic acid.

The role of intermediate compounds such as acetic, propionic and butyric acids is under study as thet appear to be very important metabolic products.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

3.0229, CELLULOSE DEGRADATION IN COMPOSTING

J.S. JERIS, Manhattan College, School of Engineering, *Bronx, New York* 10471

Solid waste disposal has become a problem of great magnitude in urban areas throughout the United States. As present disposal methods are often inadequate or uneconomical, modifications, as well as new innovations will be necessary in order to solve the present and long- term requirements of our growing society. As composting offers an end product which could have monetary value, the process needs a close evaluation. In conjunction with a reduction of the time required to obtain complete stabilization, it is anticipated that the process economics would be greatly improved. In this investigation, an attempt will be made to learn the optimum environmental conditions required by composting microorganisms. As the amount of paper, which is primarily cellulose, has become a major constituent of refuse, the study of the microbial degradation of the biologically resistant material will receive major emphasis. By delineating the environmental conditions maximizing the rate of degradation in composting, the process can be optimized and should yield a more efficient as well as a more economical operation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0230, ACID EMULSION BREAKING - ACTIVATED SLUDGE FOR BAKERY WASTE

H.A. SCHLESINGER, Ebinger Baking Company, *Brooklyn, New York* 11226

A 22 month demonstration program is planned which includes the following objectives: 1. Implement pre-construction research and development conclusions a. Finalized design of operable plant; b. Construct operable plant; c. Initiate operation of finalized plant; d. Evaluate plant operations. 2. Define operating parameters for optimization of process and treatment plant operations. 3. Provide operating data to produce an effluent suitable for, at maximum, injection into ground-water supplies per Suffolk County standards. 4. Develop critical criteria for treatment of a heavily loaded waste of high solids content for, at maximum, discharge into ground waters utilized for water supplies. 5. Determine on an operating scale the amounts and optimum disposal methods of the solid wastes produced. 6. Make all technical operating data available in 'Summary Technical Report' for utilization and guidance of other planning, designing or operating industrial wastewater plants for upgrading the quality of bakery wastewaters to various degrees.

Work will be performed at the Ebinger Baking Co. plant site at Lot No.5, Melville, Long Island, New York

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0231, DESIGN OF WASTE TREATMENT FACILITIES BY COMPUTER

J.J. DEGROAT, Technicomp Incorporated, *Great Neck, New York* 11021

This project contract was undertaken to explore the possibility of automating the design of a municipal sewage treatment plant. The word automating is here used to indicate that complete construction plans and specifications should be prepared on digital computing and automatic drafting machines. Included within the computer programs to be developed will be the design equations governing the various process kinetics and associated unit operation designs. The majority of programming will be in Fortran IV for the IBM 360/65 or the CDC 6600. Automatic drafting will be undertaken using the Universal Drafting Machine and the Orthomat Action Language. The project was started on July 1 1969 and should terminate on December 31, 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0232, POULTRY WASTE DISPOSAL AND ASSOCIATED ODOR CONTROL

W.E. BURNETT, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (032906990133)

OBJECTIVE: Identify factors which cause objectional odors in manure and ways and means of controlling them.

APPROACH: Bacteriological studies will be made of organisms that may be responsible for undesirable odors.

PROGRESS: A number of odorous compounds in poultry manure have been identified by chemical and organoleptic tests. The organoleptic tests that have been conducted indicate that the odor of accumulated poultry manure is a complex mixture of hydrogen sulfide, ammonia, diketones, mercaptans, sulfides, organic acids (C(2) - C(5)), indole, and skatole, and as yet other unidentified compounds. Anerobic microbial activity in poultry manure has been shown to be an important contributor of these obnoxious odors through the accumulation of sulfate reducing bacteria (Desulfovborio), methane-producing bacteria and an increase in concentration of volatile organic acids that seem to parallel the microbial population increase. To control odors, 44 masking agents, conteractants, deodorants and digestive deodorants were tested. Only 1 (a masking agent) seemed to merit further investigation and in this case the cost seemed prohibitive. Aeration of liquid manure seemed to reduce odor somewhat, but not to a degree that would be completely acceptable.

SUPPORTED BY U.S. Dept. of Agriculture

3.0233, WASTE DISPOSAL

N.C. DONDERO, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00170)

OBJECTIVE: Define microbiological and environmental conditions most conducive to solubilization and voltilization of poultry waste products.

APPROACH: Poultry manure will be lyophilized to afford a constant starting material as well as to facilitate a comparison of results in the course of the study. The quantity of water-soluble organic and inorganic material and water insoluble organic and inorganic material will be estimated by appropriate methods in

the lyophilized manure. Complex microflora obtained from a spectrum of environments and pure starter cultures will be coupled with diverse physical conditions such as water content, pH value, degree of aerobiosis and temperature under laboratory conditions. After these experimental treatments the aforementioned quantities of water-soluble and water-insoluble materials will be estimated and compared with base line values. These comparisons will reflect influence of variables upon solubilization and volatilization of the manure components.

PROGRESS: Microbial and chemical changes taking place in stored poultry manure have been studied with particular reference to the generation of odors. An organoleptic test ('matching standards') was developed to evaluate odor control substances for use with stored poultry manure. Making agents were most effective, deodorants less so, and enzyme preparations least so. Preliminary field trials indicate cost of deodorant treatment to be about 14 cents per hundred gallons of liquid manure when used prior to field spreading. In laboratory tests, manure held without added water produced less odor than liquid manure. The decomposition of uric acid by bacteria caused the formation of significant amounts of ammonia. Only a part of the sulfide was formed by sulfate-reducing bacteria. Odorous short-chain fatty acids (C(2)- C(5)) accumulated, probably as the result of the metabolism of high numbers of clostridial bacteria. The concentration of fatty acids increased to 2000 mg/l in 16 days and declined steadily. Methane- forming bacteria were present in small numbers until rapid multiplication began after 28 days. The odor intensity of stored liquid manure increased steadily during the 30 days of observation.

SUPPORTED BY U.S. Dept. of Agriculture

3.0234, HANDLING AND DISPOSAL OF POULTRY WASTES

A.G. HASHIMOTO, State University of New York, U.S.D.A. Agric. Eng. Res. Div., *Ithaca, New York* 14850 (901-031-B611)

OBJECTIVE: Develop equipment and management procedures to reduce the pollution hazards from poultry wastes in caged layer egg production in the Northeast.

APPROACH: Determine the components in poultry wastes that cause noxious odors and evaluate masking agents that will reduce, eliminate or cover them. Feasibility studies will also be made of alternate techniques that will fit into production systems and develop the engineering technology of the most promising of these. Some of the alternates are waste treatment in lagoons and oxidation ditches; land disposal by spreading or deep plowing and storage methods that will permit holding the wastes when conditions are unfavorable for land disposal. Immediate, urgent and long range corrective measures to control pollution will be included.

PROGRESS: Preliminary investigations have shown that aeration lowers the odor and nitrogen levels in chicken manure slurries. The preliminary investigations have also shown that if high nitrogen removals are necessary, a two-stage waste disposal system would be necessary. The first stage would consist of an aeration unit to minimize the production of odorous gases and convert complex nitrogenous compounds to ammonia. The second stage would be an ammonia desorption unit to raise the pH and strip ammonia gas out of the slurry by aeration. The limiting phase of the system outlined above is the rate of ammonia stripped out of the manure slurry. Therefore, the initial emphasis of this research project is to investigate the factors affecting the rate of ammonia being stripped out of poultry manure slurry. A theoretical equation has been developed which indicates that temperature, pH and air flow rate have a significant affect upon the rate of ammonia stripping. The evaluation of the above mentioned factors are currently being investigated.

SUPPORTED BY U.S. Dept. of Agriculture

3.0235, SYSTEMS FOR ALLEVIATING ODORS FROM POULTRY WASTES

D.C. LUDINGTON, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (901-031-B612)

OBJECTIVE: Through preliminary research studies and cost analyses determine systems of poultry manure disposal having the most promise for successful incorporation into poultry production enterprises, particularly where odors are a major problem.

APPROACH: Study poultry manure management and handling to reduce odor production by investigating thermal methods of removing moisture and low-volume direct aeration for oxidation. Investigate wet scrubbing and filtering of exhaust air from ventilation systems to remove odorous materials and screen agents to mask obnoxious odors.

PROGRESS: Mechanical devices which will promote drying of the manure before the manure enters the pit are being tested. Manure will not dry enough when the manure drops directly into the pit to successfully control odors. Frequent removal removes manure before bacteria have a chance to produce odors. The effects of air velocity on moisture removal have been studied and the data is now being compiled and analyzed.

SUPPORTED BY U.S. Dept. of Agriculture

3.0236, POULTRY WASTE HANDLING SYSTEM DESIGN

D.C. LUDINGTON, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (901-031-B617(CA))

OBJECTIVE: Develop technology for a complete system to handle, treat and store poultry manure utilizing the removal of moisture as a method for control of odors.

APPROACH: Screens and sloped plate devices will be studied as a means of enhancing waste drying before dropping into the collection pit. The screen opening and configuration and the plate angle and configuration will be evaluated as they affect the flow of drying air in and around the manure. Moisture content of the manure and odors emanating from it will be the standard used to measure effectiveness. Commercial design scrapers and experimental designs will be evaluated to determine the effectiveness for removal of waste from the collection pit. Design requirements of storage facilities that will aid in reducing odors will be evaluated. Inside and outside storage facilities will be used. Measurements will be made of humidity, moisture content, age of manure, temperature of drying, temperature of storage, and time of storage. Evaluation of storage effectiveness will be based on odors, microorganism growth--such as molds--and NH(3) and CO(2) production. Research will be conducted in the laboratory and in the field.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

3.0237, DISPOSAL AND UTILIZATION OF DAIRY AND POULTRY MANURES BY LAND APPLICATION

D.C. LUDINGTON, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00333)

OBJECTIVE: Develop and evaluate disposal and utilization systems for land application of treated and untreated dairy and poultry manure that will minimize the pollution of water, soil, and air.

APPROACH: Develop and evaluate process systems for handling and treating dairy and poultry manures for application to the land. Properties essential to the design and evaluation of the systems will be measured and integrated into the analysis of the system. Biological, thermal, and physical processes will be studied. The system will be evaluated on the ability to minimize air pollution during storage and land application and water pollution after application.

PROGRESS: Chambers containing 4 liters were aerated at rates of 3, 2, 1 and 0 cfh. A detention time of 40 days was employed and the temperature was 16 C. The following analyses were made on the samples withdrawn: total and ortho phosphate, total Kjeldhal and ammonia nitrogen, COD, pH, alkalinity, total and volatile solids and olfactory threshold. The ash was analyzed for Ca, Mg, K and Na. The air leaving the chambers was analyzed for NH(3), CO(2), odor presence and offensiveness. The pH of aerated systems is relatively high (8.5-8.7) thus increasing the amount of nitrogen loss in the form of NH(3). At the end of 70 days the loss of total nitrogen in chamber one was 37%, in chamber two 35%, 19% in chamber three and 3% in chamber four. The odor offensiveness of the chambers at 40 days were 3.0, 4.2, 6.0 and 8.2 (increasing number indicates increasing offensiveness). Large quantities of nitrogen can be removed from

poultry manure during aerated storage. This loss will not increase the CrN ratio enough to make the manure optimum for soil microflora assimilation. By adding lime to the slurry and raising pH, significantly greater quantities of nitrogen can be removed. The offensiveness of the waste was considerably reduced by low rate aeration.

SUPPORTED BY U.S. Dept. of Agriculture

3.0238, SANITARY MILK PRODUCTION
R.P. MARCH, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00666)

OBJECTIVE: Study the factors of importance in sanitary production and handling of milk on farms. Methods for measuring sediment and problems in sample collection and storage will be investigated.

APPROACH: Procedures and chemicals will be evaluated and special attention will be given to the determination of heat loss during cleaning in relation to methods and materials available. Testing and evaluation of pumps, releasers, filters and other items will be conducted in the interest of making better equipment available to farm and milk plant operators. Research on the causes and prevention of off- flavors will continue and field surveys of milk flavor quality will be made. Cooperation with Departments of Agricultural Engineering and Animal Husbandry and the College of Veterinary Medicine in the milk machine project will continue.

PROGRESS: Waste disposal - A field study of milking center waste disposal systems and their relationship to milk sanitation has been continued to point out the need for more research and extension help in this area. Universal sample - A new system of collecting farm bulk tank milk is being field tested. This is a universal sample which would simplify the sampling system for the bulk hauler and for the laboratory. Fresh vs. composite samples - Preliminary studies indicate that testing fresh samples for fat content four times per month could replace the need for collecting a daily composite sample. Sediment testing - Preliminary studies indicate that a 6 oz. sample of milk can be used to determine the sediment content of milk in lieu of a 16 oz. sample.

SUPPORTED BY New York State Government - Albany

3.0239, POULTRY WASTE MANAGEMENT AND ODOR CONTROL
C.E. OSTRANDER, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00892)

OBJECTIVE: Develop better methods of handling, storing and use of poultry waste products and to eliminate odors emitted from these.

APPROACH: Studies will be made at our research farm and in the field of methods of handling, storing and using or disposing of poultry wastes. Solids, pH, effects of chemical application on the product will be sampled and studied. Effects of temperature, relative humidity and atmospheric pressure on odors emitted will also be studied.

PROGRESS: Screening and testing of chemicals for the suppression and prevention of odors from poultry manure from poultry houses has been continued, some 10 additional chemicals have been tested in the laboratory. None of the chemicals tested showed sufficient promise to be tested in our environmental chambers at our research farm, or were they tested at commercial poultry farms. AK-Tiv-X and Atlas G-271 when tested in liquid poultry manure produced some change in odor, but the odor was still rated objectionable by odor panelists. Methogen (Paraformaldehyde) was tested in fresh liquid poultry manure for the prevention of odor, and in 42 day-old liquid poultry manure for the suppression of odor over a 30-day period. Neither of these tests showed favorable results. There was a definite lowering of PH noted in the 30- day test. Odor panelists reported a change in the odor, but a majority strongly objected to the resulting odor.

SUPPORTED BY New York State Government - Albany

3.0240, POULTRY MANURE PROPERTIES, HANDLING AND DISPOSAL
A.T. SOBEL, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00042)

OBJECTIVE: Determine chemical, physical and rheological properties of poultry manure related to handling, disposal, and/or utilization; investigate several methods of disposal and utilization.

APPROACH: Properties related to handling, disposal or utilization of manure will be determined. Samples will be gathered from various sources to obtain a broad range of breed, management, and other factors which will influence the composition and quantity of manure produced. Such conditions will be recorded so that ranges can be established for various properties, as extremes of these ranges are important in handling manure. Manure will be investigated as a solid waste and as a suspension in water. This information will then be used in trial methods in laboratory (or in the field if indicated) and results extended to consider what would be involved in handling larger quantities of manure.

PROGRESS: Studies were continued on the factors which affect moisture removal from chicken manure. Studies on the effect of air velocity on drying time were initiated. No results are available. Techniques for measuring odors and gases were applied to various manure collection systems on a laboratory and semi-field scale basis. Chicken manure stored in a diluted state produces considerably more H(2)S than when stored in an undiluted state but release of the H(2)S is only about twice as fast. Diluted manure also produces more NH(3) but the undiluted manure releases more NH(3). The relationship between the production and release of these gases is due to their solubility in water and pH. During quiescent storage, the strength of the odors released is comparable for both systems but vastly different in quality. Manure collected in a low moisture state about 25 percent, wet basis had a minimum odor rating. Also there was substantial weight and volume reduction for the dry collection. Preliminary investigations have been initiated on enhancing drying under caged laying hens by various means of mechanical devices.

SUPPORTED BY U.S. Dept. of Agriculture

3.0241, POULTRY MANURE DISPOSAL AND ASSOCIATED ODOR CONTROL
A.T. SOBEL, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (901-031-B609)

OBJECTIVE: Make an engineering feasibility and cost analysis of elements deemed to have most promise of successful incorporation into commercial enterprises.

APPROACH: Study manure management, handling and disposal methods and equipment (including experimental) currently in use in New York State poultry enterprises. Analyze and evaluate selected component features and elements showing promise of productive adaptation. Report analysis of probable results of combining equipment and methods into systems recommended for further study under experimental conditions.

PROGRESS: A study of methods for removal of water from poultry manure shows the equilibrium moisture content at 70 F. to be 19% w.b. at 90% RH and 9% w.b. at 10% RH. Typical drying times to equilibrium under static conditions were 45 hours at 35% RH and 70 hours at 56% RH both at 80 F. Variation of the manure within the samples has more effect on drying than does humidity variation within a (over -) 15% range of RH. The loss of water from a manure surface is less than that from a free water surface and in a batch sample of manure the loss decreases with time. The moisture loss from the batch sample of manure occurred in the top 1/4-inch of depth. Reducing the thickness of the manure sample had a significant effect on the drying characteristics.

SUPPORTED BY U.S. Dept. of Agriculture

3.0242, IMPROVEMENT OF TREATMENT OF FOOD INDUSTRY WASTE
S.B. TUWINER, R A I Research Corporation, *Long Island City, New York* 11101

3. SOLID WASTE MANAGEMENT

To investigate on a laboratory scale electrochemical oxidation of milk whey as a method of waste treatment.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

3.0243, IMPROVED CAPABILITIES OF BIOLOGICAL SYSTEMS TO ASSIMILATE OIL
R.N. SIMONSEN, Amer. Petroleum Institute, *New York, New York* 10020

The project will consist of a study of laboratory scale activated sludge waste treatment systems which will be operated to determine their tolerance to various types and amounts of hydrocarbons, the nature of the interference of the hydrocarbons, the fate of the hydrocarbons in the system, and to study methods for improving pretreatment of the influent and of improving the operation of the systems.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

3.0244, SEPARATION OF SANITARY SEWAGE FROM COMBINED SYSTEMS OF SEWERAGE
M.B. MCPHERSON, Amer. Soc. of Civil Engrs., *New York, New York* 10017

The general concept on which the project is based involves discharging comminuted or ground sewage from individual buildings and/or building complexes through relatively small pressure tubing laid in existing building connections, and thence into new pressure conduits suspended in existing street sewers. The new separate sanitary sewage pressure conduits would then discharge into existing interceptors that would convey the sanitary sewage to treatment works. Storm water alone would be carried in what were formerly combined sewers. The most comparable alternative to meet the same objective is traditional, complete separation by means of new sanitary sewers and attendant separate sanitary and drainage building connections. The project scheme was conceived by Dr. Gordon H. Fair of Harvard University.

The basic objectives of the project are to determine the physical feasibility and limitations of the project scheme or modifications thereto, and to arrive at measures of cost for comparison with the traditional method of separation for evaluation of investment feasibility.

Headquarters for the project are provided by Harvard University at 40 Oxford Street, Cambridge, Mass. 02138.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0245, HYDROLYSIS OF SLUDGE USING LOW PRESSURE STEAM WITH SO2 AS A HYDROLYTIC ADJUNCT AND TO STUDY THE UTILIZATION OF THE RESULTING HYDROLYSATE
B.C. REIDY, Foster D. Snell Incorporated, *New York, New York* 10011

To conduct a feasibility study to determine the effectiveness of a chemical process utilizing dilute sulfurous acid to digest and hydrolyze sludges of various types produced in waste disposal processes.

An evaluation of the economic aspects of the process will be made once the best reaction conditions are determined. This evaluation will include factors affecting the desirability of incorporating this process as an alternate disposal system. These include: (1) Chemical composition of digested products and the solid residue. (2) Process and equipment costs which are a function of temperature, pressure, and chemical composition. (3) Raw materials costs, such as SO2. (4) A study of methods of ultimate disposal of the undigested (inorganic), portion of the sludge and its potential use as fertilizer or soil conditioner, etc. (5) A study of the utilization of the concentrated digest as a fermentation adjunct, cattle feed (digest molasses), etc.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0246, URBAN SCIENCE AND ENGINEERING
R. NATHANS, State University of New York, School of Arts, *Stony Brook, New York* 11790

In collaboration with the Rand Institute of New York City and with the cooperation of public agencies in Nassau and Suffolk Counties, the Urban Systems Engineering group will conduct interdisciplinary research on flow of solid wastes and on fire protection.

Data obtained from existing literature and a case study of the sources and disposal of solid wastes will be used to construct a benefit-cost model of the waste-disposal system.

Building on the experience of the Rand Institute with research on fire protection, operations analysis will be concerned with problems of fire protection in an area characterized by rapid urbanization. Computer simulations will be used to develop estimates of benefits and costs associated with alternative systems.

The aims are to determine the analytical investigations that are likely to be of immediate benefit to public agencies, to develop a close working rlationship with the Rand Institute, to strengthen the interdisciplinary research resources of the Urban Systems Engineering group, and to construct a series of models describing the essential features of selected urban systems. The research will be closely tied to a graduate program involving students in engineering, economics and physical sciences.

SUPPORTED BY U.S. National Science Foundation

3.0247, PIPELINE FLOW OF SOLIDS-LIQUID SUSPENSIONS
R.M. TURIAN, Syracuse University, Research Institute, *Syracuse, New York* 13210

The primary objective of the proposed research is to assess the effect of suspending medium characteristics and suspended solids properties on: 1. the steady state pipe flow behavior of the suspension, 2. pressure lossess and other problems associated with the flow through pipe bends or other disturbances in the flow path, and 3. problems arising from sudden stoppage and subsequent start-up of the flow. The suspending medium characteristics will be varied using Newtonian liquids of different viscosities and densities, suspensions of solids fines of different concentrations and polymer average molecular weight. The suspended solids characteristics, on the other hand, will be varied using different concentrations of iso-dimensional particles, different solids densities, and different distributions of particle sizes and densities. Supplementary viscometric, settling, and other tests will be conducted to characterize the suspended systems investigated and their components. These supplementary tests will also serve to evaluate the utility and limitations of such measurements in the prediction of the pipe flow behavior of the suspension. The ultimate aim is to establish guidelines for optimum design and economic evaluation of a sludge or suspended waste pipeline or piping system.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0248, INCINERATION OF PLASTICS FOUND IN MUNICIPAL REFUSE
R.W. HEIMBURG, Syracuse University Res. Corp., *Syracuse, New York*

A systematic study of the destruction of synthetic polymers, especially plastics and plastic-rich refuse by two incineration methods will be performed. The two methods are (1) direct burning of the refuse, and (2) anaerobic heating followed by burning of the volatile matter. Of particular interest are (1) the chemical and toxicological nature of the stack effluent and (2) the interaction of the solid residue with water. We are ultimately interested in finding a process and/or set of incineration conditions which results in the destruction of plastics-rich refuse with minimum air and water pollution.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0249, JOINT LAND-USE FOR CONSERVATION OF NATURAL RESOURCES AND DISPOSAL OF SOLID WASTES
H.I. STERN, Rensselaer Polytechnic Inst., School of Engineering, *Troy, New York* 12181

The rapid growth of urban-suburban regions creates a demand for new construction materials such as sand and gravel, while simultaneously encroaching upon the land used for mining such mineral aggregates. Urban growth also results in the increased generation of solid waste and the resulting search for suitable land fill sites. Since the mineral aggregate production and delivery operation is spacially complementary to the solid waste transportation and disposal activity, the optimal manner of doing both operations will be investigated. For multi-site joint operations a special problem of dual purpose truck assignments and scheduling of deliveries is to be studied. The problem must be coupled with the sequencing of opening and closing times for mineral sites which reflect resource conservation policies.

SUPPORTED BY U.S. National Science Foundation

3.0250, OXYGEN TRANSFER IN CONCENTRATED MICROBIAL SYSTEMS
D.R. WASHINGTON, Rensselaer Polytechnic Inst., School of Engineering, *Troy, New York* 12181

This project has at its immediate aim, the development of mathematical models to express the oxygen transfer, oxygen utilization for concentrated mixed microbial cultures. A major effort is being made to evaluate the coefficients appropriate for the models. The investigation involves the study of cultures ranging from 15 gm/l to 50 gm/l suspended volatile solids.

The long range objective of the research is to develop a biological process for the direct treatment of concentrated industrial wastes which are susceptible to biological degradation. Synthetic wastes (45% dextrose; 45% non-fat milk, 10% yeast extract) in concentrations up to 30 gm/l COD have been treated by this process with over 99% COD removal.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0251, MICROBIOLOGY OF ANAEROBIC SLUDGE
R.A. MAH, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

An ecological apparaisal of the sludge fermentation is essential to an understanding of the contribution and significance of various physiological types of anaerobic bacteria participating in the degradation or organic compounds to methane and carbon dioxide. This investigation is concerned with an estimation of the total fermentation by whole sludge of certain carbohydrates, fatty acids, and amino acids. The significance of the bacteria which attack these compounds will be evaluated by isolation of pure cultures, estimation of their numbers in sludge, and determinations of their rates of fermentation of specific substrates.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0252, ANIMAL WASTE COMPOSTING WITH CARBONACEOUS MATERIAL
C.B. DAVEY, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

Poultry manure has been mixed with sawdust and composted in a high rate thermophilic composter. The temperature increases to 60 to 70 degrees C within 24 hours and remains at this level for another 24 hours before decreasing. During this period, the available carbon is supplied by the manure. Nitrogen loses were found to be approximately 3 percent. After being removed from the composter, the material is stored. During storage the cation exchange capacity of the compost increases to about 67 milliequivalents per gram. The odor becomes that of fresh soil.

Plant growth studies in green houses using compost at least four weeks old were made. Tomatoes planted in a mixture of soil and 10 percent compost by weight exhibited an increase in dry weight of 400 percent over untreated plants after 90 days. The tomato yield was also greatest at this treatment. Wheat and millet also exhibited the greatest dry weight increase at this treatment. Green beans had their greatest dry weight increase at the one percent level. Seed production and root nodule growth was also greatest at this level.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0253, PHYSICAL AND CHEMICAL CHARACTERISTICS AND STABILITY OF CUCUMBER PRODUCTS
J.L. ETCHELLS, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC05109)

OBJECTIVE: Conduct chemical, microbiological and technological research relating to the preservation, curing and storage of cucumber pickles and to the properties of raw and processed products.

APPROACH: Investigations will be made of the effects of alternative raw product handling techniques upon microbiological, physical and chemical properties of the raw product over time and upon the processing characteristics of the product. Alternative means of controlling the microbial population so as to obtain controlled fermentation will be investigated.

PROGRESS: Brining with a 'Salt-Free' Brine: The ever mounting problems attending waste disposal from the brining and manufacturing operations of the brined vegetable industry have directed our curiosity to the possibility of fermenting cucumbers in a SALT-FREE brine (meaning, of course, free of sodium chloride). Six common organic salts, including sodium chloride (potassium chloride, ammonium nitrate, potassium chloride, ammonium nitrate, potassium nitrate, magnesium sulfate, and ammonium sulfate) were tested at three concentrations (3, 6 and 9%) in cucumber-juice broth for their ability to support growth of various species of lactic acid bacteria and yeasts. All the test organisms grew almost equally as well in all the six salts at the 3% concentration; higher concentrations showed the most inhibitory effect on the gas-forming species of lactic acid bacteria. The brine yeasts grew well in all six salts at all three concentrations. Brining tests in 1-gallon jars supported the findings just mentioned. The results demonstrated that in general, the cucumbers brined with the five different inorganic salts produced vigorous acid fermentations. Further information will be gained when the brine-stock from all lots is evaluated.

SUPPORTED BY North Carolina State Government - Raleigh

3.0254, PULP INDUSTRY POLLUTION ABATEMENT THROUGH PROCESS MODIFICATION
P.J. KLEPPE, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC04025)

OBJECTIVE: Study the possibility of converting the reducing sulphur components in the kraft pulping process to non-polluting substances by oxidation with oxygen before blowing, and of replacing the chlorination and alkali extraction stages in bleaching with one oxygen/caustic stage.

APPROACH: From a study of pulping kinetics optimum conditions will be determined for oxidation of sulphur compounds in the pulp digester and laboratory trials undertaken. Studies on bleaching kinetics will also be undertaken to determine the feasibility of utilizing a one stage oxidation-caustic process. Laboratory evaluation of the resultant pulps shall be also undertaken.

PROGRESS: About 80% of the lignin in a Kraft pulp containing 10.5% lignin could be removed in 80 minutes at 100 C by oxygen and alkali. The gain in brightness was about 25-30 G.E. units and the ratio of lignin to carbohydrate removed was considerably higher than for Kraft pulping. The alkali consumption was less than 10% NaOH and the consumption of oxygen was only about 3% (based on pulp). The results indicate strongly that removal of lignin from high yield pulps by oxygen and alkali can be a feasible and economical process, and can replace the chlorination and 1st alkali extraction stages in bleaching of pulps. An inplant study was also made on materials balance in white water recirculation during paper maker. An M.S. thesis on the latter study is in preparation.

SUPPORTED BY U.S. Dept. of Agriculture

3.0255, SURVEY OF PULP AND PAPER MILL EFFLUENT CONTROL AND TREATMENT
C.N. ROGERS, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC04017)

3. SOLID WASTE MANAGEMENT

OBJECTIVE: Survey and evaluate methods of effluent improvement for paper mills in the south.

APPROACH: Survey industrial operations by questionnaire and direct contact. Evaluate and analyze findings to identify problems. Prepare report.

PROGRESS: During 1968 questionnaires were sent to about 60 of the major pulp and paper producers in the South who had previously shown interest in our project. These companies represent about 90% of the tonnage produced in the South. Forty-five of these questionnaires have been completed and returned, and the remainder are expected within the next few months. These questionnaires, which were extensive in coverage and tailored to fit our interest, were filled in as completely as possible by nearly all of the mills. Many of the mills installed facilities to provide the information which we requested. It should be pointed out that almost all of the mills provided us with all technical and cost data available to them. Many managers have stated that the questionnaire has been helpful to them, as it has pointed out information that they should know about their own operations for improved results. During the past year about 10 of the mills have been visited to get additional information and to verify some that was given previously. We propose to visit an additional ten mills which will give 1/3 coverage of those participating. We are currently using information provided by this project in a program of teaching pollution abatement as well as in other research projects.

SUPPORTED BY U.S. Dept. of Agriculture

3.0256, FARM ANIMAL WASTE DISPOSAL

G.L. PRATT, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-H-04-013)

OBJECTIVE: Characterization of physical, chemical and biological properties of livestock and poultry wastes, improvement in management systems with regard to handling treatment and disposition of wastes.

Approach: An evaluation survey will be made of farms in North Dakota using liquid manure handling systems for hogs and poultry. The lagoon system of sewage disposal receiving liquid manure from a hog house will be studied in detail including temperature, odor, B.O.D., etc. Open pit septic tanks will also be studied.

Progress: A lagoon is being used for disposal of hog wastes. The system was modified by adding a settling tank between the barn and lagoon. A high pressure water system was installed to clean the barn. The effectiveness of the removal of solids from the wastes by the settling tank will be evaluated. Three reinforced concrete grids are being evaluated to determine design criteria for floor systems for cattle and hogs. A cage laying system was installed at the poultry plant with a gutter system designed to be cleaned with wash water. Water is salvaged from the wastes to be reused for washing the gutters under the cages. Odor from the reused water is a problem. The Bacteriology Department has worked on the identification and enumeration of the microbial flora of the Nutrition Center Sewage lagoon. The pigmented organisms appear to belong to the bacterial families Thiorhodaceae (probably Thiopedia rosea) and Athiorhodaceae. Assay of influent and lagoon waters are underway to determine the concentration of biochemically important nutrients and metabolic byproducts. No practical applications have been made.

SUPPORTED BY U.S. Dept. of Agriculture

3.0257, LIVESTOCK WASTE DISPOSAL SYSTEM INVOLVING REUSE OF WATER

G.L. PRATT, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-S-04-010)

OBJECTIVE: Compare and evaluate on the basis of available information the components needed to condition animal waste water for reuse, assemble pilot treatment systems to evaluate performance of components in field use.

APPROACH: Initial phase will involve a review of components that are available for separating solids from liquid, for eliminating undesirable chemical elements, and for neutralizing pathogens. Commercially available components will be investigated. Available information on quantity of materials that will have to be handled will be summarized. Evaluation of mechanical performance of selected systems will be made in a pilot disposal assembly. Waste material will be collected from livestock and introduced into test systems. Rate of buildup of undesirable chemical elements in reused water will be determined. After these rates have been established, efficiencies of equipment available for removing these chemical elements will be evaluated. Determination of efficiencies of pathogen neutralizing equipment will be the final stage of pilot test sequence.

PROGRESS: In one phase of the work treatment of overflow from settling tank that collected beef waste was emphasized. No treatment, aeration, and treatment with aluminum sulfate (alum) were tested for settling tank overflow. The settling tank removed the bulk of solids. Alum treatment of the overflow was effective in reducing total solids to the point where it was nearly feasible to provide final treatment. In the second phase of the work a slow sand filter was tested under controlled conditions to determine its adaptability for final treatment of reclaimed water. Tests were run at three temperatures, 45 F, 70 F, and 100 F. Controlled amounts of organic material were added to the influent of the filter. The filter was easily managed and adaptable to a wide range of conditions. Its performance was better at 70 F than at 45 F or 100 F.

SUPPORTED BY North Dakota State Government

3.0258, WASTE TREATMENT FACILITIES DEMONSTRATION

C.R. MOORE, Union Stockyards Company, *Fargo, North Dakota* 58078

The project will consist of a pilot study and demonstration of the Union Stockyards Company of West Fargo, North Dakota waste materials. A study shall be made of the effluent leaving the pens and wash rack of the Stockyards Company from April 1, 1970 until the treatment facilities are constructed.

Treatment facilities consisting of a screen for removing solids, a sewage lift station, and primary and secondary waste stablization ponds shall be constructed. During the summer of 1970 when this construction is taking place, samples of the effluent shall be taken and tested periodically.

After construction of the treatment facilities, the effluent from the screen and waste stablization ponds shall be sampled and tested until Sept. of 1971. After this time a written report and evaluation shall be prepared on the results.

At the present time there are 48 sales and feed lots in North Dakota which have no treatment facilities, there are 50 in South Dakota and nearly as many in Northern Minnesota. From the pilot study made with this project it is proposed that we can demonstrate a practical and economical method of treating the wastes from these other feed lots and stockyards.

Since most of the operators of feed lots and sales lots visit the Union Stockyards in West Fargo periodically it would be an ideal place for these people to observe the operation of the treatment facilities.

It is felt that through the construction of the facilities proposed we will be able to sufficiently reduce the suspended solids and reduce the B.O.D. to acceptable limits for discharge into the Sheyenne and Red Rivers.

The project will be started June 1970 and completed in December 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0259, ULTIMATE DISPOSAL OF SLUDGES BY SURFACE SPREADING

J.O. EVANS, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

Land surface provides low cost dewatering and oxidation of organic sludges with additional benefits from added soil fertility. Certain insoluble mineral wastes such as calcium carbonate and phosphate are compatible with many soils and can also act as fertilizers. Since dewatering of sludges by sedimentation, centrifugation, or filtration is expensive, a study of wet sludge disposal on land surfaces has been initiated. Pipeline transport of sludges and stabilization to prevent nuisance odors will be studied. Distribution programs to minimize pollution from runoff and percolation will be devised. Long term effects of repeated sludge applications to various soil types will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0260, SUSPENDED AND COLLOIDAL SOLIDS REMOVAL--FLOCCULATION BY ORGANIC POLYMERS
S.A. HANNAH, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

The need for solids-liquid separation arises at a number of steps in the treatment of wastewater either by chemical or biologic processes. The newly developing organic flocculants represent the best currently available group of chemicals to 1) increase efficiency of solids-liquid separation, 2) minimize sludge mass and 3) improve thickening and filtration properties of sludge.

The overall objectives of this study are to 1) investigate the application of new organic flocculants in waste treatment, 2) determine the mechanism of the flocculation by organic polymers and 3) develop methods for the control of dosage to obtain economic use of these relatively expensive compounds.

A wide variety of polymer compounds distinguished as to chemical composition, charge type, charge density and molecular weight will be studied. The polymers will be studied both alone and in conjunction with inorganic hydrolyzing chemicals such as aluminum or iron salts. Variables to be evaluated include polymers, dosages pH, ionic and solids characteristics of wastewater before and after treatment, effects of agitation and mode of addition of polymer. Experimental apparatus and instrumentation used in the study will include: jar test apparatus, miniature sand filters, microelectrophoretic techniques, colloid titration, and streaming current measurement devices.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0261, SUSPENDED AND COLLOIDAL SOLIDS REMOVAL--SOLIDS SEPARATION BY CHEMICAL TREATMENT AND FILTRATION
J.F. KREISSL, U.S. Dept. of the Interior, Federal Water Quality Admin., *Cincinnati, Ohio* 45226

The separation of suspended solids, either those existing or created by chemical and biological treatment, from waste effluents is a recurring step in the series of processes for advanced methods of treating wastewaters. Plain sedimentation followed by surface or depth filtration have proved to be insufficient for the production of the high quality of effluents required for membrane or adsorption processes. Chemical treatment to obtain coagultion and flocculation followed by filtration appears to be the most promising approach for the complete clarification of wastewaters.

The overall objectives of this investigation is to develop a clarification process which will encompass the following 1) coagulation- flocculation in an upflow-solids contact clarifier, 2) filtration using depth filters such as sand, sand and coal or other media combinations.

The experimental apparatus will consist of a series of specially designed columns, approximately 1 foot square, in which the functions of coagulation-flocculation and rough sedimentation can be accomplished. Effluent from these treatment devices will be filtered in a variety of filter media columns. Some of the experimental variables will include 1) upflow velocity, sludge blanket depth, type of coagulant, coagulant dosage, mixing conditions, time of coagulation or flocculation, filter media and rate, etc. Performance of the process will be assessed by measuring such parameters as turbidity, coagulant ion, head loss, etc.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0262, TREATMENT OF BEAN HOUSE WASTES FROM A VEGETABLE TANNERY
J.D. EYE, Univ. of Cincinnati, School of Engineering, *Cincinnati, Ohio* 45221

The objectives of the project are to demonstrate the feasibility of treating bean house wastes from a tannery and to obtain basic data for the design of full scale treatment plants. Excess lime from the lime bearing wastes will be removed with polyelectrolytes. The clarified lime wastes will be mixed with non-lime bearing wastes and neutralized with acid to a pH of 8.5 - 9.0. The organic material in the blended neutralized wastes will be reduced by a combined anaerobic- aerobic biological system.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0263, HEAT TRANSFER STUDIES ON SLUDGE SUSPENSION
UNKNOWN, Rand Development Corporation, *Cleveland, Ohio* 44110

The proposed project is a study of disgested sludge which is to be economically disposed of by transport in small diameter pipelines, and which can beneficially be used in land surface reclamation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0264, FIRESIDE METAL WASTAGE IN MUNICIPAL INCINERATORS
P.D. MILLER, Battelle Memorial Institute, *Columbus, Ohio* 43201

The objectives of the work planned are to identify the conditions that lead to the corrosion of metals in solid-waste incinerators, to determine the mechanisms by which the loss occurs, and to devise means of preventing corrosion in these installations.

Field studies will be carried out by continuing the practice of inserting probes in operating municipal incinerators. Corrosion rates will be determined my measuring the weight loss of specimens held at selected temperatures. Analyses of the deposits, and of the corroded metal will help strengthen the conclusions which have already been reached as to the cause of the attack.

Possible mechanisms by which the corrosion is occurring will be established by laboratory studies. The role of individual corrosive constituents will be determined. Reasonable explanations for attack at 800 F and 1000 F have already been obtained, but additional studies are required to explain results at temperatures of 600 F and lower.

Particular emphasis in this year's effort will be directed toward developing practical procedures for the alleviation of the metal wastage. Field studies will include evaluations of both a variety of alloy compositions and of protective coatings applied to plain carbon steels. Consideration will be given to the most effective design or operating conditions which will reduce metal wastage.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0265, RENOVATION, UTILIZATION OR SAFE DISPOSAL OF EFFLUENT FROM SEPTIC TANKS AND SEWAGE PLANTS
B.L. BONDURANT, Ohio State University, Agricultural Experiment Sta., *Columbus, Ohio* 43210 (OHO00346)

OBJECTIVE: Study and develop methods for renovating sewage treatment effluents. Determine possible and practical uses of sewage treatment effluents and renovated effluents as related to agricultural production and rural water supplies.

APPROACH: Soil will be used as a medium for renovating sewage treatment wastes with emphasis on maintaining aerobic conditions within the soil, the effluent and at the interfaces through proper loading, drainage, transpiration and evaporation balances. Lysimeter columns will be used in the laboratory, sites where unsatisfactory septic tank performance occurs will be studied later. Observations of phosphates, nitrates, pH and permeability will be made where growers are using treatment plant effluents. Septic tank effluent will be tried for lawn irrigation, flushing toilets, etc.

PROGRESS: Soil lysimeters 19 inches in diameter and 6 feet high were obtained from one soil for purposes of conducting leaching studies. Installation is in progress. Several contacts were made with owners of existing septic systems regarding modification of their systems to permit reuse of the water. A milkhouse waste disposal system was partially installed, but no data have yet been collected.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY U.S. Dept. of Agriculture

3.0266, FARM ANIMAL WASTE DISPOSAL

E.P. TAIGANIDES, Ohio State University, Agricultural Experiment Sta., *Columbus, Ohio* 43210 (OHO00413-S)

OBJECTIVE: Determine physical, chemical and biological properties of animal wastes. Evaluate various systems of farm waste management. Test under experimental conditions, one or more promising systems in waste handling treatment and disposal.

APPROACH: Facilities at Wooster and Columbus will be used to collect data on the daily defecation rates of dairy cattle, beef cattle, swine, poultry and sheep. Samples will be analyzed for total and volatile solids, specific gravity, BOD, COD, C, N, P, K, B, Ca, Mg, Zn, etc., and correlated with feed, animal and production parameters. New systems utilizing processes used in industrial waste processing will be studied. Processes to be considered for investigation are field spreading of liquid manure, decomposition at low temperatures, incineration, aeration, algae production, coprophagy, sterilization drying at high temperature, etc.

PROGRESS: In the determination of the oxygen demand parameters of animal wastes, seeding, temperature, method of determination, and type of waste have a significant effect. Storage of samples at below 2 C, dilution do not have a significant effect. The quantities of the total excrement from animals is significantly affected by the feed, the weight of the animal, and the type of the animal.

SUPPORTED BY Ohio State Government

3.0267, CONVERSION OF EXISTING ANAEROBIC DIGESTERS TO AEROBIC DIGESTERS - FULL PLANT SCALE

H.W. AUGENSTEIN, Hamilton City Government, *Hamilton, Ohio*

Hamilton, Ohio, is a city of about 75,000 people located on the Great Miami River in Southwestern Ohio. This city has a modern, split- treatment activated sludge sewage plant designed for 12 MGD primary treatment and 6 MGD secondary treatment. Separate sludge digestion and vacuum filtration are included. The wastewater received is somewhat atypical because of a one million gallon daily contribution by a local paper industry. This waste contributes a high percentage of the raw sewage solids and appears to be partly responsible for continuous difficulty with anaerobic digestion.

The research project involves the conversion of two existing floating cover digesters (80 ft. diameter, 15 ft. sidewall) aerobic units. After conversion, the covers will rest on the ledge and will be properly vented. The installation will include three 300 cfm blowers equipped with ammeter type flow indicators. Diffusion will be by a 96 inch diameter eductor tube in each digester.

One converted digester will be operated on a carefully controlled program of varied sludge volumes, aeration rates and temperatures using a mixture of raw primary and waste activated sludge. The other unit will take the excess sludge.

Vacuum filtration of the aerobically digested sludge will also be examined.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

3.0268, ENGINEERING SYNTHESIS OF EFFICIENT, ECONOMICAL DAIRY PRODUCTION SYSTEMS

W.L. ROLLER, Ohio Agric. Res. & Dev. Center, *Wooster, Ohio* 44691 (OHO00347)

OBJECTIVE: Improve the efficiency of milk production systems by the application of engineering principles to the equipment, processes and controls needed for dairy mechanization.

APPROACH: Review technical literature pertaining to dairy mechanization and synthesize several possible production systems on paper for study. Locate areas where reasonably small advances in technology may improve the total system efficiency and work on these developments. Begin the development of research approaches for solving major problems existing in dairy farm mechanization. As research approaches become apparent, projects will be outlined and submitted for support to carry out the research.

PROGRESS: This past year work was completed on system equations to compute expected returns from milk production systems and equations were incorporated into a computer program. Milk production systems using different types of housing, milking parlors, manure handling facilities and feeding systems were analyzed by use of work routines, cost budgets and expected-returns equations. Systems at different levels of milk production, cow life, and system life were compared. New layouts of the system called free stanchion housing (FSH) were drawn and ventilation requirements calculated. FSH was found to have less investment and labor requirements than best existing enclosed free stall system for herd sizes above 100 cows due to a redesigned feed manger layout. New areas of research needed to improve milk production systems include field testing of FSH, freezing of chopped hay, and mechanical removal of the milking claw. An automated calf feeder capable of feeding calves predetermined amounts of milk or milk replacer at specific times of the day, using a pipeline feed distribution system, was developed and tested for reliability. Improvements were made in the mixing chamber so that recirculation of liquid is used to achieve mixing of milk replacer. Calf performance testing was started.

SUPPORTED BY U.S. Dept. of Agriculture

3.0269, PHOSPHATE REMOVAL BY ACTIVATED SLUDGE PROCESS APPLICATION - PLANT SCALE DEMONSTRATION

L.D. LIVELY, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

Objective - The positive confirmation of an imposed biological phosphorus removal on a sustained basis at a plant which had a prior record of limited removal of phosphorus.

Locate and study activated sludge sewage treatment plants which meet critical design criterion pertinent to biological phosphate removal. The plants are to be located in different geographical regions of the Continental U.S.A. Chemical and operational characteristics will be determined to ascertain what changes are necessary for such plants to serve as demonstration plants for the biological phosphate removal process.

Description - 1. Negotiate, establish, and monitor plant scale research demonstration for five municipalities to be operated for one full year. 2. Establish system to monitor three additional sewage treatment plants known to be removing phosphorus by the activated sludge process at the present time. 3. Conduct survey and amenability studies on four more activated sludge plants in the Northeast, Southeast, Northwest, and Southwest Regions of the FWPCA to complete scope of phosphate removal project in selecting plants and identifying parameters critical to mechanism, kinetics, operation, and sustenance of the process.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0270, PHOSPHATE REMOVAL BY ACTIVATED SLUDGE PROCESS SPECIFICATION - PLANT SCALE RESEARCH

F.M. PFEFFER, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

Objective: The verification and quantification of the specific design and operational parameters which control phosphorous removal in activated sludge plants.

Description: Conduct one-year plant scale research program to meet objectives at a city of choice, known to be removing phosphate on a plant scale.

Define range and limits of operation and design parameters of phosphate removal process.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0271, RESEARCH INITIATION-PHYSIOLOGICAL AND STRUCTURAL STUDIES OF SPHAEROTILUS NATANS IN RELATION TO THE BULKING OF ACTIVATED SLUDGE

J.M. ROBERTSON, Univ. of Oklahoma, Graduate School, *Norman, Oklahoma* 73069

The role of Sphaerotilue natans in the bulking of activated sludge will be investigated with particular emphasis on conditions and mechanisms which lead to the bulking situation. Possible chemical binding of sludge materials in a bulked mass by sheath/slime layer or by esterification of the polymer, poly-B-hydroxbutyric acid, will be determined by radiotracer technique, chemical measurements and by direct examination with an electron microscope. Further investigations will be directed toward the elucidation of mechanisms which favor the growth of the highly aerobic S. natans over normal floc-forming organisms at lower oxygen levels. Elucidation of causes of bulking would permit engineers to better design and operate sludge aeration processes.

SUPPORTED BY U.S. National Science Foundation

3.0272, EVALUATION OF BEEF FEEDLOT WASTE MANAGEMENT ALTERNATIVES
A.F. BUTCHBAKER, Okla. St. Univ., Agricultural Experiment Sta., *Stillwater, Oklahoma* 74075

The objectives of this research are: 1. To develop beef feedlot design criteria to minimize pollution from runoff waste and to facilitate handling of solid and liquid animal wastes. 2. To examine alternative feedlot waste disposal to obtain a minimum cost system for effective waste disposal.

The two major segments of the research are the determination of feedlot waste management design criteria and the computer design and analysis of alternative systems. Feedlot design criteria will be determined by examining the literature, observing feedlot operations in major beef producing areas of the Midwest, Southwest, and far West, performing an operational analysis of waste handling operations, and investigating geographical factors that may affect feedlot waste- management systems. Evaluation of alternative waste-management systems for feedlots will be examined by extending a current systems computer program for the evaluation of alternative systems for forage and feedlot operations.

The project begins in June 1970 and ends in February 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0273, CATTLE FEEDLOT PEN DESIGN
A.F. BUTCHBAKER, Okla. St. Univ., Agricultural Experiment Sta., *Stillwater, Oklahoma* 74075 (OKL01208)

OBJECTIVE: Conduct feeding period tests to determine effects of crowding and stress due to space allowance per animal and pen configuration effects in cattle feedlot pens; determine the effectiveness of an oxidation ditch under a slotted floor in beef cattle waste reduction and pollution and fly control.

APPROACH: Crowding and pen configuration stress will be determined by weight gain of two pens of cattle confined to a specified space per animal as compared to gains by a control group, to determine optimum gain vs. cost information for cattle on slotted floors. The control pen will be an outside pen on dirt, comparable with commercial feeding facilities. Waste disposal under the slotted floor will be accomplished by an oxidation ditch, to determine amount of reduction, water needs, power requirements, odor and fly control, and the hydraulic properties of the ditch. Information monitored will include dissolved oxygen, pH, total and volatile solids. BOD, COD, N, K, P, nitrates and nitrites will also be monitored periodically.

PROGRESS: Oxidation ditch studies for cattle waste reduction and pollution control are currently in progress, to obtain design parameters for outside installations in the Southwest. Some foaming and icing has occurred in three weeks of near zero weather but the rotor has continued to perform well. Reduction performance has not been evaluated as activated sludge has not yet been produced. The general objectives initially presented have been met and results published. A revision of the project is to be prepared with primary objectives of investigating the performance of an oxidation ditch for cattle waste reduction and possible lagooning of ditch effluent to minimize pollution potential. No design parameters are currently available for performance of oxidation ditches in open feeding shelters for the Southwest.

SUPPORTED BY Oklahoma State Government

3.0274, RESEARCH INITIATION - REMOVAL OF ORGANICS BY TRICKLING FILTERS
E.E. COOK, Okla. St. Univ., School of Engineering, *Stillwater, Oklahoma* 74074

Trickling filters are artificial beds of stones or porous medium over which an organic waste is applied. Microorganisms present in the organic waste (or supplied from other sources) accumulate on the filter medium and, when they come in contact with the waste and air, remove the organics contained in the waste flow for use as nutrients in biological metabolism. Observation has indicated that the greater the surface area afforded by a particular filter medium on which the microorgainisms can grow and adhere, the greater the ability of the trickling filter to remove the organics contained in the waste stream applied to it.

This research will investigate various trickling filter mediums containing various specific surface areas. The different trickling filter mediums will be compared as to their capability of organic removal per square foot of available surface area, and the relationship of organic removal to available surface area will be determined.

SUPPORTED BY U.S. National Science Foundation

3.0275, BIOLOGICAL CONCEPTS FOR DESIGN AND OPERATION OF THE ACTIVATED SLUDGE PROCESS
A.F. GAUDY, Okla. St. Univ., School of Civil Engineering, *Stillwater, Oklahoma* 74074

During the past nine years, the principal investigators have conducted extensive laboratory research into a variety of aspects of the activated sludge process. These investigations have encompassed kinetic and mechanistic studies of both 'steady' operation and behavior under shock loadings of many types, as well as studies of the mechanisms of metabolic control which operate in heterogeneous populations. The number of man-years which have been devoted to this research is conservatively estimated at seventy-five. All of these studies have been conducted under controlled and comparable conditions. Fifty-eight research papers and publications have emanated from this work to date. However, a large amount of data has not yet been completely analyzed or published.

During the current year the objective is the correlation and conceptual analysis of all of these data, both those previously published and those to be published, leading to preparation of a final treatise on conceptual biological principles governing design and operation of the activated sludge process in terms which can be understood and used by practicing engineers with a wide variety of backgrounds as well as by researchers in the field.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

3.0276, IMPROVED METHODS, EQUIPMENT AND FACILITIES FOR INEDIBLE ANIMAL BY-PRODUCTS RENDERING PLANTS
D.R. HAMMONS, Okla. St. Univ., U.S.D.A. Transp. & Facil. Div., *Stillwater, Oklahoma* 74074 (TF2-101A)

OBJECTIVE: Develop improved layouts, equipment, and methods for increasing efficiency in plant operations; and determine criteria for controlling salmonella contamination in animal by-products rendering plants.

APPROACH: Collection of data concerning both operating efficiency and control of salmonella contamination is nearing completion. These data have been collected from a series of studies of a broad cross- section of small and medium sized rendering plants representing significant variables such as facilities and equipment used, volume produced, handling and processing methods employed, and final products prepared. Data will be analyzed and one or more manuscripts covering the significant findings will be prepared.

PROGRESS: Results of engineering studies in rendering plants indicate that improved layouts, work methods, and equipment can reduce operating costs. These analyses also indicate

that increasing operating efficiency without taking into account the problem of salmonella contamination in rendering plants would not provide the guidelines and assistance needed by this industry. Case studies were completed in six cooperating Oklahoma rendering plants to obtain environmental data for evaluating total bacteria count causes and effects in in-plant operations and product contamination relationships to environmental factors. Some common factors found to be contributing to the high incidence of salmonella in inedible rendering plants are: (1) Excessively long conveyors were used after the cooking process which allowed the product to cool and become recontaminated, (2) uncovered conveyors allowed recontamination of cooked material, (3) crossover conveyors permitted raw material to pass directly over cooked material, (4) poor operating methods allowed product to remain in perc pans too long, (5) almost complete lack of concern by the rendering industry, (6) cross traffic between departments permitted mixing of cooked and raw material, and (7) inadequate grinding of raw material prior to cooking resulted in incomplete kill in the larger pieces.

SUPPORTED BY U.S. Dept. of Agriculture

3.0277, UTILIZATION OF BARK WASTE
H. AFT, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE-F-00861)

OBJECTIVE. Study methods for chemical and physical utilization of bark.

APPROACH. Conduct chemical studies on hemicellulose and lignin of inner bark and develop gas-liquid chromatographic methods for analysis of aliphatic alcohol component of bark extractives and suberin of Douglas fir bark. Determine molding properties of bark with variables of species, particle geometry, moisture content, and chemical additives or extractives prior to molding.

PROGRESS. Two principal lines of research effort were maintained in the physical utilization of bark: (1) pelleting, and (2) molding. Good to excellent pellets of 1/4-and 1/2-inch diameters have been made of several different species of bark and bark mixtures. Pelleting offers a practical application in transport of bark wastes. Bark molding involved several types of products with bark extension of the plastic. Preliminary economic analyses appear favorably inclined toward commercial application. Cooperative efforts are continuing with a number of forest products and engineering companies interested in use of bark as raw material. Chemical utilization has involved studying the detailed chemical composition of Douglas fir bark. A hexane soluble wax fraction that contains two long chain fatty alcohols and phenolic-like compounds and a benzene soluble wax fraction which has a pleasant, aromatic odor were isolated. Various bark carbohydrates were extracted from the inner bark of Douglas fir when successively extracted with 80/20 ethanol/water, 2/1 benzene/ethanol, hot water, dilute ammonium oxalate, and acidified sodium chlorite. Treatment of bark with gaseous ammonia increased the nitrogen content from 0.46% to 4.08%. The treated bark is being separated by various solvent extractions.

SUPPORTED BY Oregon State Government

3.0278, ENVIRONMENTAL POLLUTION PROBLEMS AND ABATEMENT CONTROL ALTERNATIVES
R.M. ALEXANDER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00833)

OBJECTIVE. Identify the important environmental pollution problems in Oregon and assess their current and potential significance. Relate present federal, state and local abatement and control policies and programs to these problems. Identify alternative policies and programs that may have relevance to these problems and assess their social, economic and political implications.

APPROACH. As the objectives indicate, a review will be made of significant environmental pollution problems in Oregon and current abatement policies. Alternative policies that may be relevant to Oregon's situation, and possible economic, social and political implications of these policies, will be considered.

PROGRESS. This project was activated in 1967 to cover a study undertaken for state government in Oregon on waste disposal policy. The project was completed with publication (April, 1968) of a report entitled, 'Waste Disposal and Environmental Quality in Oregon--An Assessment of Public Policy'. This report reviewed '...the nature of the wastes that produce environmental pollution in Oregon and on the abatement and control technology available... and ...an assessment of present public policy in Oregon, possible improvements, and alternatives that may offer certain advantages.'

SUPPORTED BY Oregon State Government

3.0279, DOUGLAS FIR BARK AS A FILTER MEDIA FOR THE DISPOSAL OF ANIMAL WASTES
M.G. CROPSEY, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00901)

OBJECTIVE. To prevent the pollution of streams and undergtound water by the liquid wastes from livestock enterprises by using Douglas fir bark as a trickling filter in the waste disposal system.

APPROACH. Experiments will be conducted to determine the relative effectiveness of various parameters in the use of Douglas fir bark as a filter media. Some of the parameters tested will be: Ratio of manure to water. Ratio of quantity of bark to the quantity of manure and water. Rate of flow of the liquid through the filter media. Size of bark particles. Life of bark as a filter media. The results will be determined by the reduction of B.O.D., nitrogen and phosphorus of the effluent and the undissolved solids. The experimental data will be extrapolated in order to design a livestock waste disposal system. When sufficient data has been obtained, a model plant will be set up to determine the effectiveness of this method of reducing the wastes of a livestock enterprise.

PROGRESS. Samples of water polluted 1, 2, 4% by weight with poultry manure are being tested to determine the effect of rates of flow, bark size, and quantity of bark in the cleaning of water. The water is tested immediately after being polluted and after five days of filtering for its B.O.D., turbidity, residue upon evaporation, and its nitrogen and phosphorous content. In as much as these tests have not been competed at this date, no conclusions can be made.

SUPPORTED BY Oregon State Government

3.0280, MANAGEMENT PRACTICES AFFECTING SWINE PRODUCTION
D.C. ENGLAND, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00527)

OBJECTIVE. Increase number farrowed per litter and reduce incidence of undersized pigs. Improve pre-weaning survival and growth. Development and testing of new and improved methods and facilities for feeding, cleaning, and manure disposal for hogs raised in confinement.

APPROACH. Data will be collected on ovulation rate, embryo mortality, number of live and dead pigs, and individual birth weights of pigs in relation to number of pigs nursed in the preceding lactation, number of services required, grouping of sows not previously together as opposed to individually housed animals and groups of animals previously housed together, effect of drugs to relieve stress at breeding time, prophylactic use of antibiotics at breeding time, and induction of mating during lactation. Influence of environmental factors upon preweaning growth and survival will be investigated through studies of: artificial feeding of pigs of different birth weights, temperatures most nearly optimum for pigs of different birth weights, amounts of milk obtained by pigs of different birth weights and at different udder section locations, methods of artificial feeding and effectiveness of protective facilities to prevent crushing & chilling. For growing finishing swine, studies will be made of feed wastage & means of preventing it, space requirement with different types of floorings, comparisons of various kinds of bedding areas, & handling methods to induce pigs to use preferred areas of manure deposition. Self-cleaning floors and automatic disposal of collected fecal and urinary wastes will be developed and tested.

PROGRESS. Prolificacy and breeding performance have remained high with total confinement on slotted floors. Birthweights of litters from gilts, but not from sows, were in-

creased by feeding 2, 2-dichlorovinyl dimetyl phosphate (DDVP) during last three weeks of gestation. Postnatal survival was affected similarly. DDVP in ration of gilts prior to breeding did not increase ovulation rate; inclusion after breeding did not affect embryo survival to 25 days. Inclusion of DDVP in ration of market hogs, both full- and limited-fed, did not change average daily gains or carcass traits. Energy stores thus do not appear to be mobilized by DDVP for metabolism in animals of these ages. Further studies underway to better define mode-of-action of DDVP in swine.

SUPPORTED BY Oregon State Government

3.0281, CHEMICAL TRANSFORMATION OF SOLID WASTES

V.H. FREED, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00860)

OBJECTIVE: A study of chemical transformation of solid waste with the view of conversion of solid waste to products of economic value or reduction of volume for easier handling. Includes classification of solid wastes, investigation of methods of chemical transformation of solid wastes, and development of pilot plant operations including studies of engineering and economic aspects.

APPROACH: Following the initial classification and identification of solid waste, studies on chemical transformations will be undertaken, initially on simple wastes such as paper, straw and bark. Significant findings will be applied to municipal solid wastes. These studies should lead to a pilot plant operation utilizing chemical transformation techniques.

PROGRESS: The study of hydrogenation of solid wastes to oils was continued. Bark, straw, rubber, and paper were used. Catalysts such as hydrogen iodide, tetrahydronaphthalene, tin chloride, and platinum were used. Oil yields from 15-20% are attainable using gaseous hydrogen, a catalyst, 350 C, and 4500 psi pressure. The oil produced by hydrogenation of bark using HI-(2) catalyst was analyzed by a commercial laboratory and found to contain 65% aromatics and 35% saturated hydrocarbons. The use of cellulose chemistry to produce products from wastes was continued. Straw, pulp, and paper have been used to produce such derivatives as cellulose acetate, cellulose acetate-butyrate, cellulose maleate, cellulose succinate, methyl cellulose, cellulose phthalate, and benzyl cellulose. Many can be formed into a solid disc under pressure and elevated temperature. Three methods of acetylating the cellulose were evaluated, a solution process, a fiber process, and a vapor phase process. Cellulose crosslinking can be achieved with diisocyanate. A solid disc was produced from the product of straw and tolylene-2,4-diisocyanate. Furfural was produced from the pentosan extract of straw and a pentosan removal technique was evaluated. Destructive distillation of straw and tires produced over 50% condensible liquids and over 30% solid residue. The rubber ash was 20% and the straw ash 6%. The remainder apparently carbon. Wastes such as straw can be mixed with resins and formed into solid sheets under pressure and elevated temperatures.

SUPPORTED BY Oregon State Government

3.0282, CHEMICAL TRANSFORMATION OF SOLID WASTES

V.H. FREED, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Solid waste disposal problems can be alleviated to some degree if methods can be developed to transform waste materials into usable products or if waste components can be reclaimed for reuse.

The objective of this project is to study the reclamation of solid wastes through chemical treatment. Some of the basic work, such as literature searching and laboratory experimentation, has been completed and several processes for transforming wastes to usable products appear to be potentially useful. These processes will be studied in more detail to evaluate economic and engineering factors.

A large part of many solid wastes is cellulosic in nature; therefore a study of the chemistry of cellulose has been undertaken in detail. It is possible that waste cellulose could be used as raw material for the production of such cellulose derivatives as cellulose acetate, cellulose nitrate, ethyl cellulose, cellulose xanthate, and carboxymethyl cellulose.

Hydrogenation, ammoniation, and destructive distillation of solid wastes are other potentially useful chemical treatment processes that are being studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0283, MACRO-FAUNA IN WASTE STABILIZATION LAGOONS

R.L. GOULDING, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Waste stabilization lagoons are man-made environments that are becoming a more prominent feature of land use. The fauna adapted to this habitat has received little attention. In view of the potential importance of the macro-fauna which may be beneficial in that they contribute to the biological breakdown of organic matter or harmful as potential disease vectors or nuisance organisms, it is imperative that a thorough ecological study of this habitat be carried out.

The long-term objectives of this proposal are to measure the contribution of the macro-fauna in the breakdown of putrescible organic wastes; to understand the pathways through which this is effected; and to assess the beneficial and detrimental results caused by the macro- fauna in lagoons of various designs.

The major emphasis will be a study of the production ecology of Glyptotendipes barbipes; the most abundant macro-invertebrate in the lagoons.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0284, LASER MEDIATED LIGNIN SOLID WASTE FERMENTATION

D.A. KLEIN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00894)

OBJECTIVE: Lignin residues derived from the pulp and paper industries have not been utilized fully, leading in many cases, to stream pollution and solid waste disposal problems. Prior studies on microbial degradation of lignin have shown these compounds to be degraded slowly, even under optimal laboratory conditions. The major objectives of this study are to obtain data on the effects of lasers and irradiation energy sources on the configuration of lignin substrates, and to evaluate effects of such modifications on microbial transformation and degradation processes.

APPROACH: By modifying the secondary and tertiary structures of lignin substrates in aqueous solution, is planned to develop processes by which the lignin polymer can be degraded completely, for use as a carbon source, or be modified by microbial transformations to yield chemical intermediate of commercial interests.

PROGRESS: Work with both fungal and bacterial growth systems in pure cultures has indicated that photolysis during low or high pH conditions, in comparison with pH 7.0, permits retention of a greater portion of ligninsulfonate carbon. By use of varied photo-oxidative conditions, it has been possible to render residual ligninsulfonate carbon up to 70% bio-utilizable. Without photolytic modification negligible bio-utilization is observed. Light wavelengths of under 210 nm are required, and as little as 0.5 Watt of output power should give the potential for an efficient single-pass treatment system. Information on the nature of biological responses to photooxidized ligninsulfonates has also been obtained. Fungi appear to utilize lower- weight polymeric products produced earlier in photomodification as well as aromatic lignin subunits, while bacterial responses appear to be related primarily to the utilization of aromatic subunits produced in later stages of the photooxidation process. Microbial economic utilization coefficients with photolytically-produced lignin sulfonate fragments can be equated to use of conventional carbon sources. Model compound studies using alpha-conidendrin have confirmed accumulation and utilization of aromatic subunits derived from photolysis.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY Oregon State Government

3.0285, ENVIRONMENT AND MANAGEMENT OF LAYING HENS

J.E. PARKER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00021)

OBJECTIVE: Determine laying hen response and develop recommendations with respect to feeding systems, water consumption, lighting schedules, poultry waste disposal, cage space allowances and other environment factors.

APPROACH: Continue the lighting programs with emphases shifted toward evaluating intensity; evaluation of feeding systems involving periodic changes in dietary protein or energy; cage management practices involving regrouping or relocation as well as water saving practices such as restriction and recirculation.

PROGRESS: A study was conducted in 2'x2' cages using 4, 6, 8 and 10 hens per cage (1, .7, .5 and .4 sq. ft./hen) with and without roosts installed in the cages. Hen-day egg production was 66.2, 61.4, 61.0 and 57.0% for 4, 6, 8 and 10 hens per cage, respectively, but did not differ significantly for any treatment. The addition of roosts significantly decreased feed consumption and tended to improve feed conversion. Feed conversion was significantly better with 4 than with 10 hens per cage. Body weight gain was significantly lower with 10 than with 4, 6 or 8 hens per cage. Egg weight and percent cracked eggs were not significantly affected by any treatment. Another study was conducted using 1, 2 and 3 hens per 12'x18' cage (1.50, .75 and .50 sq. ft. per hen) with and without the addition of roosts and with a normal or a high nutrient density (HND) feed. The HND feed significantly reduced feed consumption and improved feed conversion. There was a significant roost X feed interaction for feed conversion. Adding roosts to cages with normal feed significantly improved feed conversion, but with the HND feed there was no effect from adding roosts. Also, eggs tended to be heavier from hens with roosts on normal feed than in the other groups. Egg production, body weight gain and percent cracked eggs were not significantly affected by any treatment. These studies indicate that it might be practical to provide only .5 sq. ft. per hen in cages, that adding roosts might improve feed efficiency and that it is not practical to use a high nutrient density feed.

SUPPORTED BY Oregon State Government

3.0286, MICROBIOLOGICAL TREATMENT OF POTATO WASTES

D.S. MAY, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

In order to better understand the role of microorganisms in the biological treatment of potato processing wastes, several areas will be investigated. The processing waste streams will be characterized to determine chemical constituency with respect to nutrients, organic materials, and trace materials. Attempts will be made to isolate and identify the predominant organisms existing in present treatment systems and determine their role in stabilization of the waste. Using bench-top treatment chambers the growth of these organisms and the conversion of the waste will be followed closely by chemical and biochemical analysis. Organisms which provide good decomposition will be further studied under the influence of nutrient additives which may enhance microbial activity. The feasibility of incuding cultures of highly active microorganism will be investigated. Consideration will be given to the development of biological flocs which may be recovered from the system and used as food material for livestock.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0287, CHEMICAL AND ENGINEERING ASPECTS OF POTATO PROCESSING WASTES TREATMENT

L.J. NIELSON, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

This investigation will evaluate the several potato processing wastes for treatment both as separate wastes and as a combined flow. Emphasis will be on increasing efficiency of waste treatment for protection of receiving waters and for reduction of treatment costs. Research will consider possible by-product recovery by use of polyelectrolytes and/or pressurized air flotation. The economics of dehydrating potato starch wastes for recovery of a useable product will be examined.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0288, PULP AND PAPER WASTE CONTROL AND TREATMENT

R.H. SCOTT, U.S. Dept. of the Interior, Federal Water Quality Admin., *Corvallis, Oregon* 97330

Development of State of Arts Document covering principal segments of pulp and paper production, in-plant control and treatment for waste reduction, processes in-plant leading to destructive disposal, or utilization and by-product development. Consideration of available means for waste salvage for re-use, water conservation and in-plant concentration and distribution of waste fraction in weak waste streams. Review of present knowledge regarding waste treatment technology as practiced in the industry.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0289, RESEARCH ON AN ANIMAL-WASTE POLLUTION CONTROL SYSTEM

E.D. GROSSMANN, Drexel University, School of Engineering, *Philadelphia, Pennsylvania* 19104

Three areas of investigation are associated with this research effort: the steam drying of the animal waste, characterization of the odors in the dried waste, and toxicological and nutritional studies of the dried waste. Factors to be determined include the effect of manure moisture content on drier operation, the effect of mass velocity on both heat transfer and mass transfer, the influence of superheat in the drying medium (steam), the mechanism of drying, bed depth influence, particle size and shape effects, and the influence of nozzle orientation.

Both organoleptic testing or subjective evaluations and analytical testing by means of gas-liquid chromatography, infrared spectroscopy and mass spectroscopy will quantitatively and qualitatively define the odors present in the dried manure and the liquid waste resulting from the drying operation.

Toxicological studies will involve many chemical tests including pH, alkalinity, iron content, phosphate content, nitrate content, sulphur content, chloride content, water and ether soluable material content, and nitrogen content. Animal feedings will also be used to determine the toxic effects of the dried manure. Those prducts found non-toxic will be evaluated for nutritive value by feeding to rats.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0290, INTEGRATED WASTE MANAGEMENT - WATER SYSTEM USING RADIOISOTOPES FOR THERMAL ENERGY

R.W. MURRAY, General Electric Company, *Philadelphia, Pennsylvania* 19123 (AT(30-1)-4104)

The objectives of this program are to design, develop, fabricate and test an engineering model of a completely integrated Waste Management - Water System (WM-WS) using Radioisotopes for Thermal Energy (RITE). This is to be a complete system capable of collecting and processing wastes from four men for a 180-day simulated space mission. Subsystems include feces, trash and urine collection; water reclamation; storage, heating and dispensing of the water; storage and disposal of the feces and urine residue and all other waste material by incineration.

Spacecraft life support systems require heat for several regenerative and recovery processes. RITE has shown to be a very reliable means of providing this heat with a significant savings in the weight normally required for an electrical heat power supply. The resulting reduction in space vehicle weight greatly reduces the required launch rocket thrust and thereby the overall cost of the space voyage. The proposed program integrates several waste

management and water recovery functions into one coherent system to permit multi-purpose use of components and efficient utilization of the RITE.

The WM-WS Program is to be accomplished in seven (7) phases; namely, (1) Design waste incinerator/waste reclamation (WI-WR) unit, (2) Fabricate and test WI-WR, (3) Evaluate test data, (4) Design total WM-WS, (5) Fabricate WM-WS, (6) Test WM-Ws for 10 days, (7) Test WM-WS with RITE for 180 days.

SUPPORTED BY U.S. Atomic Energy Commission

3.0291, PIPE TRANSPORT OF SOLID WASTE

F.D. KETTER, Univ. of Pennsylvania, School of Engineering, *Philadelphia, Pennsylvania* 19104

The broad objective of this proposal is to examine the applicability of the technology of bulk solid transport in pipelines to the collection and removal of solid waste. Whether the pipeline transport of solid waste may be considered as a serious alternative to the truck collection, depends upon the answers to two questions which are fundamental: 1) Is pipeline transport of solid waste technologically feasible? and 2) How does solid waste pipeline compare economically with the present truck collection?

As the result of Grant UI 00541 it was established that under one special set of conditions (those prevailing in the center city of Philadelphia) the collection and removal of solid waste in a combined pneumatic and slurry system is technologically feasible and economically attractive.

It is intended to extend the range of the study examining in particular 1) the technological feasibility of pipeline collection and removal of solid wastes of varying compositions different than those already studied, 2) the feasibility of pumping solid waste slurries with higher concentrations than 12% which is already established - including problems in crushing and pumping, 3) search for reliable criteria for the design of solid waste pipeline which at the present time is lacking, 4) extension of economical comparison of pipeline system with the truck collection to situations different than business districts of the large cities using the methods of system technology, and 5) a study of possible utilization of pipeline as a biological reactor for stabilization of organic matters during conveyance of the solid waste slurry.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0292, VORTEX INCINERATION OF COMBUSTIBLE WASTES

C.H. SCHWARTZ, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

To conduct research on incineration. A pilot-scale vortex incinerator with a nominal capacity of 200 pounds of refuse per hour has been designed, constructed and tested. It is refractory-lined, provided with continuous charging, agitation, and has ports for directing secondary air to the center of the vortex.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0293, PYROLYSIS OF SOLID WASTES

D.E. WOLFSON, U.S. Dept. of the Interior, Bureau of Mines, *Pittsburgh, Pennsylvania* 15213

The pyrolytic conversion of noxious and harmful municipal and industrial refuse and other organic based pollutants into potentially useful materials without adding to environmental pollution.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0294, UTILIZATION OF AGRICULTURAL WASTES IN CROP PRODUCTION

H.D. BARTLETT, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01585)

OBJECTIVE: Develop and evaluate methods for efficient handling and utilization of animal and poultry manures as sources of crop nutrients; develop and evaluate methods for combining manure with various vegetable wastes to obtain organic fertilizers and soil amendment products of nutrient value in crop production.

APPROACH: A liquid manure handling system will be constructed, in conjunction with a dairy stall-barn, for study of handling methods and equipment in relation to operational performance, energy requirements and efficiency. Methods and equipment will be developed for making sub- surface applications of liquid manure to agronomic soils. Surface and sub-surface applications of liquid manures at different treatment rates, will be made to plots of various crops. Effect of respective treatment methods and rates will be evaluated in terms of crop growth response and crop quality. Studies will be made to develop methods for making use of numerous agricultural wastes for compost or other organic fertilizer products of value in crop production.

PROGRESS: Liquid manure treatments were made to replicated corn plots at 20, 40 and 60 ton per acre with fall application-fall plowed, fall application-spring plowed, spring application-spring plowed, top dressing after planting and when plants were 15 in. high. Yields were not significantly different between treatments, although there was a trend toward higher yields with higher application rates. Trials, using liquid poultry manure as a nitrogen supplement for mushroom compost, with horse stable litter as a base, did not produce a satisfactory compost. Mechanical break up of the slurry will be necessary for even distribution of the slurry throughout the stack. Furthermore, uniform heating was not attainable, either due to uneven application of the supplement or the microbial activity. An additional 1500 Douglas fir seedlings from various seed sources were planted and fertilizer treatments were applied. Soil samples were analyzed to determine treatment effects on nutrient levels. Growth measurements have been made and are currently being analyzed. Mowing and herbicide treatments were used to control competing vegetation. Manure treatments have caused problems of stimulating weed growth which provide cover for mice and voles that damage trees; it has not yet been determined whether increased growth rate may offset these disadvantages.

SUPPORTED BY Pennsylvania State Government

3.0295, FEED AND WASTE HANDLING IN THE DAIRY OPERATION

H.D. BARTLETT, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01670)

OBJECTIVE: Evaluate and develop methods and equipment for mechanization of handling materials in dairy livestock feeding operations, particularly stall barns. Evaluate and develop methods and equipment for handling and distribution of wastes from dairy production systems.

APPROACH: Studies will be made of existing feeding equipment installations to evaluate labor requirements and equipment costs for feeding dairy cattle in stall barns by mechanical feed carts and with various manager conveyor feeding systems. Work will be done on the development of mechanical feed conveying equipment. Studies of dairy waste management will include handling of animal excrement and the waste water used in cleaning milk houses and milking parlors.

PROGRESS: A mechanical feeder for supplying silage and grain to cows in stall barns has been designed and is being installed. The distribution system is a flight-chain with adjustable volumetric feed compartments for each cow. It will distribute measured quantities of each type of feed to individual cows according to production needs. Using the same conveyor for both types of feed and combining feed compartment construction for each pair of cows greatly reduces the cost of the mechanical equipment. Analyses were made of the power requirements of such a system by laboratory tests of friction forces for the respective feeds and related construction materials. A prototype was constructed to determine flow characteristics of the respective feeds in this type of system. The feeder will be evaluated for functional and mechanical operation in the next three months. An expandable orifice nozzle has been designed and installed in a system to dispose of milking parlor and milk house wastes by distribution on land through a sprinkler irrigation system. The orifice size is controlled by a spring loaded retainer which allows the orifice to open when line pressure increases due to restriction or stoppage by accumulation of solids in the orifice. Further development is necessary on the elastic liner. This system is being

tested under winter conditions. The system will be evaluated in relation to pollution problems of odors, flies and ponding.

SUPPORTED BY U.S. Dept. of Agriculture

3.0296, SUBSURFACE DISPOSAL OF ANIMAL MANURE
H.D. BARTLETT, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01787)

OBJECTIVE: Develop and evaluate disposal and utilization systems for land application of treated and untreated dairy and poultry manure that will minimize the pollution of water, soil and air.

APPROACH: Manure will be applied, up to 100 T/acre/year, approximately 4 inches below the surface of soil in forage grass vegetation when soil conditions permit operation on the land. Applications also will be made to corn plots before planting, after planting, and after harvest. Frequency and amount of application will be varied on replicated 1/2 acre plots. Nitrate will be analyzed on soils sampled with regard to depth of sample, season, and treatment. Crop yields and tissue analyses also will be used in determining soil productivity and nitrogen removal.

PROGRESS: Treatments of liquid manure (dairy cows) were applied approximately 4 in. below the surface of a recently established seeding of Pennmead orchard grass during the period May-Sept. 1969. Application rates of 15, 30, 45, 60 and 75 T/A were made in 15 ton increments with successive applications made when soil conditions permitted passage of equipment over the previous application. The treatments were arranged in randomized block design with four replications on 20 ft. x 50 ft. plots. Suction lysimeters were installed in each plot at depths of 1, 2, 3 and 4 ft. (1 each per plot, Aug. 1969). Water samples were taken from the lysimeters at weekly intervals beginning Oct. 27, 1969. The samples are being analyzed to determine NH(4), NO(3), P, organic nitrogen, Cl and pH. Analyses will be made for Cations: Ca, Mg, Na and K. Also, tissue analysis will be made on orchard grass samples taken from each plot. Samples of the waste were taken for crop nutrients and BOD analysis. The same treatments rates for the respective plots will be repeated in the spring and summer of 1970. Also, the water, crop tissue and soil moisture analyses will be continued.

SUPPORTED BY U.S. Dept of Agriculture

3.0297, AGRICULTURAL WASTES - POULTRY MANURE DISPOSAL AND USE
G.O. BRESSLER, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01588)

OBJECTIVE: Develop methods of drying and handling poultry droppings in a poultry house; determine relationships among temperature, moisture, air movement and drying rates of fresh poultry droppings; determine effect of drying poultry droppings upon kind and levels of micro-organisms, odors, amount of fly infestation; incinerate dry droppings and determine caloric value of droppings, chemical composition of ash, economic feasibility of method, methods of merchandising.

APPROACH: Two poultry houses with flocks of about 3000 leghorn layers in each will be used initially for conducting experiments. Adjustments will be made in equipment placement and ventilation design to provide a positive system of drying droppings. Drying rates of poultry droppings will be related to temperature and moisture conditions. Kind and level of micro-organisms will be determined by using recognized air sampling techniques. House odors will be determined by gas chromatographic analyses. Dry droppings will be incinerated and heating value determined. Ash remaining after incineration will be analyzed for chemical composition and value of ash for plant growth determined by running pot and field experiments in combination with plant tissue analysis.

PROGRESS: Improve the efficiency of drying poultry manure, average air velocity over the manure was increased from around 200 to over 500 feet per minute. In present experiments manure can be dried to about 30% moisture in wintertime without use of heat cable, for about 1/4 cent per dozen eggs. The main problem now is to achieve further drying to about a 10% level at a lower cost than that achieved by use of heat cable in the floor of the poultry house. Experiments with ashed poultry manure have indicated that: (1) foliar analyses of beans grown in soil treated with ash showed significant increases in levels of K, Mg, G and Na, Ca and Mn decreased significantly. (2) Ashed chicken manure increased the soil pH and also soluble salts.

SUPPORTED BY Pennsylvania State Government

3.0298, CONSERVATION AND RENOVATION OF WASTE WATER
L.T. KARDOS, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01481)

OBJECTIVE: Determine effect of irrigation with sewage plant effluent on yield and other plant response parameters of agronomic and forest vegetation; determine to what extent agronomic crops, trees, and soil mantle can renovate sewage plants effluent and permit its recharge to ground water; determine effects of application of sewage plant effluent on physical, chemical and biological properties of soil; compare effectiveness of various surface and sprinkler distribution methods for disposal and renovation of sewage plant effluent.

APPROACH: Agronomic and forested areas will be irrigated with chlorinated sewage plant effluent at weekly intervals with sufficient quantities to secure recharge to ground water but at rates of penetration which will permit renovation of effluent in biologically active portion of soil mantle prior to its recharge to ground water. Effects of the effluent on crop and tree growth and on soil properties will be determined. Engineering studies will compare several methods of applying the effluent to determine their effectiveness as distributing systems on a year round basis.

PROGRESS: Chlorinated effluent was applied to forest and crop areas in quantities from 1 to 4 inches per week. Drought occurred in four of the years and increases in crop yields ranged up to 300%. Harvested crops removed nitrogen equivalent to 100% of the applied nitrogen and 80% of the applied phosphorus. Red pine diameter and height growth were increased by one inch of effluent at weekly intervals but responses to 2 inches per week were unfavorable. Young hardwoods responded favorably to all levels of application whereas the mature hardwoods did not. Terminal height growth of the white spruce was increased to 400%. Removals of nitrogen and phosphorus, two constituents primarily responsible for eutrophication of streams, were excellent. After 5 years, water percolating through the soil at the 4- foot depth on plots receiving 2 inches of effluent weekly had an average concentration in Nov.-Dec. 1967 of only 0.06 mg/1. of phosphorus and 6.4 mg/1. of nitrate-nitrogen. Recharge of the groundwater table from plots receiving 2 inches per week was equal to 90% of the applied effluent. Physical, chemical, and biological properties of the soil were not adversely affected.

SUPPORTED BY U.S. Dept. of Agriculture

3.0299, USING CROPLAND FOR SEWAGE WASTEWATER AND SLUDGE DISPOSAL
L.T. KARDOS, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01809)

OBJECTIVE: Determine interaction of soils and plants with sewage wastewater and sludge disposed on cropland and forestland, with emphasis on P, boron, and N reactions in the soil and with the biosphere and on the soils potential for removing N from wastes by denitrification; develop systems for land disposal of wastewater and sludge.

APPROACH: Cropland and forestland will receive various amounts and proportions of sewage wastewater and sludge. Yields and composition of agronomic crops and forest foliage, wood, and litter will be used to evaluate annual nutrient removal in harvested crops and nutrient absorption, storage, and recycling in forest stands. Chemistry and kinetics of P fixation on and penetration into soil will be studied. Adsorption and desorption of boron in layers of the soil mantle and its significance in potential boron toxicity will be evaluated. Effect of various combinations of wastewater and sludge loading on nitrification and denitrification will be examined. Hydrologic effects such as perched water tables, interflow and runoff will be measured.

PROGRESS: Hydrologic studies were initiated on a reed canarygrass site to determine the most effective sequence of irrigation of sewage effluent for producing minimum runoff with max-

imum renovation. The reed canarygrass area continues to be the most effective in controlling NO(3)-N through puts to the groundwater. During September-October average NO(3)-N concentration in the soil water at the 4-foot depth was 1.42 mg/1. in the reed canarygrass area which was receiving 2 inches of effluent at weekly intervals but was 9.06 mg/1. in a similarly effluent treated silage corn area. Forested areas receiving 2 inches of effluent weekly have had NO(3)-N concentrations exceeding 10 mg/1. at the four- foot depth. Red pine receiving 2 inches of effluent became severely chlorotic in 1968 whereas the one-inch treated area showed on chlorosis. Several denitrifying microbes were isolated from effluent treated soil by enrichment culture under anaerobic conditions and their denitrifying capacities determined under various conditions of temperature, oxygen tension and pH.

SUPPORTED BY U.S. Dept. of Agriculture

3.0300, SOLUBLE PHOSPHORUS REMOVAL IN THE ACTIVATED SLUDGE PROCESS

R.R. KOUNTZ, Penn. State University, School of Engineering, *University Park, Pennsylvania* 16802

This project will develop a process for the removal of phosphorus from municipal waste waters utilizing chemical precipitation of the phosphorus within the aeration and settling units normally used in the activated sludge process. The work will be conducted at the waste water treatment plant owned and operated by The Pennsylvania State University. Studies will be conducted to determine the relative merits of sodium aluminate and filter alum as precipitating agents, the efficiency of the coagulant in removing phosphorus over a one year operating period, the effect of the sludge digester on the inorganic precipitate. Costs and operating information for a 2.1 mgd domestic waste plant will also be ascertained.

SUPPORTED BY Soap & Detergent Association

3.0301, SEPTIC TANK SYSTEMS AND PRODUCTIVITY OF PENNSYLVANIA SOILS

R.P. MATELSKI, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01632)

OBJECTIVE: Determine and predict the soil factors responsible for adequate septic tank usage. Identify the soil properties responsible for observed variations in productivities.

APPROACH: Field measurements and later laboratory soil determinations of the effect of seasonal variation, perched water tables and the variability within a mapping unit on waste water movements will be studied to predict efficiencies of septic tank tile disposal fields. The field percolation tests will be studied and improved. Yields of important crops on soils with variations in slope, erosion, fertilizer treatments and management will be measured and evaluated. Soils will be characterized in the laboratory to determine the soil factors contributing to yield variation.

PROGRESS: Further statistical evaluations of 250 sites on 90 soil series in 25 counties indicated considerable percolation test rate variation of individual tests within a single site. Field designated permeability classes recorded at the time the soil was described were generally lower than the determined percolation rates. Soil drainage classes were found to be closely related to percolation rates, with 82% of the moderately well, somewhat poorly and poorly drained sites having rates slower than 2.5 cm/hr and 76% of the well drained sites having rates greater than 2.5 cm/hr. Measured yields of ear corn for 1967 and 1968 in Chester and Mifflin Counties on 20 soil series were subjected to multiple regression analyses. Of the 60 soil, management and weather factors; July precipitation, plant population, percent of subsoil clay, available potassium, pH of the subsoil, amount of disease, depth of solum, percent of organic carbon and percent of coarse fragments explained 72% of the yield variation. Additional percolation testing for septic tank use recommendations was continued in Snyder, Butler and Bedford Counties. The presence of deep fragipans prevented certain supposedly well drained soils from passing the percolation standards of the Pa. Dept. of Health.

SUPPORTED BY Pennsylvania State Government

3.0302, HIGH-RATE, MULTIPLE MEDIUM FILTRATION FOR SECONDARY TREATMENT OF MUNICIPAL WASTE WATER

J.B. NESBITT, Penn. State University, School of Engineering, *University Park, Pennsylvania* 16802

This project will study the treatment capability and economic feasibility of a high-rate, multiple medium filter for the secondary treatment of municipal waste water. The study will be conducted on a model filter constructed at the Pennsylvania State University sewage treatment plant. Effluent from the primary settling basins in the plant will be chemically coagulated and passed through the model filter.

The following analyses will be made of the influent to and effluent from the filter: (1) biochemical oxygen demand (BOD), (2) chemical oxygen demand (COD), (3) soluble and total phosphorus, (4) ammonia and nitrate nitrogen, and (5) turbidity.

Studies will be made to determine: 1. the effect of size of the top medium and different coagulants on effluent quality as measured above and on the length of filter run. 2. the washing rate and time of wash that will produce the most economical operation. 3. the feasibility of vacuum filtration for the disposal of filter wash water. 4. the economics of a waste water disposal system utilizing primary treatment; high-rate, multiple medium filtrations; and separate sludge digestion with vacuum filtration of digested sludge.

SUPPORTED BY Pennsylvania State University

3.0303, SYSTEM OF SWINE PRODUCTION DESIGNED TO IMPROVE COMPETITIVE POSITION

G.W. SHERRITT, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01759)

OBJECTIVE: Develop a system of swine production that will, through control of environment, provide high levels of feed efficiency, productivity, and health; through feed and manure handling systems, minimize labor requirements.

APPROACH: Develop and evaluate a 'farrow-to-finish' housing and management system in terms of feed requirements per pound of pig marketed, age of pigs marketed and pigs per litter marketed. The ventilation, feeding and management practices that will make the system work will be developed through continuous recording and changes as necessary. An evaluation of the economics of the total system will be made when it has been completed and is functioning.

PROGRESS: Data was accumulated on two crops of pigs in the farrow- to-finish system of production over the last year. Additional information on control of air movement and humidity through alternate ventilation methods was studied. Completion of the project, summarization of the results, and publication is expected in the coming year.

SUPPORTED BY Pennsylvania State Government

3.0304, EVALUATION AND DEVELOPMENT OF SPECIAL PURPOSE COALS

W. SPACKMAN, Penn. State University, School of Earth Sciences, *University Park, Pennsylvania* 16802

This contract will entail the collection of coal samples of all ranks from all over the United States, with particular attention paid to those areas that contain coal types that may be of value in existing or potentially feasible processes involving coal gasification liquidification, sewage treatment, etc. Not less than twenty coal types will be selected from the total samples on the basic of availability, potential for economics separation, use potential, and petrographic and chemical distinctiveness.

These samples will be subjected to standard petrographic analyses and to proximate and ultimate chemical analyses. The samples will also be subjected to any additional analyses which will yield information of value in determining each coal types' reaction in any given process. Petrographic and physical properties will also be studied as an heterogeneous coal product. The

bulk coal samples will be processed by commonly employed preparation and separation techniques in an attempt to concentrate the selected coal types, these techniques being altered and modified as information from the physical analyses of the coal types become available.

Split of the coal types selected for this contract will be made available to other OCR contractors upon request and chemical, petrographic and physical evaluations will be made of coals being investigated in connection with other OCR projects.

SUPPORTED BY U.S. Dept. of Interior - Off. of Coal Rch.

3.0305, RECOVERY AND UTILIZATION OF PROTEINS AND OTHER VALUABLES FROM POTATO STARCH FACTORY WASTES

E.O. STROLLE, U.S. Dept. of Agriculture, Eastern Utilization Res. Div., *Wyndmoor, Pennsylvania* 19118 (E3-6-55)

OBJECTIVE: Develop an optimum method of recovering proteins from potato starch factory wastes to reduce the BOD of effluents. Construct a prototype plant for demonstration, market development, cost and design optimization.

APPROACH: Study protein recovery by heat coagulation, foam fractionation, simultaneous concentration and coagulation, dewatering and drying methods. Optimize process for cost and design. Construct prototype unit. Utilization and market development. Demonstrate process to potential users.

PROGRESS: A survey of starch factories was made to determine the composition of protein water in America. Soluble solids ranged from 1.5-2.8%. Sedimentation studies were made on proteins coagulated by steam injection heating. The effect of soluble solids and pH on % coagulated, settling mechanism, detention time and purity of protein were evaluated. The filtration of protein slurries was studied in a plate and frame filter press. The slurries were readily filterable over a pH range 3.0-5.0 and temperature range of 50-180 F. Other work revealed that for efficient operation of the ion exchange columns used to recover the other valuables, a residual protein level of 180 ppm or lower was required. These studies have shown the feasibility of quantitatively recovering the proteins by steam injection heating to 180-220 F at a pH 3.0-4.0, followed by conventional solid-liquid separation methods, after which the other constituents may be removed by ion exchange. Equipment to study foam fractionation of the proteins has been assembled. Synthetic polyelectrolytes were tested and found to be ineffective in precipitating the proteins. Cost studies will be made and used together with design data to optimize the protein recovery process.

SUPPORTED BY U.S. Dept. of Agriculture

3.0306, DESIGN OF FACILITIES FOR ANIMAL WASTE DISPOSAL

D.J. VANREST, Univ. of Puerto Rico, Agricultural Experiment Sta., *Mayaguez, Puerto Rico* (PR-C-00410)

OBJECTIVE: Develop design and management criteria for anaerobic digesters as a primary method of animal excrement stabilization in Puerto Rico, evaluate by means of pilot systems combinations of secondary methods of stabilization and utilization of effluent from anaerobic primary systems.

APPROACH: A series of pilot plant digesters will be installed to determine optimum conditions for certain design parameters, viz, method of initiating fermentation; loading rates per cubic foot of digester volume and circulation rates of digesting material. Parallel trials on secondary systems will be made on the effluent from the primary system with aeration, settling and plant and fish cultures.

PROGRESS: Efforts have been concentrated on gathering field data from a single plot digester to improve the quality of the assessment of solid reduction, B.O.D. reduction and operational characteristics. Equipment was installed to oxygenate part of the digester to test the value of a two-stage process. On four occasions now anaerobic fermentation has been initiated from a single pail of 'seed' material, and successfully managed for a six month period without undue odors or difficulty by the single expedient of monitoring the pH and adding sodium bicarbonate when necessary to counteract excessive acidity. The method of waste disposal can therefore be considered as practical and proven.

SUPPORTED BY Puerto Rican Government

3.0307, DEMONSTRATION OF A NEW PROCESS FOR THE TREATMENT OF HIGH POLLUTANT CONCENTRATION TEXTILE AND FINISHING WASTES

C.P. POON, Univ. of Rhode Island, School of Engineering, *Kingston, Rhode Island* 02881

The principal objective of this project is to establish a new, compact economical waste treatment system for textile dyers and finishers.

The process is a compact system occupying no more than 2,700 sq.ft., which is available in an existing mill building. It will use an anaerobic-aerobic oxidation unit incorporating activated carbon, and an activated carbon adsorption filter multiple column unit. The carbon units can be easily regenerated in-place by biological oxidation.

The project will use a full scale unit to treat the entire waste stream (125,000 gpd) at Palisades Industries in Peace Dale, R.I.

The start of construction is scheduled for 1 December 1969, and the project should be completed on 1 November 1970.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

3.0308, THERMOPHILIC AEROBIC PROCESS FOR WASTE TREATMENT

J.F. ANDREWS, Clemson University, School of Engineering, *Clemson, South Carolina* 29631

Mesophilic aerobic digestion has been shown to be feasible for the treatment of primary and waste activated sludge. Digestion rates, reduction in volatile solids, destruction of pathogenic organisms, and solids-liquid separation should be improved by operation at thermophilic temperatures. Theoretical calculations show that sufficient heat can be obtained through thermogenesis to maintain thermophilic temperatures. This process would also have great potential for the combined treatment of garbage and sewage sludge.

Theoretical mathematical models will be developed for the steady- state process using basic continous culture theory. These models will attempt to predict effluent substrate concentration, organism concentration, and reactor temperature. The effects of limiting oxygen transfer rate at lower detention times will be included.

Mixed cultures of thermophilic microorganisms will be established in continous flow, complete-mixing reactors. The primary variables studied will be temperature, detention time and oxygen supply rate. The theoretical mathematical models previously developed will be modified to conform to observed data.

The response of the steady-state process to perturbations in reaction mixture temperature will be measured. A quantitative measure of process stability will be determined using appropriate process dynamics techniques.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0309, DESIGN OF A WATER DISPOSABLE PACKAGING CONTAINER

S.F. HULBERT, Clemson University, School of Engineering, *Clemson, South Carolina* 29631

The objective of the research is to develop a water glass container which can be readily and economically fabricated, which can be protected from premature dissolution by suitable surface coatings and which will dissolve rapidly when such surface layers are penetrated. The economic and engineering aspects of the resulting water soluble packaging container are being evaluated as well as its advantages over conventional container materials from the disposal point of view.

The superstructure is a water soluble sodium silicate glass. Five basic process methods of applying inert barrier films are being investigated: (A) Chemical Vapor Deposition, (B) Surface Dealkalization, (C) Liquid Ion Exchange, (D) Vapor Ion Exchange, (E) Polymer Coating Applications.

Bottles are presently being hand blown from crucible melts. The project is now moving from the laboratory stage production of water disposable glass containers to the pilot plant stage. The technical and economic aspects of producing these disposable containers with suitable glass melting facilities and machines for

fabricating the bottles combined with coating equipment is now being worked out on a pilot plant basis. Some modification of conventional glass tanks and bottle machines will probably be necessary. Clemson University is planning a symposium during the coming year for the glass container industry and the food packaging industry concerning the results of its efforts to develop a water disposable glass packaging container.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0310, WASTE DISPOSAL FROM FOOD PROCESSING PLANTS IN SOUTH CAROLINA

J.R. LAMBERT, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631

The objective of this master project which is concerned with water resources is to determine the effectiveness of the soil mantle for purification of waste water from food processing plants. This will be done by studying the effect of the application of waste water on the hydrologic conductivity of the soil, and by studying the effects of various waste disposal application treatments on the quality of downstream flow. The interrelationships of engineering, agronomic, microbiological, meteorological, and climatic factors required for proper design and operation of an efficient and safe system for distributing waste on the surface of South Carolina soils will also be determined. Waste water from a pilot food processing plant will be applied at different application rates and intervals to lysimeters constructed of undisturbed soil with various vegetative covers and the quantity and quality of seepage will be measured. Lysimeters containing disturbed soil will be used to study the effects of soil properties, soil depth, and rate of application of the waste water on composition of the percolate from the soil and the effects of the waste on the physical and chemical properties of the soil.

SUPPORTED BY South Carolina State Government

3.0311, WASTE DISPOSAL FROM FOOD PROCESSING PLANTS IN SOUTH CAROLINA

L. VANBLARICUM, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00746)

OBJECTIVE: Determine the nature of waste from S. C. food processing plants. Devise and evaluate methods for utilizing waste from food processing plants. Determine methods by which in-plant waste and be modified or reduced. Determine the effectiveness of the soil mantle for purification of waste water from food processing plants.

APPROACH: Initial research will be associated with identifying waste constituents. Determine the economics of the manufacture of certain by-products from the various waste material. Treat chemically with various organic and neutralizing agents various waste samples an effort to modify or reduce the BOD values and neutralize the waste.

PROGRESS: Tomatoes were successfully peeled with both KOH and NaOH caustic solutions. While some differences between the two caustic compounds were noted, it was concluded that KOH could be used in place of NaOH at the same concentrations on a weight basis. Canners who dispose of their liquid waste by sprinkler irrigation on cropland can substitute KOH for NaOH and thereby realize the valuable addition of a plant nutrient to their waste. Peaches are relatively easy to peel with caustic solutions, and it was found that KOH could be substituted for NaOH in peeling operations at the same concentrations on a weight basis.

SUPPORTED BY South Carolina State Government

3.0312, FARM ANIMAL WASTE DISPOSAL AND POLLUTION CONTROL

P.R. MIDDAUGH, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00411)

OBJECTIVE: Characterization of physical, chemical and biological properties of livestock and poultry wastes; improvement in management systems with regard to handling, treatment and disposition of wastes.

APPROACH: Animal wastes will be analyzed for Oxygen Demand, Dissolved Oxygen, Methane, Nitrogen forms, Suspended Matter, Chlorine Requirement, Surfactants, and Water Analysis by methods outlined in 'Standard Methods for the Examination of Water and Wastewater,' Eleventh Edition, 1960, or in 'Official Methods of Analysis of the Association of Official Agricultural Chemists,' (A.O.A.C) Ninth Edition, 1960. Data thus obtained will be used to develop design criteria for stabilization ponds and reduction tanks on the basis of number of animal units.

PROGRESS: Bacterial methods for determining fecal streptococci were studied and three types of surface waters, the James River in South Dakota, a dairy lagoon and a municipal waste discharge, were surveyed for kinds of fecal streptococci. A modified membrane filter technique was developed as a potential, rapid method for isolating and characterizing types of fecal streptococci for their possible use in tracing water pollution sources to distinguish municipal (human) wastes, by identifying Streptococcus fecalis and its biotypes, from bovine (ruminant) wastes by identifying Streptococcus bovis biotypes. A total of 302 representative fecal streptococci were isolated from the three types of surface waters and were biochemically characterized into known species as S. faecalis and biotypes or as S. bovis. The dairy lagoon yielded fecal streptococci which were 39% typical S. faecalis, 35% S. faecalis biotypes, 8% S. faecalis var liquefaciens, 1% S. fecium and 9% were S. bovis which originate from ruminants. No S. bovis was isolated from the municipal human wastewater or from the James River in South Dakota which consisted entirely of S. faecalis or its varieties. Further studies are planned to improve the sensitivity and reliability of method for detecting S. bovis and to determine the survival of S. bovis and S. faecalis in polluted waters as indicators of ruminant versus human fecal pollution. Membrane filter studies indicate rapid identification of S. bovis is possible.

SUPPORTED BY U.S. Dept. of Agriculture

3.0313, ANALYSIS OF COMPLETE LIVESTOCK PRODUCTION SYSTEMS

H.G. YOUNG, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00437)

OBJECTIVE: Obtain service and design information on livestock management systems.

APPROACH: Information will be obtained on following specific areas of management systems. Mechanized and automated feeding systems for Swine, Beef, Dairy Cattle, and Poultry; various confined management systems for feeding swine. Various proportions of slotted floors, farrow to finish housing and various feeding systems; housing systems for dairy cattle to include Free Stall, Loose Housing and Stanchions; livestock waste disposal systems to include waste disposal lagoons, liquid handling and spreading.

PROGRESS: Investigations in Free Stall Calf Housing at the Dairy Research and Production Unit were initiated in the fall of 1968. Variables being studied are variations in stall width, steel and wood slotted floors and sawdust and straw bedding materials. Time lapse photography is being used to study the behavioral patterns of dairy calves 6 weeks to 5 months in age. A thesis will be published on the results of this study by June 1, 1969. Environmental studies of beef cattle are being conducted to determine if various degrees of shelter have any effect on the rate of gain and feed efficiencies of fattening steers. No trends have been established at this time and a bulletin will be forthcoming in the spring of 1970.

SUPPORTED BY South Dakota State Government

3.0314, COLLECTING AND TRANSPORTATION OF HOUSEHOLD WASTE

A. BOYSEN, Natl. Swedish Inst. Bldg. Res., *Stockholm, Sweden*

Object. To follow the development of new methods.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY Swedish Government

3.0315, TREATMENT OF COTTON TEXTILE WASTE BY ENZYMES AND UNIQUE HIGH RATE TRICKLING FILTER SYSTEM

J.L. YOUNG, Holliston Mills Incorporated, *Kingsport, Tennessee* 37662

The proposed project is to be divided into three phases.

The object of Phase I is to determine which method of desizing is the most satisfactory and economical method to use with both process control and biological treatment as the criteria.

Phase II of the project consists of design and construction of the AquaTair high rate trickling filter system modified to treat a cotton greige goods processing plant waste. The overall objective of this phase is to discharge an acceptable effluent to the receiving stream.

The object of Phase III is to determine experimentally the blend of enzyme necessary to break down the organic sludges produced to render them biologically reactive to further aerobic decomposition.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

3.0316, FARM WASTE DISPOSAL

J.I. SEWELL, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00277)

OBJECTIVE: Develop operational characteristics and design criteria for animal waste disposal facilities in Tennessee.

APPROACH: Three existing liquid manure installations on experiment stations will be operated under varying conditions to determine best procedures for agitating and unloading the pits. In model studies, effect of pit shape, baffles, columns, and different types of agitators will be determined. Predictions based on the model studies will be tested at field installations. Laboratory tests and pilot-plant studies on decomposition of manure in lagoons will be conducted. Based on these studies, a lagoon will be constructed. The lagoon will probably have two stages. The first anaerobic stage will be small, and will be equipped for sludge removal. The second larger stage will operate under aerobic conditions. Design criteria for lagoons under Tennessee conditions will be developed.

PROGRESS: Liquid manure systems costing about $10,000 are in operation at two experimental dairies, each milking between 100 and 150 cows. About 1.5 cubic feet of liquids and manure per cow per day was put into the pits, the period between pit emptyings varied between 30 and 50 days, and the pits were agitated at 2 and 3 week intervals. Little sediment has collected in the pits. The effects of internal obstructions and baffles on manure pit agitation were investigated by laboratory model studies. In tests with 4 different baffle arrangements where the agitator nozzle was located at the end of the baffle and directed flow down the sides of the baffle, the combined use of side and center baffles decreased the deposition of solids significantly over that where either center or side baffles were used alone. A manure slurry irrigation experiment has been initiated, the facilities have been designed, and construction is underway. The system consists of a large concrete holding tank, combination slurry agitator-pump and portable irrigation pipe with one large sprinkler. The holding tank is located so that manure can be slushed into it. During rainfall, the tank will receive the first 1 1/2 inches of surface runoff and manure from the lots. The benefits of manure slurry irrigations on crops and the effect of slurry irrigation on ground water quality will be evaluated.

SUPPORTED BY U.S. Dept. of Agriculture

3.0317, INFLUENCE OF ENVIRONMENT ON PERFORMANCE OF HENS

H.V. SHIRLEY, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00144)

OBJECTIVE: Study the performance of hens subjected to: constant controlled temperature and humidity, conventional floor method of management and, conventional laying cages.

APPROACH: The performance of hens in 3 types of laying houses will be studied. The houses, each 24' x 48' are designated conventional (shavings used as litter), individual cages, and slatted floors. The principal variation in treatments between years will be floor space per hen. In the conventional house pullets will receive 2 and 3 sq. ft./hen. In the slatted floor house pullets will be housed at the rate of 1, 1 1/2, and 2 sq. ft./hen. One and 2 pullets per cage will be used in the cage house. Different methods of mechanical manure removal and different wall and roof constructions will also be studied in the slatted floor house. Performance of each house will be measured in terms of number of eggs produced per hen housed, number eggs per sq. ft. floor space, feed consumed per doz. eggs, mortality and returns over costs.

PROGRESS: The performance of layers housed at densities of 1, 2, and 3 birds per 10' and per 12' cage is being studied in a series of two experiments. The first experiment ended in August, 1968 and the second is currently in progress. Generally, the results have indicated that as space per hen decreases there is a decrease in the rate of lay and in body size but with an improvement in feed required per unit of eggs produced. The income over costs has been in favor of two hens per cage. Currently in progress is a study comparing the performance of pullets with that of hens force-molted at the end of the first laying year. Restricting feed intake of mature hens resulted in lowered production, reduced egg size and body weight. Feed per unit of eggs was not affected. Limiting the feeding time did not significantly affect performance as the hens apparently adjusted their feed intake to the available time. Limiting the time water was available resulted in a decrease in egg production and feed consumption. Specific gravity and Haugh units of eggs were not affected.

SUPPORTED BY U.S. Dept. of Agriculture

3.0318, ANALYSIS OF SOLID WASTE DISPOSAL METHODS

W.J. BOEGLY, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

Currently, it is estimated that an average of 4.7 pounds of solid waste are produced per person per day in the United States. This figure is expected to rase to 6.8 pounds per person per day in 2000. Collection and disposal of this material represents a significant and costly problem in dense urban areas. Basic collection and disposal systems have changed little for many years. Open dumps, sanitary landfill, and incineration remain the principal disposal operations. New collection and disposal systems may be needed to handle the growing volume of solid wastes. Bulk volume reduction near the source followed by underground transport through pipelines would appear to offer a potential solution to the solid waste problem in urban areas. Experimental studies with typical materials in municipal waste have been initiated on the possible use of a wet-oxidation process as a volume reduction method.

It has been found that slurries of paper and plastics (which constitute at least 50 per cent of urban municipal refuse) can be oxidized at temperatures around 200 degrees C. Current studies are directed at the potential use of catalysts and changes in operating methods to further reduce operating temperatures.

SUPPORTED BY U.S. Atomic Energy Commission

3.0319, APPLICATION OF HYPERFILTRATION WITH DYNAMICALLY-FORMED MEMBRANES TO TREATMENT OF MUNICIPAL SEWAGE EFFLUENTS

K.A. KRAUS, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831

Oak Ridge National Laboratory will investigate the application of hyperfiltration with dynamically-formed membranes to the treatment of municipal sewage. Primary and secondary effluents will be included in the study, but with special emphasis on activated sludge effluent. An assessment of both organic and inorganic rejection will be made. Various membrane support materials of various pore sizes will be evaluated and the necessity of using filter aids (with the larger pore sizes) and film forming additives will be examined. Diatomaceous earth, polyelectrolytes, and the hydrous oxides of iron (III) and aluminum (III) would be the first choices if such substances are needed. Salts such as nitrate, ammonia, and phosphate will be monitored to investigate the question of specificity of salt rejection. The effects of pressure,

temperature, and influent pH upon product quality and flux will be investigated. To extend the period of high flux, some studies of methods of preventing membrane-fouling via turbulence promoters or backwashing are also proposed.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

3.0320, DISPOSAL OF ANIMAL WASTES BY AGRICULTURAL PRACTICES IN THE SOUTHERN PLAINS

B.A. STEWART, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Bushland, Texas* 79012 (SWC-026-EBUS-3)

OBJECTIVE: Development of management practices for disposing of animal wastes by: determining the maximum quantity that can be applied without impairing crop production; measuring pollutants moving through soil treated with high rates; evaluating the effects on soil properties; determining decomposition rates with and without mixing with soil.

APPROACH: Laboratory, greenhouse, and field experiments will be used. Animal wastes will be applied at varying rates and frequencies. Laboratory studies will deal with rates of decomposition, ammonia volatilization, and microbial transformations of nitrogen. Greenhouse and field studies will be concerned with effects of time and rates of application on crop production. Movement of pollutants through soil toward groundwater will be followed in field studies.

PROGRESS: Playas, naturally occurring shallow lakes, are being used by feedlot operators to impound runoff. Following 1 year of usage during a period when storm runoff occurred, profile samples taken to a depth of 13 feet indicated only minimal seepage into the Randall clay in the playa bottom. Chloride movement was apparent to only 2 feet and significant nitrate levels were found only in the surface foot. These results indicate that these playas may be a real asset to the feeding industry, but additional studies are needed. Soils on the slopes surrounding playa bottoms are more permeable and seepage could be greater when sufficient runoff occurs to submerge these soils. Preliminary field studies concerned with management of manure showed high salt, ammonium, and nitrite concentrations in a clay loam soil treated with high rates of manure and that crop production was limited. Sorghum grain yields were reduced by manure applications of 120 tons/acre or more, and observations showed early season growth reduction on plots treated with 60 tons/acre. Salt concentrations increased to depths of 3 feet or more during the growing season. A greenhouse study showed that during 2 crops of grain sorghum, 1 unit of N from ammonium nitrate was equivalent to 2.4 units of N applied in feedlot waste.

SUPPORTED BY U.S. Dept. of Agriculture

3.0321, CHARACTERISTICS OF WASTE FROM SOUTHWESTERN CATTLE FEEDLOTS

D.M. WELLS, Texas Technological University, Water Resources Center, *Lubbock, Texas* 79409

The purpose of this research is to evaluate the effects of various parameters such as climatic conditions, types of rations, density of cattle, slope, and type of surfacing material on the characteristics of wastes from southwestern cattle feedlots. Specifically, the objectives are to determine the quantity and quality of runoff from beef cattle feedlots as they are affected by the above parameters, and to develop recommendations and design criteria for feedlot waste management control.

performed on nearby commercial feedlots to verify the results of the work on experimental feedlots.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

3.0322, SOIL TREATMENT OF CATTLE FEEDLOT RUNOFF

E. MERRITT, Meat Producers Incorporated, *Melissa, Texas* 75071

Description: The project will consist of evaluating and demonstrating a spray-runoff soil treatment process for the removal of organics and nutrients from rainfall runoff of a 12,000 head cattle feedlot. The project is to be started April 1, 1970 and the anticipated completion date is June 30, 1972.

Objectives: To determine suitability of spray-runoff soil systems for treatment of feedlot runoff. To development preliminary design criteria and wastewater loading rates for treatment of runoff with a spray-runoff soil system. To demonstrate treatment achieved with a well-designed spray-runoff system.

Work Plan: The project will consist of two phases of work: 1. The first phase will encompass a comprehensive research evaluation of the adaptability of the spray-runoff treatment process to the treatment of rainfall runoff from a beef cattle feedlot. Meat Producers, Inc. will emphasize the on-site supervision and operation of the wastewater collection and treatment facilities. Staff from the Robert S. Kerr Water Research Center will guide us in operation of the system and conduct the research evaluation of the system to achieve objective 1 and 2. 2. The second phase will be devoted to demonstration of the system by Meat Producers, Inc.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0323, FUNDAMENTAL STUDIES OF COMPREHENSIVE DISTRICT PLANNING IN URBAN AREAS

T. MISE, Road Research Laboratory, *Berks, Crowthorne, United Kingdom*

The fundamental factors of the city planning policy in Osaka are under study. Among them are water supply, sewage disposal, public nuisance, safety against disaster, and access to sunlight in high density residential districts. Data on these factors are being gathered for analysis and are expected to be of importance in better city planning.

Document provided by Highway Research Information Service.

SUPPORTED BY Osaka City University

3.0324, STABILIZATION OF LOW-GRADE AND WASTE MATERIALS

P.T. SHERWOOD, Road Research Laboratory, *Berks, Crowthorne, United Kingdom* (005194)

Studies are being made to further the use of low-grade materials such as chalk, pulverized fuel and ash and colliery shale which exist in large amounts in Britain and at low cost. Lime and cement are both being examined as possible stabilizing agents. The results will help in the disposal of waste materials and, more importantly, will conserve the supplies of better quality materials that are in short supply and are needed by the building industry. Studies with chalk have advanced beyond the laboratory stage and experimental lengths of cement- stabilized chalk road base and subbase have been constructed on a major road.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

3.0325, HYDROGRAPH METHOD OF SEWER DESIGN

C.P. YOUNG, Ministry of Transport, *Berks, England, United Kingdom* (002380)

Following the publication of Road Note No. 35 which was written to guide engineers in the use of the R.R.L. hydrograph method of sewer design, the laboratory operated a computer service on a repayment basis and a total of well over 100 drainage schemes for about 60 local authorities and consulting engineers were computed. Experience gained during the operation of the laboratorys computer service showed that the original computer programs needed improvement in order to cope with the much wider range of circumstances that was at first envisuged, and these improvements led to a new method of interpreting the basic hydrograph method. Research is still proceeding at the Meteorological Office into the characteristics of heavy rainstorms, and refinements to the programs are required from time to time to incorporate the results of this research.

Document provided to SIE by the Highway Research Information Service

3. SOLID WASTE MANAGEMENT

SUPPORTED BY United Kingdom - London

3.0326, LEACHING AND RECOVERY OF COPPER FROM ORES AND WASTE DUMPS
L.G. EVANS, U.S. Dept. of the Interior, Bureau of Mines, *Salt Lake City, Utah* 84112

Leaching and Electrorefining: Develop improved methods for recovering copper and byproducts from mine waste dumps, heaps, and in- place fractured deposits.

Reaction Kinetics: Make a theoretical study of the mechanism of dissolution of copper minerals in acid media.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0327, STABILIZATION OF PLANT TAILINGS
R. HAVEN, U.S. Dept. of the Interior, Bureau of Mines, *Salt Lake City, Utah* 84112

Develop means of stabilizing mineral processing plant wastes by physical, chemical, vegetative, and combination methods to prevent wind and water erosion.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0328, DEVELOPING NEW USES FOR MILLING RESIDUES
E.G. VALDEZ, U.S. Dept. of the Interior, Bureau of Mines, *Salt Lake City, Utah* 84112

Develop constructive uses for disposal of solid waste materials such as mine wastes, slags, drosses, flue dusts, tailings, and residues generated in chemical and metallurgical processing. Consider production of various metallic or ceramic products, such as refractories, light weight aggregates and possibly conversion of mineral wastes to usable soils.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0329, PHYSICAL PROPERTIES OF THE SOILS OF VIRGINIA
D.F. AMOS, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0200055)

OBJECTIVE: Study the physical properties of various soil series of the state and obtain data on the ranges in these properties. Correlate the physical data with field characteristics to provide supporting data to local health directors and other agencies in evaluation of land for sewage disposal and other urban uses. Study the physical properties and their relation to the genesis and morphology of the various soils.

APPROACH: This study of soil physical properties will be in the following areas: Permeability measurements of important soil types of Virginia to include in place measurements of restricting layers and laboratory measurement of hydraulic conductivity. Interelationships of soil characteristics and the seasonal march of the water table in various Virginia soils to include important soils in the Coastal Plains and Piedmont regions. Extent and nature of the shrink-swell properties of Virginia soils, and soil moisture characteristics and related physical properties of the soils of Virginia.

PROGRESS: Substantial progress was made in characterization of 84 soil profiles from 11 counties. Particle size analyses, swelling potential, and liquid, plastic, and shrinkage limits were determined for each profile. Bulk density and moisture desorption data was obtained for 2/3 of these profiles, with additional sampling required to complete the set. Field studies were initiated in Chesterfield County to determine corrosion potential of certain soil. An initial study in Hanover County yielded excellent data on percolation (infiltration) rate by major horizon for selected profiles of the Cecil, Appling, Faceville and Marlboro series. Preliminary work on a technique to measure strength of development of fragipans in Hanover County soils was quite promising.

SUPPORTED BY Virginia State Government

3.0330, UTILIZATION OF CELLULOSE AND RELATED COMPOUNDS AS NUTRIENTS
R.D. BROWN, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0616007)

OBJECTIVE: Clarify current uncertainties regarding the number of enzymes involved in extracellular degradation of cellulose and the individual functions of these enzymes. Conduct comparative studies of the cellulase systems of various representative bacteria and higher fungi in order to arrive at generalizations it is not now possible to formulate. Explore the technical feasibility of applying this new knowledge to practical problems in food and feed processing, waste disposal, textile processing and related operations involving cellulosic materials.

APPROACH: Using highly purified enzyme preparations the function of cellulases acting alone and in concert will be studied using representative fungal and bacterial species.

PROGRESS: Using the Trichoderma viride cellulase as a model, we have further characterized the essential components of this enzyme system in order to more fully understand the cellulolytic process. A 'C(1)' enzyme which attacks hydrocellulase preferentially has been purified 25-fold from culture filtrates of T. viride. This is the highest purity hydrocellulase known to us, and it is homogeneous as determined by rechromatography, ultracentrifugation and polyarylamide disc gel electrophoresis at pH 9.0. It contains carbohydrate and has a molecular weight of about 44,000. Its amino acid composition reveals a high content of acidic and hydroxylated amino acids and the lowest proportion of non-polar amino acids of any enzyme for which we have seen data. There is more than one type of 'C(1)' enzyme present, as revealed both by ion-exchange chromatography and preparative disc gel electrophoresis. The molecular differences between them may be small-- at this point microheterogeneity due to variable carbohydrate content is suspected. Electrofocussing has revealed that some of the 'C(1)' protein is quite acidic with PI 0. Our future work will be directed toward a more complete description of this cellulase system to permit increased precision in the choice or design of cellulases for application to the practical problems of modifying plant foodstuff.

SUPPORTED BY U.S. Dept. of Agriculture

3.0331, MICROBIAL RELEASE OF SOLUBLE PHOSPHATE IN AN ACTIVATED SLUDGE ENVIRONMENT
C.W. RANDALL, Virginia Polytechnic Institute, School of Engineering, *Blacksburg, Virginia* 24061

The proposed research plan involves laboratory investigation directed at evaluating the factors which affect the microbial release of phosphate back to solution after uptake by an activated sludge system has occurred. The primary approach is to evaluate the effect of activated sludge process operational parameters such as dissolved oxygen and ORP levels, rate and duration of aeration, loading conditions, duration of anaerobiosis, etc., on release of soluble phosphate from the activated sludge microorganisms. A second area of investigation is the ability of various chemicals to stimulate or inhibit activated sludge phosphate release.

Parameter evaluation would employ the following methods. 1. Small scale batch-type experiments to study the effect of the various operational parameters individually. 2. Continuous flow experiments to further study the parameters and their combined effect, and to determine the feasibility of process modification.

Investigation of chemical effects will employ the following methods. 1. Batch-type experiments of individual chemical effects. 2. Warburg respirometer studies to determine lasting effects of chemical addition on sludge performance.

Data will be correlated for clarification of the basic mechanisms of soluble phosphate release from activated sludge microorganisms.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0332, MATERIAL DISPOSAL
W.A. CLARK, U.S. Navy, Weapons Laboratory, *Dahlgren, Virginia*

Technical Objective: Dispose of scrap, military personal property and perform related salvage operations resulting from the conduct of research, development, test and evaluation programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0333, PILOT PLANT FOR UNDERWATER STORAGE OF COMBINED SEWER OVERFLOW
B.W. DAHL, Amer. Standard Incorporated, *Falls Church, Virginia* 22045

The problem under investigation is to see if combined sewer overflow water can be retained for short periods in flexible underwater storage containers and subsequently returned to the sewer system. A 200,000 gallon pilot plant will be built and operated to demonstrated the practicality of temporary storage in underwater containers. Operation of the pilot plant for a one year period will allow us to evaluate the ability to operate such a plant and assess the related costs.

Overflow from a 20 acre drainage basin is metered and directed to a pumping station. The flow is than pumped to the flexible storage container anchored in the river. After the flow in the sewer subsides the water in the container will be pumped back to the interceptor sewer. A recirculation system in the container will keep the solids in the system in suspension. In conjunction with the operational program chemical and biological tests will be conducted to assess the character of the storm water both before and after storage and be related to the duration of runoff and storage periods. This project is being conducted in Cambridge, Maryland on the Choptank River. This project was started in Fiscal Year 1968 and will be completed in Fiscal Year 1970.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0334, ISOLATION OF LYTIC AGENTS RELATED TO SPHAEROTILUS
D.J. GEASON, Randolph Macon Womans College, Undergraduate School, *Lynchburg, Virginia* 24501

The primary purpose of this research problem is the isolation and identification of those factors which are responsible for the sudden and dramatic disappearance of the bulking effect caused by Sphaerotilus in activated sludge in sewage treatment plants.

The importance of Sphaerotilus in filamentous bulking can be evaluated using fluorescent antibody techniques which serve to distinguish these organisms from other filamentous organisms with which they may be confused such as Bacillus cereus var. mycoides and Geotrichum candidum.

In those cases where Sphaerotilus is considered to be the cause of bulking, an attempt is being made to determine the conditions under which they are likely to become the dominant organism, and to identify the physical factors and natural predators which may lead to a sudden disappearance of the bulking effect.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0335, UTILIZATION OF FOOD PROCESSING PLANT EFFLUENTS AND THEIR EFFECTS ON SOILS AND CROPS
G.A. PEARSON, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Norfolk, Virginia* 23501 (SWC-027-ANOR-3)

OBJECTIVE: Investigate the utilization and/or disposal of food processing plant effluents and their effects on soils and crops.

APPROACH: Samples of effluents are analyzed for chemical composition. Soil and plant samples are analyzed to evaluate the effects of effluents on the chemical and physical properties of the soil and on the physiological tolerance of the crops.

PROGRESS.

SUPPORTED BY U.S. Dept. of Agriculture

3.0336, ECONOMIC OPTIMIZATION OF SECONDARY TREATMENT AND DETERMINATION OF LOAD TO CONTROL BIOLOGICAL GROWTHS IN A STREAM
H. AMBERG, Crown Zellerbach Corporation, *Camas, Washington* 98607

This project will seek to determine the costs of mechanically aerated lagoon treatment of pulp mill and paper mill wastes by examining in detail the comparison of retention time, aerated lagoon depth, basin configuration, recycle and parallel versus series operation of tow lagoons. Information will also be obtained concerning treatment achieved by multiple lower hp surface aerators compared to two high hp units. Further, the project will, by use of test streams, seek to determine the degree of treatment needed to prevent slime growth in the receiving stream.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

3.0337, COMMUNITY CAGE HOUSING OF LAYING CHICKENS
R.S. HANSEN, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01343)

OBJECTIVE: Develop efficient designs of community cages, including feeders, watering systems, nests and other features. Determine optimum space allowances in community cages, including floor space, feeder space and watering space per hen. Develop shelters suitable for community caged layers in moderate to cool climates. Develop operating methods suitable for community cage housing of layers with emphasis on such problems as cannibalism control, sanitary measures to aid fly control, and efficient operating routines.

APPROACH: Mature pullets will be housed in community cages, generally 3' x 5'; wirepens, larger than 3' x 5'; individual cages, and 5 or 6 bird cages. The design of community cages and wire-pens will be varied in such features as feeders, watering systems, roll-away nests, perches, etc. Criteria used to evaluate results will include egg production, body weight, egg cleanliness and quality, cannibalism and operating efficiency. Cage shelter ventilation, manure removal, fly control and similar management practices will be studied.

PROGRESS: The study of the cause and cure of avian hysteria was continued. Pullets of a strain of chickens with a known nervous temperment were housed in 3' x 5' cages. In a factorial experiment population densities were 20, 30 and 40 hens per cage; blue and white incandescent light was used; a lay ration was compared with the same ration with 50 grams of niacin per ton added. The onset of hysteria was hastened and incidence increased as population density increased. Hysteria occurred under both ligts but was more severe under blue light. Changing from blue to white light alleviated hysteria. Removing the claws near the foot stopped all but one case of hysteria among hens continously under white light. Niacin seemed to delay but did not prevent hysteria.

SUPPORTED BY Washington State Government - Olympia

3.0338, LAGOONS FOR DAIRY FARMS
J. ROBERTS, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01720)

OBJECTIVE: Study bacteriological factors involved in breakdown of cow manure and methods of speeding up bacterial action and management factors, including costs, labor, and water requirements so that design criteria may be developed and made available.

APPROACH: The study as designed will include a comparison of effectiveness of three-stage process with recirculation of two different waste-municipal wastes, and dairy wastes consisting of excreta from dairy cows. Facilities have already been constructed and they are now in operation at city disposal plant.

PROGRESS: The field sprinkler system now takes fluid manure from the storage pond so that the lagoons have less loading and hopefully may function better. The lagoon system is studied by D. Proctor, Sanitary Engineering. The system carrying fluid manure to field plots is giving experience in a new project for which we expect to request funds in 1970. Three circular plots (one sprinkler setting being a plot) were loaded with varying loads of solids. Prior to such loading, shallow and deep soil samples were taken by the Department of Agronomy. Subsequent sampling will study nitrates and nitrate movement. Future WSU research on manure disposal will likely emphasize land (soil) as a receiver, with major emphasis in western Washington locations. Personnel from the Department of Animal Sciences, Agricultural Engineering, Agronomy and Agricultural Economics are planning the work.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY Washington State Government - Olympia

3.0339, TREATMENT AND DISPOSAL OF CONDENSATE WASTES FROM HIGH LEVEL WASTE SOLIDIFICATION PROCESSES
A. PLATT, Battelle Memorial Institute, *Richland, Washington* 99352

A number of low and intermediate level waste side streams result from processes now being developed for the solidification of power reactor fuel reprocessing wastes. These side streams are characterized by low volume, high acid or salt content, and significant levels of radioisotopes, particularly those which exhibit high vapor pressures at the elevated temperatures involved in solidification. This program involves development of techniques for treatment and disposal of these waste side streams.

A number of concepts including precipitation, fractional distillation, scavenging, and crystallization have been evaluated, present emphasis is being placed on sulfate distallation and incorporation of residue in asphalt. Studies will be extended to actual waste streams when they become available in the near future from a current demonstration of waste solidification. The program was initiated in FY'66 and was completed in FY'69.

SUPPORTED BY U.S. Atomic Energy Commission

3.0340, TAILINGS DISPOSAL SYSTEM (EFFECT OF DAM DESIGN ON/EFFLUENT QUALITY, SUBSTRATA STUDIES, SURFACE & SUBSURFACE DISPOSAL)
C.D. KEALY, U.S. Dept. of the Interior, Bureau of Mines, *Spokane, Washington* 99201

Purpose: To study, define, analyze, and develop solutions for problems associated with the disposal of waste products from the mining of large, low-grade ore deposits.

Problems associated with the surface and underground disposal of tailing will be defined and solutions developed with particular emphasis on stope stability, stabilization, effect of topographic conditions, underground support requirements, and effect on surface or underground water (contamination). The mining of a large, low-grade ore deposits will only be possible through the handling of large amounts of material; and, in time, the processing of this material to obtain mineral values will result in large quantities of waste products which have to be disposed of in a manner consistent with the most efficient land utilization.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0341, UTILIZATION OF SOLID WASTES FROM THE COMBUSTION AND MINING OF COAL
D.W. GILLMORE, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia*

Purpose: Develop and evaluate used for solid wastes from coal mining and combustion. Part of the program concerns the disposal of fly ash on surface mine spoil. This dumping method provides for disposal of large quantities of fly ash, aids reclamation, and encourages establishment of vegetative cover on highly acid spoils. The program has been extended to include the use of fly ash for reclaiming unsightly coal mine refuse deposits.

Sintered and raw fly ash are being tested as soil conditioners and sources of trace nutrients. Sintered fly ash is also being evaluated in laboratory and field trials as a skid-resistant agent when incorporated in automobile tires.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0342, DISPOSAL AND UTILIZATION OF DAIRY AND POULTRY MANURES BY LAND APPLICATION
A.D. LONGHOUSE, West Va. University, Agricultural Experiment Sta., *Morgantown, West Virginia* 26506 (WVA00210)

OBJECTIVE: Develop and evaluate disposal and utilization systems for land application of treated and untread dairy and poultry manure that will minimize the pollution of water, soil and air.

APPROACH: Carry out the regional objectives, this station will confine its research programs to the disposal and utilization of manures from poultry in cages. Specifically, systems will be developed to reduce moisture content soon after defecation to prevent development of obnoxious gases, reduce weight (and volume) and control flies. Evaluations will be made to determine the usefulness of the product in respect to land application (physical, chemical and biological properties); the characteristics of reconstituted products and the economic feasibility of the system(s).

PROGRESS: Designed and built basic transport machine adapted to gutter operation under poultry cages. Machine will stir, aerate and remove manure collected in gutter. Two samples of poultry droppings which were analyzed contained 833 million aerobic bacteria and 1.8 billion aerobic nonspore-formers, 115 thousand spore-formers; one billion aerobic nonspore-formers, and 406 thousand aerobic spore- formers. Samples contained 72.4% moisture; 27.6% dry matter; 24.7% volatile matter; and 75.3% ash. Typical five day biological oxygen demand analysis showed 370 mg/L, whereas raw domestic sewage averages about 250 mg/L. Preliminary studies involving the addition of a multiple microbiological culture to the feces in the manure pits, in a cage operation, demonstrated a reduction in moisture content and reduced weight of manure. Studies are planned to determine whether protein breakdown is the source of odor in droppings and, if so, how to overcome odor production.

SUPPORTED BY U.S. Dept. of Agriculture

3.0343, BIOLOGICAL TREATMENT OF SPENT VEGETABLE TANNINS
W.A. SACK, West Va. University, Water Research Institute, *Morgantown, West Virginia* 26506

The overall objective of the proposed study is to determine the feasibility of biological treatment of spent vegetable tannins and other color-producing substances in vegetable tan-house waste. Specific objectives are to: Study the kinetics of adsorption of the tannins on biological sludge; determine what part of the complex tannin extract is biodegradable by an adapted culture, and if degradation will proceed to a point of significant color reduction; study the effect of supplemental carbon sources on the extent and rate of oxidation; obtain data on sludge settleability, required detention times, allowable waste strength, and sludge concentration that may be useful in design of an oxidation ditch for treatment of tannery waste. The investigation will be a bench-scale study using spent vegetable tans containing both condensed and hydrolyzable tannins. A mixed culture developed from a domestic- waste investigation is designed to supply basic information on the adsorption and biodegradation of tans that will be useful in design of a pilot or full-scale unit. The study is directed toward the oxidation- ditch method of treatment.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0344, IMPROVED MARKETING PRACTICES AND MARKETS FOR LUMBER AND OTHER MANUFACTURED PRODUCTS OF EASTERN HARDWOODS
D.G. CUPPETT, U.S. Dept. of Agriculture, N.E. Forest Experiment Station, *Princeton, West Virginia* 24740 (NE4303)

OBJECTIVE: Improve processing, distribution, and use of lumber veneer, and other primary manufactured products with emphasis on low quality hardwoods and little-used eastern softwoods.

APPROACH: Study effects of mill size, layout, equipment, product mix, and distribution methods on cost of producing and marketing sawmill products. Evaluate systems for improving marketability of primary manufactures. Study factors affecting value, utility and use to better meet consumer demand and expand markets for sawmill and veneer mill products.

PROGRESS: Our research concentrated on important aspects of two areas of national concern: Environmental pollution control: Much of the bark residue from wood industry plants is disposed of by burning or dumping, practices that more and more states are severely limiting because of the resulting pollution. Therefore, we began research to expand markets for bark and bark products, and thus eliminate the need for burning or dump-

ing. Results of this work to date show that bark- mulch products have the greatest immediate potential; large volume markets are essential to make bark-mulch production and marketing generally economical; and large-scale application of bark mulch to highway banks, strip-mine spoils, and similar areas necessitates the use of power mulchers. Our studies showed that either raw or processed bark can be applied successfully by the power mulchers now available for other mulch products. New or expanded sources of wood products for home building. Eastern spruce and hemlock are potential sources for increased supplies of lumber and plywood. In one study of the market potential for eastern spruce plywood, 89 percent of the architects and 83 percent of the contractors indicated they would use eastern spruce plywood, provided it is properly grade-stamped. Both groups indicated that eastern spruce plywood has favorable potential for both structural and decorative uses in housing construction.

SUPPORTED BY U.S. Dept. of Agriculture

3.0345, A STUDY OF LAND DISPOSAL OF SPENT SULFITE LIQUOR AT BADGER PAPER MILLS, INC., PESHTIGO, WISCONSIN

T.A. CALABRESA, State Dept. of Nat. Resources, *Madison, Wisconsin* 53701

This cooperative project provides for the determination of the extent of movement of spent sulfite liquor both in depth and laterally from the ground surface disposal areas. This project hopefully will result in determinations of: 1. The influence that the bedrock configuration has on the subsurface movement of the waste sulfite liquor. 2. The effect limerock in the area has, if any, in neutralizing some of the acidity of the waste. 3. The potentiometric distribution of the sulfite liquor both vertically and horizontally in the surficial deposits above the limerock in the vicinity of the disposal sites. 4. The aquifer characteristics both in the unconsolidated and rock aquifers. 5. The quantity of the waste reaching the river. 6. Whether the Badger Paper Mills, Inc., shall abandon the present disposal method in favor of some other treatment method insofar as the Peshtigo River is concerned. 7. Whether such land disposal practice of this type or other strong industrial waste can be safely permitted under similar geological conditions.

SUPPORTED BY Wisconsin State Government - Madison

3.0346 PULP AND PAPER ENGINEERING SYSTEMS

W.F. CARR, U.S. Dept. of Agriculture, Forest Products Laboratory, *Madison, Wisconsin* 53705 (FPL3307)

OBJECTIVE: Develop basic improvements in the unit processes of pulp and paper manufacture; increase the utilization of logging and manufacturing residues and urban fibrous waste and associated solid waste; design and maintain pilot plant facilities for demonstration of effective process development.

APPROACH: Investigate various tree segments to establish pulping and papermaking properties. Investigate relative economics of bark separation systems with determination of tolerable bark levels in paper grades. Develop systems for the reuse of waste fibers with resulting products which could be utilized. Study factors which affect efficiency of separation of usable and undesirable fractions to establish interrelationships.

PROGRESS: Exploratory investigations have been completed to determine possible target systems for recovering wood and wood fiber products from municipal solid waste. This investigation has determined feasible systems and thus approaches for undertaking studies for obtaining information and procedures leading to an effective solution to the solid waste disposal problem. The selection of desirable wood fiber products that should be investigated as possible products from municipal solid waste was completed. Exploratory contacts with other interested groups within Federal and City governments were undertaken to determine if a combined effort in the utilization of municipal solid waste could be incorporated into a common purpose and hopefully a common system for an effective solution to the problem. To undertake studies in improving the utilization of all segments of the tree for wood fiber needs and the related area of bark utilization and economics in wood harvesting which would lead to an effective solution, a comprehensive analysis within the framework of the larger problem area of increased tree utilization was completed.

SUPPORTED BY U.S. Dept. of Agriculture

3.0347, PHOSPHORUS REMOVAL BY TRICKLING FILTER SYSTEMS

W.C. BOYLE, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

The objective of this investigation is (1) to determine the present performance of trickling filters in the State of Wisconsin with respect to phosphorus removal and (2) to study in detail the factors influencing the phosphorus removal characteristics of trickling filters.

The first phase of this study consists of a field survey of ten existing plants in the state over a one and one-half year period. Composite samples of waste water will be collected weekly and BOD, solids, pH, and total and soluble phosphorus determinations will be made. Special studies on several selected filters will be made during this period of time to ascertain the influence of digester supernatant return, organic loading, temperature and media characteristics on phosphorus removal.

The second phase of the study is being conducted in four-twelve foot deep pilot filters each with a cross-sectional area of four square feet. These plants will be studied in accordance with a factorial design to determine the effects of hydraulic load, depth, organic load, recirculation ratios and temperature on phosphorus removal. Special studies will be conducted on the filter slimes during this phase of the study. The study is being conducted at the Nine Springs Sewage Treatment Plant in Madison, Wisconsin.

Due to setbacks in material shipment, this study will not be completed before the winter of 1970.

SUPPORTED BY Wisconsin State Government - Madison

3.0348, ANIMAL WASTE MANAGEMENT WITH POLLUTION CONTROL

J. CONVERSE, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS05008-6008)

OBJECTIVE: Characterization of physical, chemical and biological properties of livestock and poultry wastes; Improvement in management systems with regard to handling, treatment and disposition of wastes.

APPROACH: Of immediate interest are treatment methods of digestion and lagooning including a detailed study of basic properties of wastes. Effects of dietary variables on quantity, chemical composition and microbial content of poultry excreta during growth and egg production will be investigated. Dietary variables will include amino-acid protein- energy balance, cellulose and lignin level, mineral level, antibiotics, anti-microbial compounds, laxatives, and water intake. Decomposition of excreta will be studied under both aerobic and anaerobic conditions.

PROGRESS: Three year averages on 0.01 acre plots show more runoff and nutrient losses from those receiving no manure than those summer manured. Greatest difference in runoff occurred during summer with unmanured plots losing nearly twice as much runoff as the average of all others. This condition has become worse with each succeeding year. On an annual basis unmanured plots lost 14% more N and 48% more P than summer manured plots. Winter manured plots have lost 3 times as much N, 2.5 times as much P and 4 times as much K as the average of all other plots. These studies indicate the need for over-winter storage of manure to preserve the nutrients and minimize stream pollution potential. They also show the need for manure as a soil conditioner and to maintain fertility. The bacteriological flora of fresh bovine feces and of anaerobically stored manure from the Marshfield Station and the ABS lagoon sludge has been compared and important groups of facultative and obligate anaerobes identified. Growing in stored manure were urea fermenters and fatty acid utilizers. They are staphylococci. Several new properties for S. saprophyticus and S. epidermidis were recognized and related to manure storage.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY U.S. Dept. of Agriculture

3.0349, APPRAISAL OF ADJUSTMENTS IN WISCONSIN AND OTHER LAKE STATES DAIRY FARMING
N.D. KIMBALL, Univ. of Wisconsin, U.S.D.A. Farm Prod. Econ. Div., *Madison, Wisconsin* 53706 (FE9-15-52-01)

OBJECTIVE: Construct a research background for development and appraisal of farm programs, and provide information needed by Wisconsin and other Lake States dairy farmers in making adjustments in their farming systems during the next few years.

APPROACH: Appraise the situation in dairy areas as to major adjustment problems, resource situations and available alternatives. Select and evaluate alternative production practices and estimate costs and output for alternative systems, taking into account prices of farm products and services. Estimate the changes in production, costs, and returns as a basis for outlining combinations that will lower costs and increase returns. Use farm budgeting and linear programming. Study the area and interregional implications of the adjustments and the effect of changes in transportation costs and provisions of milk market orders on production and distribution patterns.

PROGRESS: A manuscript entitled Economic Evaluation of Forage Handling Systems was revised and submitted for publication. The results of a study on liquid manure handling are being prepared for publication. Four types of systems were surveyed: free-stall barns with (1) all excrement put through the liquid system, and (2) part of the yard manure handled conventionally; conventional barns with (3) all liquid, and (4) part conventional. Farms surveyed were much above average in size with 85 cows and a gross income of over $50,000. The study showed that the largest cost item was the storage tank with a marginal cost of from 40 to 70 cents per cow-day of capacity. Free-stall systems had the highest costs because of the needed reinforced tank lid and more labor and tractor hours were required. The stachion barn system's cost were lower than free-stall systems. However, the freestall barn, all liquid system was second least cost when the value of the manure recovered was considered. Equating fertilizer value with costs of handling indicated the following herd sized to pay for the system was second least cost when the value of the manure recovered was considered. Equating fertilizer value with costs of handling indicated the following herd sizes to pay for the system when storage was for 120 days: free-stall, all liquid, 58 cows; part conventional, 80 cows; stanchion barn, all liquid, 44 cows; and part conventional, 67 cows.

SUPPORTED BY U.S. Dept. of Agriculture

3.0350, RETENTION OF NUTRIENTS AND OTHER POLLUTANTS IN SEWAGE BY SOILS
L.B. POLKOWSKI, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

The objective of this study is to determine the ability of a given soil type in retaining or removing nutrients and other indicators of pollution from the effluent of a septic tank-soil absorption system under actual field conditions. The site of this investigation is the Wisconsin Heights High School near Mazomanie, Wisconsin. After determining the direction of groundwater travel, 24 driven point wells were installed in the vicinity of the tile absorption field. The soil consists of a silty clay loam changing to sandy loam underlain by outwash sand and gravel.

Groundwater samples were taken from the wells weekly from April September (1967) and on a bi-weekly schedule thereafter. Analyses were made for BOD, chlorides, detergents (MBAS), nitrogen, phosphorous and coliforms.

SUPPORTED BY Wisconsin State Government - Madison

3.0351, CHEMICAL PULPING AND BLEACHING
N. SANYER, Univ. of Wisconsin, U.S.D.A. Forest Products Lab., *Madison, Wisconsin* 53706 (FPL3301)

OBJECTIVE: Develop improved pulping process for more complete utilization of all wood species as fiber or chemical raw material, while effectively reducing air and stream pollution.

APPROACH: Study pulping with oxidizing and reducing agents, polysaccharide stabilization in alkali, chemical and physical treatment of pulp for improving their strength and optical properties, recovery of cooking chemicals and byproducts, stabilizing color and strength of chemimechanical pulps toward light and aging, bleaching reactions with chemical recovery, post-delignification in digester for partial bleaching while preserving fiber strength.

PROGRESS: Wood delignification with oxygen compounds in mild alkali was investigated further for developing new pulping and bleaching processes where the sulfur compounds and attendant air pollution associated with the existing chemical pulping methods will be eliminated. In a series of model reactions, the oxidation of cellobiose with molecular oxygen and peroxygen compounds was shown to improve its alkali stability. In the course of delignification, however, wood polysaccharides were oxidatively depolymerized. Certain reaction schemes are being evaluated for preventing this and for further practical development of the method.

SUPPORTED BY U.S. Dept. of Agriculture

3.0352, WINTER STORAGE OF DAIRY WASTES IN NORTHERN CLIMATES
S.A. WITZEL, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (901-031-B616)

OBJECTIVE: Develop technology for the winter storage of dairy manures that will lead to a reduction of their pollution potential.

APPROACH: Evaluate all aspects of cold climate storage of dairy manures. The methods to be studied include stacking of the solid wastes, tank storage of wastes in liquid or slurry form, deep anaerobic lagoons, loose housing manure pack and others that may seem applicable. An analysis will be made of the wastes going in and coming out of storage to provide a basis for evaluating the reduction or altering of pollution potential as affected by the chemical and physical changes which occur in the specific storage methods. Studies will also be made of the handling methods and management requirements for installing the specific storage method into the overall waste management system.

PROGRESS: Studies were initiated on over winter storage of dairy cattle waste with 5 varying types of barns and manure storage systems. A 10,000 cubic foot storage structure at Ashland Station was filled in 125 days, a solid production including bedding of 3 1/4 cubic feet per cow per day. Seepage from the stack yielded about 2 gallons per cow per day. Minimal freezing occurred in the stack; some odor was detected under certain weather conditions. Total waste production from 2 cows for a 3-day period each month, solid and liquid wastes plus bedding, averaged slightly over 3 cubic feet per cow per day. Manure scraped from an uninsulated free stall barn into a 3000 gallon underground tank was pumped monthly under the ice into the lagoon at Marshfield Station. Frozen manure and yard scrapings containing snow were stacked on the concrete slab to prevent freezing in the tank. Little odor was detected from the lagoon. At Arlington Station, a loose housing system with manure pack storage of 180 days is used. Droppings from the feeding barn, paved lot, and manure pack were collected daily when weather permitted. They amounted to 110 lbs. per cow per day, a major portion of the manure production. Liquid manure systems were studied on two private farms. In one case, cows were confined to the barn, the liquid manure storage of 203 cubic feet per cow filled in 2 1/2 months. On the second farm when weather permits the free stall and lot are scraped into the underground tank. Odors in either case have not been typically offensive. Chemical analysis of the wastes have not been completed.

SUPPORTED BY U.S. Dept. of Agriculture

3.0353, SEWAGE PHOSPHORUS REMOVAL BY AN ACTIVATED SLUDGE PLANT
L.A. ERNEST, Milwaukee Sewage Commission, *Milwaukee, Wisconsin* 53201

The objectives of this project are to demonstrate the optimization of activated sludge process parameters for maximum sewage total phosphorus removal, to determine if a correlation

exists between activated sludge dehydrogenase activity and phosphorus removal and evaluation of process parameter effects on phosphorus level in an aeration tank. An appropriate sampling and analysis program will be initiated to evaluate the effects of process variations.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

3.0354, A MATHEMATICAL MODEL FOR THE FINAL CLARIFIER OF AN ACTIVATED SLUDGE PROCESS
W.J. KATZ, Rex Chainbelt Incorporated, *Milwaukee, Wisconsin* 53201

Develop a mathematical model expressed in computer format which will enable the prediction, with a high degree of reliability, the quantity and quality of the effluent and underflow of a final clarifier in an activated sludge treatment system as a function of the mixed liquor flow rate and characteristics.

The subsidence characteristics of activated sludge relates to the clarification and thickening properties of the sludge. Measurements such as sedimentation rates, suspended solids concentration, volatile suspended solids concentration, zeta potential, etc. are required to identify the performance of the clarifier. The relationship of these basic parameters and other variables with respect to the performance of the final clarifier is what the mathematical model must express. It is the objective of this proposal project to measure and evaluate those parameters which have interrelationships to each other that influence the operational performance of the clarifier, and to relate them, if possible, in terms or parameters which are normally available to the consulting engineer concerned with the basic design of the final clarifier.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

3.0355, LABORATORY SCALE FEASIBILITY STUDY OF USING REVERSE OSMOSIS TO CONCENTRATE PRE-TREATED DOMESTIC SEWAGE
D.G. MASON, Rex Chainbelt Incorporated, *Milwaukee, Wisconsin* 53201

The objective of the proposed project is to establish, through a laboratory scale study, the feasibility of utilizing reverse osmosis (R-O) as a means of concentrating domestic sewage for subsequent treatment by the activated sludge process. It is anticipated that successful completion of this objective will make possible a substantial reduction in the size of the equipment normally required for treatment of such flows, thereby reducing both capital and operating costs. In addition, the R-O process will produce a product water stream which, following disinfection, may be returned directly to municipal drinking water supplies.

The project will be conducted over a twelve (12) month period, and will comprise three major determinations: 1) establishment of the pre-treatment steps required to allow R-O to function effectively as a subsequent process; 2) determination of the amenability of the R-O waste concentrate stream to activiated sludge secondary treatment; and, 3) establishment of the R-O product water stream quality as meeting Public Health Service Drinking Water Standards. Preliminary cost information will also be developed to determine the engineering feasibility of the overall concept.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

3.0356, FECAL COLIFORM DIEOFF IN SEWAGE TREATMENT LAGOONS
K.T. CRABTREE, Univ. of Wisconsin, Undergraduate School, *Wausau, Wisconsin* 54401

Fecal coliform dieoff in domestic sewage lagoons. The primary emphasis is enumeration of the organisms in domestic raw sewage; primary and secondary effluents from the lagoons to determine the necessity of chlorination or some other means of disinfecting the effluents before discharge into receiving lands, streams, rivers and lakes. Various physical and chemical factors on the effects of coliform and fecal coliform counts are investigated. They are: retention time of the ponds, flow B.O.D., temperature and seasonal variation, occurrence of algal bloom, massive emergence of zoo-plankton, and of chlorination. Concomitant investigations include re-evaluation of media designed for detection of coliform and fecal coliform, effect of storage time for various sewage oriented samples, effect of incubation temperature (25, 37, 44.5 degrees C) on the coliform and fecal coliform counts. The project likewise includes enumeration of fecal streptococci and Pseudomonas aeruginosa which are considered as potential health hazards of man and animals as supplementary indices of fecal pollution. The project is jointly carried out with Prof. William C. Boyle, Dept. of Civil Engineering, and his graduate students. They are to investigate lagoons in the southern area of Wisconsin while our group is to cover central and northern Wisconsin. The project was initiated on July, 1969 and will be completed January, 1971.

SUPPORTED BY Wisconsin State Government - Madison

3.0357, STUDY OF WASTE DISPOSAL PROBLEMS
S.S. TIHEN, U.S. Dept. of the Interior, Bureau of Mines, *Laramie, Wyoming*

The purpose of this project is to study problems associated with disposal of spent shale and to devise methods for treating retorting process waters to remove contaminants or reduce them to harmless levels. Methods of treating spent shale dumps to reduce wind and water erosion and to reduce their deleterious effects on environment and ecology and methods of preventing possible contaminations of water sources by rainfall and snowfall leaching of spent shale dumps will be developed.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

E. RECYLING AND UTILIZATION

Byproduct Development, Reprocessing, Conservation of Raw Materials, and Other Related Studies.

3.0358, BROILER MANAGEMENT
G.J. COTTIER, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-10-0305)

OBJECTIVE: Study re-use of litter for broilers, fertilizer value of broiler house litter, and control of Gumboro disease. Collect data on 33 pens on litter study, 45 pens on Gumboro disease, and 90 samples of broiler house manure analyzed for nitrogen, phosphorus and potassium.

APPROACH: Continue work on broiler management.

PROGRESS: A total of 48 pens of broilers were marketed in the reuse litter study. The number of broods raised on the same litter varied from one through three. Growth, feed efficiency, and mortality were similar regardless of the number of times the litter was used. A total of 51 samples of litter were analyzed for nitrogen, phosphorous and potassium. A study on the effect of aflatoxin on different breeds and strains of chickens was conducted using 7 breeds, 2 crossbreeds, and 5 strain crosses. Criteria used were weight gain, shank color, mortality, organ size and pathological changes.

SUPPORTED BY Alabama State Government

3.0359, CONSERVATION OF RESOURCES IN MUNICIPAL WASTE
K.C. SANDERSON, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-09-0406)

OBJECTIVE: Determine means of conserving and utilizing processed garbage as: a mulch for ornamental plants, a seed coating or slurry for seeds and cuttings used to establish plants on the highway and a soil additive in the production of woody ornamental and floricultural crops.

APPROACH: Processed garbage will be compared with recommended mulches for roadside use. The effect of the mulches on soil moisture and temperature and plant growth will be determined. As aqueous slurry of processed garbage, wood cellulose, and seeds or root cuttings of various woody ornamentals will be sprayed on slopes on the roadside and survival noted. Processed garbage will be compared with standard organic soil amendments in various soil mixtures used in the production of ornamentals. The effect of processed garbage on the pH, water, retention, nutrition and plant growth will be determined.

3. SOLID WASTE MANAGEMENT

PROGRESS: Plants grown in soils amended with processed garbage yielded a reduction in height and fresh weight of chrysanthemums, dry weight of geranium and leaf-size and dry weight of gloxinnias and an increase in flowerhead length of snapdragons and plant height and flower number of Easter lilies. Chrysanthemum grown in garbage-amended media contained twice the recommended optimum range for boron. The manganese content of plants grown in garbage-amended media was at a toxic level for certain varities. Plants grown in garbage-amended media were high in potassium and zinc. Garbage did not seem to exert any adverse effect on the germination of 15 species of plants. Boron toxicity ma[illegible] ive[illegible] arred in radish and lima bean. Growing in garbage or g[illegible]age [illegible]nded media reduced the dry weight of kale, lima bean[illegible]di[illegible]nd sunflower. Compared with sawdust and pine straw, [illegible]to[illegible]ed garbage mulch gave comparable growth results [illegible]rysanthemums and petunias. Chrysanthemums grown [illegible]ocessed garbage from various sources exhibited stunting [illegible]me products. Processed garbage was combined with a nutri[illegible] chemical additions and recomposted to increase fertilit[illegible] reduce pH, soluble salts and phytotoxicity. Chrysanthem[illegible] grown in recomposted garbage-amended media did not exhi[illegible] phytotoxicity or growth reduction observed with unrecom[illegible] garbage-amended media.

SUPPORTED BY Alabama State Government

3.0360, SOLID WASTE RESEARCH UTILIZATION OF WASTE GLASS FROM MUNICIPAL REFUSE

M.E. TYRRELL, U.S. Dept. of the Interior, Bureau of Mines, *University, Alabama* 35486

Research in this project is directed to the utilization of waste glass recovered from municipal wastes either before or after incineration. Glass fractions used in the research are obtained from the solids waste reclamation continuous operating experimental plant at the Bureau's College Park Metallurgy Research Center. The principal areas of potential use of the glass to be investigated are (1) structural units, (2) thermal insulating materials, (3) glass beads, and (4) glaze frits. Emphasis of the work will be (a) to investigate mixtures of waste glass and additives and furnacing techniques required for making marketable glass wool, (b) to develop furnacing and cleaning techniques for converting waste glass into high quality glass bead products, and (c) investigations to determine the character and quality of structural block and other units made from ceramic bonded waste glass.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0361, DEVELOPMENT OF PROCESSES FOR IMPROVED FEEDS FROM AGRICULTURAL WASTES

H.G. WALKER, U.S. Dept. of Agriculture, Western Utilization Res. Div., *Albany, California* 94710 (W1-2-75)

OBJECTIVE: Convert lignified agricultural residues from vegetable and animal sources into useful animal feeds, thereby reducing environmental pollution from these waste materials.

APPROACH: Process lignified agricultural wastes to increase their cellulose digestibility. Study acidic, basic, and oxidative treatments under varying conditions of temperature and pressure of grass and cereal straws, other vegetable wastes and animal wastes. Study physical stresses like shear, compaction, dehydration and the like. Evaluate effects of processing by enzymatic in vitro methods. On promising treatments, evaluate by in vivo tests through cooperative research with other ARS divisions, experiment stations and industry groups.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

3.0362, DISPOSAL OF BRINE EFFLUENTS BY CONVERSION TO BY-PRODUCTS

R.R. GRINSTEAD, Dow Chemical Company, *Walnut Creek, California* 94598

This project will examine the application of solvent extraction methods to the separation and concentration of desalination brines to produce products which can be disposed of in normal industrial channels. Such products will include sodium chloride, sodium carbonate, magnesium and calcium carbonates, sodium and ammonium sulfates, and chlorine and caustic soda (from electrolysis of sodium chloride brine).

A dual extraction system will be studied, and will be analogous to the Desal ion exchange process for desalinating brackish water. The initial step would be based on the use of amine systems to convert anionic constituents of the brine to bicarbonates, and the second step will utilize acidic extractants to acidify the bicarbones to carbon dioxide. Among the by-products will be sodium carbonate, which can be used to remove divalent cations from the brine feed or from the original brackish water, ahead of the desalination step. In the latter case, the softened feed water would allow a greater recovery of water in the desalination step.

The rationale of using extraction methods in this application rests on the ability of extraction processes to treat and produce stronger salt solutions than ion exchange of methods, since problems of dilution due to mixing of aqueous phases are eliminated.

SUPPORTED BY U.S. Dept. of Interior - Off. Saline Wat[illegible]

3.0363, NEW AND IMPROVED PRODUCTS FROM WESTERN SOFTWOODS

L.A. MUELLER, Colorado State University, U.S.D.A. Rocky Mtn. For. Sta., *Fort Collins, Colorado* 80521 (RM3201)

OBJECTIVE: Contribute to better forest management, increased effective timber supply, and regional economic development through more efficient utilization. Develop new and improved products using western softwood timbers. Improve utilization of Rocky Mountain and Southwestern forests.

APPROACH: Develop new or improved products that will meet user requirements, match timber characteristics with user needs, and result in higher value production from available softwood timbers. New or improved products for lower common grades of ponderosa pine in the Southwest is first priority. Second is new products for other Rocky Mountain species. Third is reducing waste in woods and mills and better use of residues. Comprehensive work from product concept through pilot plant tests requires integrated marketing studies.

PROGRESS: Ponderosa pine stumpwood potential naval store source. Sample yields 31 percent benzene-soluble extractives, exceeding Southern pine. Extractives unique in that they contain about 6 percent longifolence, only domestic source and currently priced at $1,180 to $1,230 per metric ton. Engelmann spruce possible new fence post source. Successful treatment by modified double-diffusion process offers potential of adding species to approved list. Lumber can be overlaid by roll-laminating process at speeds up to 180-feet per second for $.04 to $.05 per board foot. Open defects severely limit the proportion of the lower grade lumber that can be used. Lower Common grades of Black Hills ponderosa pine lumber as components in laminated decking panels meet strength values of standard decking products. Equilibrium moisture content of laminated beams in service in area, interior and exterior, range between 6 and 8 percent; season of year of no significance. No seasonal variation found in liquid or gas permeability of inland Douglas-fir, Engelmann spruce, or lodgepole pine. Results rule out season of harvest as major cause for variability in drying and treating. Multiproduct inventory system further developed to better recognize and measure the basic stem characteristics and defect features that influence quantity and quality for most primary products.

SUPPORTED BY U.S. Dept. of Agriculture

3.0364, DAIRY CATTLE MANAGEMENT IN URBAN PROXIMITY

G.F. HAENLEIN, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00604)

OBJECTIVE: Evaluate feeding, breeding, and milk production procedures suitable to suburban conditions and maintain herd, buildings and equipment as an example of good management practices. Provide for research groups of calves, and cows with the necessary uniformity in age, genetic background and high productive capacity. Assist in training, teaching, and demonstrations for students, 4-H, FFA, and other interested organizations and visitors.

APPROACH: Under closely controlled conditions of management and detailed record keeping, current problems in dairy cattle management are being examined, e.g. milk measuring devices, different feeds, ingredients and feeding procedures, calf raising methods, the effects of management, feed and inheritance upon the composition of milk, particularly the contents of fat, solids-not-fat and protein. In cooperation with other research projects, groups of animals are being selected on the basis of their herd records and maintained e.g. several rumen fistulated cows, spayed heifers, castrated bulls and animals for analyses of blood, milk, excreta, reproductive and other organs. The necessary equipment and apparatus for quantitative feeding, sampling, and collection is designed as the need arises and machined and manufactured in cooperation with the agricultural engineers.

PROGRESS: Research with the dairy herds involved: (1) inheritance of milk proteins by (a) testing for % fat, % SNF and % protein, (b) electrophoretic identification of alpha(s)-casein, beta-casein, beta- lactoglobulin and kappa-casein genetic types for each cow, (c) antigen typing for blood types of each heifer and cow; (2) physiology of abnormal milk secretion by testing 18 cows daily for leucocyte contents, % skim protein, % casein, % whey and freezing point depression; (3) rumen microbiology by maintaining 4 rumen fistulated cows; (4) cooperative milk testing for bacteria contents with a new pilot instrument of the DuPont Company (results showed unexplained inconsistencies not related to standard methods); (5) cooperative project with the Drexel Institute - Philadelphia about utilization of animal solid waste products; (6) the new Environmental Control Large Animal Research Barn was completed and is housing groups of 3 heifers, 12 cows, 12 calves, 12 sheep and 4 horses for metabolism studies.//Extension activities

SUPPORTED BY Delaware State Government

3.0365, PEAT STUDIES

C.C. CAMERON, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

States to which project pertains: Eastern United States with emphasis on West Virginia, Maryland, Pennsylvania, New York and Maine.

Exploration of peat deposits suitable for soil conditioner and horticultural use by field study in ten areas representing major terrane types typical of northeastern United States. Five areas chiefly in New England and along the coast remain to be studied.

Objectives include: discovering physiographic and geologic controls of deposit occurrence and size: determining relation of stratigraphy and ecology to water movement and diagenesis affecting peat quality change: cataloguing major deposits according to new ASTM standards for current agricultural uses and anticipated uses in manufacture of foodstuffs and pollution controls.

Objectives are aimed at facilitating exploration by private industry and at presenting quantitative data obtained on deposit environments to assist others in their ground water, engineering, conservation, land management, and geochemical prospecting studies.

Deposits are measured, traversed, cored, and sampled for pH ASTM peat tests, and semiquantitative spectrographic analyses.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

3.0366, EFFECTS OF GARBAGE COMPOST ON SOIL PROCESSES

C.C. HORTENSTINE, Univ. of Florida, School of Agriculture, *Gainesville, Florida* 32601

Previous research under laboratory conditions showed that composted municipal refuse was an effective agent in preventing nitrification processes in animal manures. In light of current pressure on cattle feedlot operators and dairymen to prevent nitrate entry into surface and ground water supplies, this research was extended to simulated field conditions. Small lysimeters were used in which various rates of compost and cow manure were mixed with soil. A crop was grown in the soil and soil samples and leachates were collected for nitrification studies. Indications to date were that compost above 8 tons/ha applied to Arredondo fine sand prevented nitrification in manure applied at the rate of 40 tons/ha.

Field studies will be extended in an effort to determine the maximum amount of compost that may be applied to soil used for agricultural purposes. Previous research has indicated that Florida soils may be capable of assimulating as much as 200 - 400 tons/ha of compost applied on a yearly basis. However, the long time effects on soil characteristics and plant growth from such large amounts of compost are not clear.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0367, LIME TREATMENT AND IMPLANT REUSE OF AN ACTIVATED SLUDGE PLANT EFFLUENT IN THE CITRUS PROCESSING INDUSTRY

J.W. HAYES, Winter Garden Cit. Prod. Coop., *Winter Garden, Florida* 32787

The objective of this proposal will be to develop operational parameters and conduct an economic evaluation on lime treatment of effluent from a 2 mgd activated sludge system treating citrus wastes and in-plant reuse of the lime treatment effluent. The study will cover lime treatment, with the addition of coagulant aids, and dewatering of sludges by centrifugation for usage in cattle feed preparation. Determination will be made on this system's effectiveness in further reducing BOD, COD, and nutrients found in the activated sludge effluent.

The proposed project intends to demonstrate the effectiveness of lime precipitation on effluent from a 2 mgd activated sludge system treating citrus wastes. The activated sludge system consists of an aeration pond providing from 24 to 36 hours detention time with the overflow being directed into a final clarifier. Operation of the activated sludge system will afford pH control along with nutrient supplementation and sludge recirculation.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

3.0368, SOIL FERTILITY MAINTENANCE WITH FERTILIZERS, CROP RESIDUES, AND ANIMAL WASTES

W.E. ADAMS, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Watkinsville, Georgia* 30677 (SWC-031-BAW-05)

OBJECTIVE: Determine methods of improving the availability of nutrients from fertilizers, crop residues, and animal wastes on Piedmont and slate soils, clay pit spoil; the phytotoxic compounds found during decomposition; the rates at which residues and wastes can be applied without damaging the crop or polluting the ecosystem; the soil and climatic factors which affect the nutrient supply to crops and the efficiency of nutrient use by crops; the influence of fertilizers, crop residues, and animal wastes on crop quality.

APPROACH: Varying rates of inorganic fertilizers, crops residues, and poultry litter will be applied to small plots of fescue, Coastal bermudagrass, and corn; varying tillage methods will be used to dispose of animal wastes on tilled plots. Sintered ceramic candles will be buried at depths to sample ground water. Soil, forage, and crop samples will be analyzed to determine the influence of the fertility and residue treatments on crop quality.

PROGRESS: Investigations were continued at Watkinsville, Georgia to study the interaction of clipping frequency x N-K levels on the quality of Coastal bermudagrass. Total available carbohydrate (TAC) content of roots and forage regrowth were lowest in the spring and highest in the fall. In contrast, the total N (TN) content was reversed. Rhizomes contained considerably more TAC and TN than either stolons or fibrous roots. N rates (200 and 600 lb/acre) had little influence on TN content of roots. However, a wide N:K ratio (6:1) increased the percentage of TN while a narrow N:K ratio (2:1 or 1:1) reduced the TN percentage. The least forage regrowth was associated with the highest N level and the 6-week clipping frequency.

SUPPORTED BY U.S. Dept. of Agriculture

3.0369, USE OF SEWAGE TO PRODUCE ALGAE FOR LIVESTOCK FEED

UNKNOWN, Natl. Botanic Gardens, *Lucknow, Uttar Pradesh, India* (908-034-B706)

OBJECTIVE: Develop methods and equipment for economical production, harvesting handling, processing feeding of sewage-grown algae.

3. SOLID WASTE MANAGEMENT

APPROACH: Collect samples of sewage from towns in Eastern and Central Uttar Pradesh for study of various species of algae, fungi, and bacteria normally growing in sewage liquids under Indian conditions. Evaluate algae for protein content and metabolic efficiency. Grow selected algae in oxidation tanks about 15'x30' x 3' to 5' deep and study factors affecting growth, with particular reference to N,C, P, Mg, K, temperature, and light. Evaluate various harvesting methods, including mechanical, electrical, and chemical, for cost and effectiveness. Study chemical composition of the sewage grown algae for protein, carbohydrate, fat, mineral, and vitamin content. Determine nutritional and feeding qualities (including pathogenic bacteria survival) for farm animals and poultry.

PROGRESS: A survey of algal flora of sewage in relation to physico-chemical characteristics of important towns of Uttar Pradesh was undertaken. It is significant that there is a great degree of similarity in algal and physico-chemical characteristics of the sewage of U.P. towns in spite of the wide range of variation in the density of human population. The nutrients, especially nitrogen and phosphorous, which support rich growth of algae, are present in appreciable quantities. The range of pH is also favorable in most of the towns of which survey was made. These factors are of special significance for the further pilot plant studies in stabilization ponds. Thirty-two species of algae have been recorded. Cyanophycean species dominate over other groups of algae. Experiments were conducted to harvest Microcystis aeruginosa and Selenastrum minutum, which form rich bloom in L.S.G.E.D. oxidation ponds at Lucknow. It was observed that the optimum concentration of flocculants required varied from 100-400 ppm for Microcystis and 300-400 ppm for Selenastrum. Six flocculating agents were tried, out of which commercial potash alum seems to be the cheapest and most effective. The final pH of the flocculating medium is also important for effective precipitation of algae. The aluminum- containing compounds were found to be effective at acidic or more or less neutral pH, whereas iron-containing flocculants were found to be effective at alkaline or slightly acidic pH levels.

SUPPORTED BY U.S. Dept. of Agriculture

3.0370, MULTI-PURPOSE UTILIZATION OF HARDWOOD BARK THROUGH CHEMICAL MODIFICATION

C.A. ECKELMAN, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907

The potential value of bark as an untapped source of raw material is demonstrated by the fact that the forest industries remove and dispose of about 20 million tons of bark annually. Its present disposal creates air and water pollution problems. Much of the effort to utilize bark is waste oriented which means seeking uses without conversion into other forms. It is the purpose of this research to open the way to the transformation of bark into an asset. The knowledge of hardwood barks is very limited; therefore, physical and standard mechanical properties of bark of three selected hardwood species will be evaluated. Improvements in their strength characteristics, binding properties, fire resistance, and water sorption characteristics will then be sought by chemical modification with commercially available compounds. It is essential that these properties be improved, or changed if bark is to be used as the main constituent in products such as building boards and other composite materials for the housing industry, which volume wise may be an enormous outlet for such materials. However, because bark is a complex, non-homogenous, material with properties dependent on wood species, no single approach can be used to solve hardwood bark utilization problems economically. Rather, a multi-purpose approach is needed. The multi-purpose utilization will be carried out in several ways; e.g., the extraction will be removed and used as a source of chemicals and pharmaceuticals, and the remaining fibrous material - after chemical modification - will be used in production of different types of composite materials. Another possibility includes extraction of chemicals, separation of extractive - free bark into two layers, and utilizing the stronger inner layer for structural materials and the weaker outer layer as a filler or an ion exchange medium.

SUPPORTED BY Purdue University - Lafayette, Ind.

3.0371, DETERMINE LIGNIN STRUCTURE AND BIOSYNTHESIS

O.E. NELSON, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01414)

OBJECTIVE: Determine the availability of sites for esterification on the 'cores' of normal, bm(1) and bm(2) alkali lignin and solvent- extractable lignin before and after de-esterification. To determine the incorporation of phenolic monomers into the lignin 'cores' of normal, bm(1) and bm(2) corn vs. esterification onto the 'cores'. To elucidate the enzymatic reactions by which p-hydrocycinnamic and ferulic acids are esterified onto the lignin 'cores' in normal, bm(1), and bm(2) corn. To compare the phenoloxidase and peroxidase activity of normal corn with the mutants. To determine the lignin content, the composition of the 'cores', and the phenolic acids esterified onto the 'cores' for bm(3) and bm(4) mutants and the double mutants bm(1) bm(2), bm(1) bm(3), bm(1) bm(4), etc.

APPROACH: A comparison of the effects of the mutants bm(1), bm(2), bm(3), bm(4) with those of the double mutants may make it possible to ascertain which mutants are affecting early steps in lignin formation and which are affecting later steps.

PROGRESS: A group of recessive mutants in maize, the brown-midrib mutants, owe their visual differences from normal plants to the production of abnormal and colored lignins. Alkaline hydrolysis of mutant and normal lignins liberates P-coumaric and ferulic acid with a marked reduction in yield of P-coumaric acid from the brown-midrib-1 (bm(1)) mutant and its double mutants. Syringaldehyde, vanillin and P- hydroxybenzaldehyde are obtained after alkaline nitrobenzene oxidation of the lignins. The yield of syringaldehyde from all double mutants and the bm(1) and bm(2) and bm(3) mutants was less than that from normal maize. Greatest reduction of syringaldehyde occurred with bm(1) and its double mutants. Molecular core of bm(1) has carboxyl groups and these may account for its highly cross-linked nature. The bm(1) mutant may be less able to reduce carboxyl groups and/or hydroxylate the benzene ring to the syringaldehyde pattern. This results in the incorporation of an 'abnormal' component into the lignin core. Since lignin comprises 15- 25% of the dry weight of wood and many crop residues, knowledge of its biosynthesis and structure are valuable to the paper industry and in utilization of farm residues.

SUPPORTED BY Indiana State Government

3.0372, EVALUATION OF DEHULLED SOYBEAN GRITS FROM UNITED STATES VARIETIES FOR MAKING MISO

H. EBINE, Central Miso Institute, *Tokyo, Japan* (UR-A11-(40)-2)

PROGRESS: Final report has been received. Over 100 different commercial varieties of soybeans were studied as well as 24 Japanese samples. U.S. varieties found most suitable for making miso were Kanrich, Mandarin, and Comet. Seven other varieties and unnamed selections offered promise. Evaluation of the soybean grits method gave products with excellent color and flavor, and the organoleptic tests showed the miso to have a less beany flavor. This method gave high quality miso but had the disadvantage of a higher loss of water-soluble material than the whole bean fermentation. Some studies were made to determine if the soluble waste could be used as a substrate for cultivation of the mold that makes enzymes for miso production. The mold did not make the proper enzymes on this substrate. Statistical data on miso production in Japan are presented in this report.

SUPPORTED BY U.S. Dept. of Agriculture

3.0373, SINGLE CELL PROTEINS FROM CELLULOSIC WASTES

C.D. CALLIHAN, Louisiana State University, School of Engineering, *Baton Rouge, Louisiana* 70803

Due to the rapid increase taking place in the nation's and the world's population, serious pollution problems and shortage of food will have to be overcome. Cellulosic wastes from agriculture, industries and municipalities constitute a major portion of the

solid wastes, and these wastes can be converted to useful products. One of the most important products to which it can be converted is protein. Protein is the component in food and animal feed that is in shortest supply.

A versatile, continuous, chemical-microbial pilot unit is under construction. On completion it will be able to process a multiplicity of cellulosic wastes converting them to single cell protein using an organism that has already been isolated in our laboratories. Studies will be conducted with the pilot unit to evaluate the various cellulosic wastes as substrates for microbial growth and to determine the optimum conditions for economic operations. Also, other cellulolytic organisms will be investigated for their substrate specificity. As an integral part of the project the nutritional value, digestibility and toxicity of the single cell protein product will be determined. Studies will also be conducted to direct the product improvement.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0374, RESEARCH STUDIES RELATED TO DEVELOPMENT OF A CRAWFISH PROCESSING INDUSTRY IN LOUISIANA

R.T. LOVELL, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01391)

OBJECTIVE: The objectives of the study were to derive information which would be pertinent to the growth of the crawfish processing industry in Louisiana which included processing and market product recommendations, plant and equipment designs, potential crawfish supply and sources, public health aspects of crawfish as a food, utilization of waste material, and locations for plants.

APPROACH: Crawfish samples were collected during the 1966 and 1967 seasons for laboratory studies concerning bacteriological and chemical analysis data, processing methods, and product development. Survey data was collected from persons and agencies associated with the crawfish industry in the state. Plant designs and equipment were developed by cooperative work with engineering personnel from within and outside the University. Final recommendations were compiled in manuscript form and distributed to persons and agencies interested in the crawfish processing industry.

PROGRESS: Contacts with national food and industrial organizations have been established pursuant to applied development of the Louisiana crawfish industry for production of gourmet food items and utilization of waste products for animal protein feed purposes. Examination of organoleptic and overall consumer attractability of presently prepared crawfish products is in progress by these firms in conjunction with personnel and facilities of the Food Science and Technology Department. Economic and production factors of the industry are being evaluated to establish feasibility of large-scale resource input. Biological characteristics of the animal, pertinent to intensive cultivation on a predictable basis, are also under study.

SUPPORTED BY Louisiana State Government

3.0375, BARK RESIDUES AS SOIL CONDITIONER

O.L. FITZGERALD, Louisiana Technological Univ., School of Forestry, *Ruston, Louisiana* 71270 (LAZ00003)

OBJECTIVE: Determine the value of bark in three sizes as a mulch for horticulture plants. Determine the economic feasibility of marketing processed bark on a local and regional basis for use as a mulch or soil conditioner.

APPROACH: Various treatments of the bark will include composting untreated as well as with different mixtures of nutrients added prior to composting. This will be followed by a shredding operation to alter the bark to various sizes. These sizes and mixtures will be tested on field grown and container plants. Data resulting will be statistically analyzed to determine the value of these materials as mulch or soil conditioner.

PROGRESS: The manuscript for the first two-year mulch project should be published during the next three months. Dr. Wright will present a portion of this report at the Southern Agriculture-Workers meeting in Mobile, Alabama on February 5, 1969. Work has been started on renovating the beds used for a previous crop of roses grown in media where bark, sawdust and peat were used as an amendment. These beds will be tested for mineral content, for organic matter and for density. New soil will be added to raise the beds to 9 inches above ground level. Four varieties of Hybrid Tea roses will be grown and production records kept for a two year period. Further work with tomato plants grown in mixtures containing bark will be attempted.

SUPPORTED BY U.S. Dept. of Agriculture

3.0376, FEEDING BROILER LITTER TO DAIRY REPLACEMENT HEIFERS

H.H. BRUGMAN, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME03115)

OBJECTIVE: Determine cost and feasibility of feeding broiler litter to replacement dairy heifers.

APPROACH: Cost of feed, growth rates and fertility data will be collected from dairy calves fed a broiler litter and grain ration following the initial milk replacer-calf starter period of about eight weeks. The animals will be bred at about 15 months of age. The problem of drugs, antibiotics, other feed additives and their derivatives and their possible effect on human and animal health will be studied. The time for discontinuing the feeding of broiler litter prior to milk production age will be determined.

PROGRESS. In order to save cost and time preliminary work is conducted with sheep object is to develop a low priced ration suitable to automatic feeding. All concentrate ration containing 20% sawdust as a fiber source plus barley and S.O.M. as control and rations containing 20% sawdust, barley and poultry litter with and without ampro-plus and rumen inoculant added. Feed efficiency was greater in lots fed poultry litter than the control ration, ampro-plus retarded growth in lambs under 70 lbs. No effect was found when rumen inocculant was added. Rations containing urea were less efficient than the control ration. Six Hereford heifers were weight-gain tested. The index varied from 1.71 to 2.52. One bull was tested and his index was 3.39.

SUPPORTED BY Maine State Government

3.0377, BIODEGRADATION OF POULTRY MANURE

C.C. CALVERT, U.S. Dept. of Agriculture, Animal Science Research Div., *Beltsville, Maryland* 20705 (032911590121073)

OBJECTIVE: Develop biological methods for odor control, volume reduction and the production of useful products from poultry manure.

APPROACH: The procedures used will be to determine whether coprophagous insects such as the house fly and/or unicellular organisms can degrade poultry manure and reduce or eliminate odor, reduce volume and produce a useful protein byproducts. The nutritive value of fecal material after treatment will be determined by feeding them to the chicken and other animals.

PROGRESS: Poultry manure seeded with house fly eggs loses approximately 46 percent of its original water content. The manure after larvae development was essentially odorless, and loose and crumbly in texture. The material is easily pelleted. It contains about 2 percent nitrogen and may have use as a fertilizer and soil conditioner. A patent application has been made for a device to separate larvae from the manure. The fly pupae contains about 63 percent protein, with a good amino acid profile, and is the equivalent of soybean meal in supporting chick growth. The pupae yield is about 3-4 percent of fresh manure.

SUPPORTED BY U.S. Dept. of Agriculture

3.0378, RECOVERING AND REFINING SECONDARY METALS AND ALLOYS

H.S. CALDWELL, U.S. Dept. of the Interior, Bureau of Mines, *College Park, Maryland* 20740

A series of investigations is being conducted to develop new and improved processing techniques for reclaiming metal values from scrap and mineral processing wastes. Research now in progress includes: (1) the determination of optimum experimental conditions and reagents required to remove antimony from bronze and brass scrap and lead and tin from aluminum scrap by the use of intermetallic compound formation; (2) the removal of

chlorine from sal skimmings to produce a dry zinc oxide ash suitable for smelting; (3) investigation of vacuum distillation methods for removing volatile constituents from complex nonferrous scrap mixtures to produce commercially acceptable metals or alloys; (4) investigation of use of carrier gases to enhance the degree of separability and the rates of distillation of volatile metals at temperatures below the boiling point; (5) development of improved amalgam, electrorefining and electrowinning techniques for separating and refining metals from complex nonferrous scrap metal mixtures; (6) investigation of hydrometallurgy methods for extracting and recovering tin from detinning tank slimes; (7) development of hydrometallurgical methods for reclaiming metal and mineral values contained in incinerator process, and (8) a systems study that will permit selecting effective combinations of refining techniques for optimum recycling of complex secondary metals and waste materials.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0379, RECOVERY OF COPPER AND OTHER BASE METALS FROM COMPLEX METAL MIXTURES

H.S. CALDWELL, U.S. Dept. of the Interior, Bureau of Mines, *College Park, Maryland* 20740

The overall objective of the project is to develop methods for identifying, sorting, and separating metals to allow more efficient recycle of scrap and other complex metal mixtures.

Research Investigations in Progress are as follows: A. Devise simple, versatile, inexpensive identification methods to classify a wide variety of copper-base scrap with reasonable certainty. Colorimetric, X-ray, and chemical methods are being studied. B. Develop methods for removing lead from copper-base scrap that cannot be efficiently sweated. Flux refining and intermetallic compound formation methods are being studied. C. Determine if vacuum distillation is both technically and economically feasible for treating galvanized steel scrap to upgrade the scrap for steelmaking and recovering a marketable zinc product.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0380, EXTRACTION OF METAL AND MINERAL VALUES FROM MUNICIPAL REFUSE AND INCINERATOR RESIDUES

M.H. STANCZYK, U.S. Dept. of the Interior, Bureau of Mines, *College Park, Maryland* 20740

Research currently is aimed at developing continuous methods for recovering various metal and mineral values from municipal incinerator residues and refuse, and refining of these materials into products suitable for recycling back into our economy. A small prototype continuous pilot plant is being designed and developed for separating residues into fractions suitable for further metallurgical processing. As data from this pilot plant is developed, performance results are being evaluated for determining materials and energy balances, relative equipment size and operating costs for a semi-commercial size plant. Chemical processes for preparing premium grades of iron scrap from ferrous fractions and for recovering precious metals from fly ash also are being developed. Physical processes for producing an uncontaminated glass fraction, and separating clear glass from colored glass are being investigated.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0381, ENHANCED CELLULASE PRODUCTION BY MUTATION

M.H. MANDELS, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Technical Objective: Increase degradation of cellulose by mutation to develop strains that produce greater quantities or cellulolytic enzymes and/or enzymes having greater specific activity on cellulose. Enzymatic degradation to convert cellulosic waste to food appears feasible. More active enzyme preparations will increase the rate of breakdown, reduce or eliminate pretreatment of the substrate, and improve the economic potential of the process.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0382, SCRAP AND RECYCLE RESEARCH

N.B. MELCHER, U.S. Dept. of the Interior, Bureau of Mines, *Saint Paul, Minnesota* 55111

To develop efficient methods for recovering and reusing iron, steel, and ferroalloy metal scrap and waste and to reduce or eliminate environmental pollution and disposal costs.

Continue research on production of foundry iron from ferrous scrap. Work will be conducted to produce commercially acceptable foundry iron and synthetic foundry pig iron from ferrous scrap. Automobile and other ferrous material will be blended as required. Foundry iron and synthetic foundry iron will also be produced using prereduced pellets.

Continue research on a selective oxidation of ferrous scrap to produce a high quality iron oxide and a clean residual scrap iron of high purity, and devise methods to recover the nonferrous elements. Investigate more fully the effect of process variables such as time, temperature, and gas atmosphere; to determine the effect of oxidation promoters and the influence of nonferrous contaminants on process reactions.

Provide supporting petrographic services to examine raw materials and reduced products by microscope and X-ray; describe and photograph pellet microstructure as required.

Conclude research on recovery of copper from high copper-bearing materials, such as armatures and motors.

Investigate the kinetics and mechanism of oxidation of steel scrap with carbon dioxide, water vapor, and their mixtures with nitrogen, carbon monoxide, and hydrogen.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0383, SYNTHESIS OF L-DOPA FROM WOOD PULP WASTE

F. GILMORE, Univ. of Mississippi, Graduate School, *University, Mississippi* 38677

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Mississippi State Government

3.0384, RECYCLING OF STEELMAKING FURNACE DUSTS

P.G. BARNARD, U.S. Dept. of the Interior, Bureau of Mines, *Rolla, Missouri* 65401

To develop treatments for removing certain deleterious elements from iron foundry and electric furnace and BOF steel making dusts that will permit recycling of the iron-rich residue and recovery of the nonferrous metals in usable form. (1) Continue research to develop treatments for removal of zinc, lead, and copper to levels that allow recycling of iron-rich residue in the steel plant. (2) Make a suitable agglomerate, low in lead and zinc, by simultaneous reduction-induration of pellets. Investigate the addition of coarsening agents as coke breeze, fine sinter, or mill scale to improve pelletization chaacteristics of the dust. Study the possible elimination of lead and zinc by reduction of small pellets. (3) Develop economically and technically feasible methods for recovering zinc, lead, and copper from steel furnace and iron foundry dusts.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0385, UTILIZATION OF PROCESSING WASTES AND SCRAP

L.W. HIGLEY, U.S. Dept. of the Interior, Bureau of Mines, *Rolla, Missouri* 65401

To develop low-cost procedures for the extraction of metals, metal compounds, and minerals from base metal processing wastes; and to determine new applications for the utilization of low-grade base metal scrap.

Specific elements of the objective are substitution of zinc die-cast scrap for high-purity zinc in desilvering of lead bullion, and recycling of zinc retort residues, electrolytic zinc plant leach

residues, and copper alloy furnace dusts. Research on these materials is needed to develop uses, rather than discarding as wastes in some instances, and to overcome underutilizationn in other instances.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0386, UTILIZATION OF WASTE PLASTICS FROM URBAN REFUSE

J.L. HOLMAN, U.S. Dept. of the Interior, Bureau of Mines, *Rolla, Missouri* 65401

The overall objective is to develop methods for making use of plastics discarded in urban waste. Plastic disposable consumer products will be characterized as to distribution of types and formulations. Adhesive bonding of mixed plastics will be investigated and bulk properties of scrap plastic compared with those for virgin plastic as new uses are sought for mixed plastic scrap. The feasibility of using scrap polyvinyl chloride as a source of HCl or C12 in metallurgical processes will be emphasized. Since large-scale use of plastics is creating a serious problem because of unsatisfactory disposal methods, this project is aimed at making useful products from plastic wastes.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0387, TUBE TRANSPORT - AN IMPROVED CONCEPT OF URBAN REFUSE COLLECTION, TRANSPORTATION AND RECYCLING

B.G. WIXSON, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

An improved concept for the processing and tube transport of urban solid wastes was achieved by a grinding process coupled with the transportation of wasted suspended in an improved emulsion. An experimental pilot-plant was constructed using a hammermill, a 20 HP electric motor, a SWG 12H type CDQ Moyno sewage pump and one hundred foot loop of four inch PVS pipe discharging into a 300 gallon reservoir. An experimental chemical material was furnished by the Petrolite Corp., St. Louis, to form a very thick emulsion that would liquidize under pressure, and jell and suspend ground particles if pumping pressure was released. The emulsion was made with water and served as a lubricant to the pump and pipe during operation.

Solid wastes used in the study were derived from ordinary municipal refuse. Reduction of wastes was generally feasible by use of the hammermill. Tube transport flow tests were carried out to compare the differences between the use of water and emulsion as the transport media for urban wastes. The emulsion was found to be superior to water by (1) permitting larger, denser particles of processed solid wastes to be carried without the settling problems normally encountered when water was used as the transporting media; (2) Shredded wastes could be separated from the emulsion and the emulsion could be reused; and (3) the emulsion acted as a lubricant and reduced wear on pumps and pipes.

Research is continuing to determine the economic and applied value of such a system to crowded urban environments. New concepts developed from this study would assist in rehabilitating some urban environments and planning future urban communities to avoid refuse problems.

SUPPORTED BY University of Missouri

3.0388, USE OF POULTRY FAT AND MEAT SCRAPS

G.W. FRONING, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (W6-1-72(C))

OBJECTIVE: Find remunerative uses for poultry meat and fat recovered from the less valued parts of the carcass.

APPROACH: Emulsifying and cohesive properties of variously treated poultry parts such as backs, neck, skin and fat will be determined and evaluated in terms of comminuted sausage-type products.

PROGRESS: Turkey muscle protein was fractionated into actin, myosin, actomyosin, and a total gross myofibril fraction, and the emulsifying characteristics of these fractions were determined. Actin had an extremely high emulsifying capacity; its upper limit was not established. Emulsifying capacity for the other fractions decreased in the following order: actomyosin, myosin, myofibrils, and finally whole meat. Emulsion stability paralleled emulsifying capacity. The superior emulsifying capacity of prerigor muscle to post rigor muscle could be duplicated in post rigor muscle by adjusting the pH back to prerigor levels. Blending deboned meat with salt and holding for 24 hours at 35 F. before chopping, and higher levels of salt in the sausage formulation, both reduced gel-water release and solids release from the subsequently formed emulsions, and also reduced cooking loss. Combination of mechanically deboned turkey meat and soybean protein (at 25% of total protein) was found to give a satisfactory sausage. Optimum conditions were established for utilization of Paoli deboned turkey frame meat and Bebun deboned turkey frame meat. It appears that there is a need to standardize these products, in terms of fat content and tissue constituents, if they are to attain wide commercial usage.

SUPPORTED BY U.S. Dept. of Agriculture

3.0389, SOIL PRODUCTIVITY AS AFFECTED BY MICROBIAL ACTIVITY IN CROP RESIDUES AND ANIMAL WASTES

T.M. MCCALLA, Univ. of Nebraska, U.S.D.A. Soil & Wa. Cons. Div., *Lincoln, Nebraska* 68503 (SWC-031-DLI-4)

OBJECTIVE: Determine the effects of crop residue management and animal waste additions on the kinds and number of microorganisms in soils, their release of nutrients and production of toxins, and the significance of such microbial activity to crop production.

APPROACH: Laboratory and filed investigations will be conducted on the effects of kinds and amounts of crop residue and animal waste additions and management on the kinds and numbers of microbes in soils, the rate of release of plant nutrients and the production of plant growth promoting and inhibiting compounds. Microbial activity will be related to soil moisture, temperature and aeration conditions. Chemical analyses and bioassays will be conducted to determine the nature and amounts of toxins produced.

PROGRESS: Penicillium urticae populations as high as half of the total fungal populations were found in soil samples from spring and fall soil samples taken from stubble-mulched wheat fields in five states. The mold produces the phytotoxin, patulin. Concentrations as high as 75 p.p.m. of soil were extracted from stubble-mulched soil. Patulin applied to plots of wheat at three locations in Nebraska for 3 years reduced germination, tillering, survival and yield when applied at seeding. Spring applications reduced height, grain yield, and kernel size. Effects on yield were less the later the patulin was applied. Yield reductions as high as 26 percent have been noted in the field, but the toxicity depends on field conditions that are poorly understood.

SUPPORTED BY U.S. Dept. of Agriculture

3.0390, CHEMICAL PROCESSING OF ITANIUM SCRAP AND RESIDUES. TITANIUM CHLORINATION RESIDUES

C.C. MERRILL, U.S. Dept. of the Interior, Bureau of Mines, *Boulder City, Nevada* 89005

Purpose: Develop methods to recover and recycle the metal values resulting from the wastes produced in the production of titanium tetrachloride. This waste material contains niobium, tantalum, titanium, zirconium, vanadium, chromium, iron, and aluminum. Methods of separating these elements will be studied, and procedures will be developed for the recovery of the valuable components.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0391, ELECTROLYTIC REFINING OF ALUMINUM SCRAP

T.A. SULLIVAN, U.S. Dept. of the Interior, Bureau of Mines, *Boulder City, Nevada* 89005

Purpose: To improve processes for reutilization of metal and mineral values for which present commercial methods are inadequate or inefficient.

3. SOLID WASTE MANAGEMENT

Initial work will explore the use of the 'Hoopes type cell' to produce high-purity and/or aluminum base alloys from aluminum scrap metal products with particular emphasis on abundant low value scrap or waste metal.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0392, A NEW PRACTICAL APPROACH TO DAIRY WASTES
W.K. JORDAN, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00311)

OBJECTIVE: Find methods to reduce waste water volume through reuse. Recover food materials for human use and animal feed. Realize savings through reuse of cleaning compounds. Reduce over-all use of water and provide an effluent from the food plant that minimizes contamination of ground and surface waters.

APPROACH: Effluent from the University dairy will be examined for amount, B.O.D., fat and solids, alkalinity, and bacterial count. Salvage of food material will be by separation or concentration. Potential reuse of cleaning solutions will be determined in the laboratory and then in the plant. Modification of plant practices will be tried to minimize water use.

PROGRESS: A study of the temperature, composition, and flow of all effluent from the University dairy plant led to improved plant practices resulting in savings of water, fuel, detergents, and edible food solids. Although approved, the project has not been funded. No additional work has been started.

SUPPORTED BY U.S. Dept. of Agriculture

3.0393, TREATMENT AND UTILIZATION OF WASTES
F.J. HUMENIK, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03295)

OBJECTIVE: Investigate biological methods for removal and conservation of nutrients from agricultural, processing and domestic waste; examine methods for conversion of harvested biomass nutrients into a suitable high protein food.

APPROACH: A symbiotic algal-bacterial system will be developed toward practical applications for removal and conservation of wastewater nutrients. Applicable algal species will be investigated and ecological relationships considered in determining the optimum environmental and operating conditions. Methods of harvesting and processing algal- bacterial biomass for producing a high protein food will be examined.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

3.0394, WOOD RESIDUE PRODUCTION AND FEASIBILITY OF CONVERSION TO A SALEABLE PRODUCT
D.H. STEENSEN, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC04022)

OBJECTIVE: Determine the amount of wood residues produced and the amount currently contributed to air and ground pollution: locate those areas capable of supporting a residue-using firm: and determine the economic feasibility of converting wasted wood to a saleable product.

APPROACH: Primary wood-using firms will be surveyed. Collected data will be used to generate production coefficients suitable to up- dating the survey and analyzing the economics of waste conversion.

PROGRESS: Initial and follow-up contacts have been held with the cooperator, North Carolina Department of Conservation and Development to assay the volume and types of wood residue being generated in primary conversion plants in North Carolina. Preliminary studies have been made to conduct a study of residues being generated in N. C. furniture plants and possible avenues for their salability.

SUPPORTED BY U.S. Dept. of Agriculture

3.0395, SYNTHETIC FILLER FOR USE IN HIGHWAY CONSTRUCTION
R.F. STOOPS, Univ. of North Carolina, School of Engineering, *Raleigh, North Carolina* 27600

The objective of this preliminary investigation is to determine the feasibility of developing a low-cost synthetic filler for asphalt and concrete pavements. The material will be designed for high skid resistance and night visibility. It will be a crystallized glass made from readily available waste products insofar as possible. Work will include making glasses, crystallizing them, and evaluating their properties. Differential thermal analysis, x-ray diffraction, and electron microscopic techniques will be used to determine optimum crystallization conditions. Properties such as hardness, crushing strength, whiteness or reflectivity, wear and skid resistance, chemical corrosion resistance, and oil penetration will be determined. The project began on 1 July 1970 and should be completed by 31 December 1971.

SUPPORTED BY North Carolina State Government - Raleigh

3.0396, FERRIC CHLORIDE PROCESSING
F.E. BLOCK, U.S. Dept. of the Interior, Bureau of Mines, *Albany, Oregon*

OBJECTIVE: To develop a process for the recovery of chlorine and a usable iron oxide byproduct from waste iron chlorides generated in the direct chlorination of ilmenite to produce $TiCl_4$.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0397, UTILIZATION OF WASTE BARK
R.A. CURRIER, Oregon State University, School of Forestry, *Corvallis, Oregon* 97331

Specific Aims of this proposal: Physical: 1. To study the formation of pellets from bark as a model system for the preparation of other molded products from bark. 2. To determine which basic information obtained from pelleting studies may be extrapolated for use in preparing other molded and extruded articles from bark, or mixtures of bark and plastics.

Chemical: 1. To obtain a more detailed description of bark, particularly the carbohydrate and polyphenolic polymers, i.e. bark phenolic acids, phlobaphenes, tannins and 'bark lignin' fractions. 2. To prepare derivatives (acetate esters, methyl ethers) of the polysaccharides and compare their properties with those of carbohydrate derivatives presently in commercial use. 3. To determine the reactivity of these chemical components with ammonia and their role in the fixing of nitrogen in bark.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0398, CONVERTING INCINERATOR RESIDUE TO USEFUL MATERIALS
P.E. MORGAN, Franklin Institute, *Philadelphia, Pennsylvania*

Work will be extended to produce at least 600 lbs. of road aggregate material for testing by Federal and State highway authorities. Possible uses for incinerator ash for cement, as a soil will be pursued; for the latter some plant growth studies are being examined free of charge to this project. An economic study of processing and the logistics of transportation, sociological implications etc. will be carried out by people skilled in chemical engineering and systems science. Recommendations will be made at the end of the period for scale up to a pilot plant suitable for a demonstration project.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0399, CONVERSION OF POULTRY MANURE TO USEFUL PRODUCTS
G.O. BRESSLER, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01829)

OBJECTIVE: Develop for layers automatic system drying manure to low level moisture; eliminate obnoxious odors for manure use in plant growth media; prepare products by combining dry manure or ash with anthracite refuse to test under greenhouse and field conditions.

APPROACH: Dry manure from 80% to 30% moisture by stirring, aerating. Dry from 30% to 9% commercial dryer. Obtain least cost combination. Develop automatic system for floor and cage operations. Determine relationship of stirring aerating manure and production obnoxious odors. Establish minimum

commercial dryer temperatures to achieve moisture stability, minimize microiorganisms, retain maximum plant nutrients. Combine dry or ashed poultry manure with anthracite refuse other waste products. Conduct greenhouse and field trials for physical and chemical capability product or plant growth. Apply to strip mine and spoil banks to establish cover crops. Measure benefits to soil and acidity.

PROGRESS: An automatic system of drying poultry droppings inside a poultry house to about 30% moisture and to less than 10% moisture in a commercial dryer has been developed. Mechanical difficulties in equipment require further developmental work. The dried poultry manure has been applied with a hydro-seeder to experimental plots on coal mining spoil bank land, on divider strips and highway embankments and on a dam breast. Manure treated plots were compared with plots treated with lime and fertilizer according to Penna. Department of Highways recommendations. All plots were seeded with a slope mix grass and Crown Vetch seed mixture. By the end of the summer the growth of grass and vetch on the manure plots was just as satisfactory as on the fertilizer and lime treated plots. Use of the commercial dryer operated at 250 F. cut bacterial counts in the manure from as high as 31 billion per gram to as low as 400,000 organisms per gram of manure. Enteric type bacteria were reduced from 24 million to as low as 400 per gram of manure. Greater root nodulation has been found with Crown Vetch and beans where dried manure was applied to the soil compared with lime and fertilizer plots. No Salmonella organisms were isolated from the dried manure.

SUPPORTED BY U.S. Dept. of Agriculture

3.0400, REUSE OF PLASTICS RECOVERED FROM SOLID WASTES

D.R. PAUL, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

It is estimated that about 90% of all plastics in municipal refuse are the chemical types polyethylene, polystyrene, and poly(vinyl chloride). The remaining 10% includes a broad assortment of chemical types. Development of suitable processing schemes and demonstration of desirable properties of the reprocessed materials is a necessary first step. Initial work will be restricted to the three types of plastics predominant in wastes. Fundamental properties of plastic blends made from these materials will be examined. If reuse can be made possible, this will eliminate the need to dispose of this segment of municipal or industrial solid waste. The sale of recovered plastics will provide an additional source of income to aid the finances of solid waste disposal and/or use.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0401, PHYSICAL AND CHEMICAL PROCESSING OF FERROUS SCRAP

C.J. CHINDGREN, U.S. Dept. of the Interior, Bureau of Mines, *Salt Lake City, Utah* 84112

Develop improved procedures for recovering marketable steels, cast iron, and nonferrous metals from scrapped automobile. Construct and test improved automobile incinerator. Devise methods for recovering byproducts from nonmagnetic discard of automobile shredding plants.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0402, RECOVERY OF HEAVY METALS FROM ELECTRONIC SCRAP

R.O. DANNENBERG, U.S. Dept. of the Interior, Bureau of Mines, *Salt Lake City, Utah* 84112

Develop improved processes for recovering gold, silver, copper, and other precious and base metals from diverse types of electronic scrap.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0403, WOOD WASTE REUSE IN CONTROLLED RELEASE PESTICIDES

G.G. ALLAN, Univ. of Washington, School of Forestry, *Seattle, Washington* 98105

The broad aim of this research is to reuse solid waste such as bark, pulping wastes and screenings, lignin and sawdust.

This will be done by first recognizing that all these solid wastes are abundant low-cost polymers containing replaceable hydrogen atoms.

Secondly, these polymers will be employed as substrates to which pesticides can be chemically attached to afford inactive solid waste- pesticide combinations.

Finally, these combinations will be so designed as to slowly release the active pesticide over the desired period of time thus improving their safety and efficiency and permitting the use of new more transient and readily metabolized pesticide materials.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0404, MINERALS AND SULFUR MODES IN COAL

C. KARR, U.S. Dept. of the Interior, Bureau of Mines, *Morgantown, West Virginia*

Purpose: A. To determine specific minerals in coal, fly ash, boiler deposits, waste coal, and similar materials, and their amounts, using original methods based on mid- and far-infrared spectroscopy and nuclear quadrupole resonance spectroscopy. Relationships between various inorganic chemicals in particulate pollutants and in boiler deposits with the minerals in coal can be established, and economic utilization of valuable minerals in coal and coal waste can be advanced. (B) To determine the various specific modes of occurrence of sulfur in coal, beyond the conventional, unspecific, wet-chemical determination of 'pyritic,' 'sulfate,' and 'organic' sulfur, by means of Sulfur-33 wide- line nuclear magnetic resonance spectroscopy. This vital information has a direct bearing on sulfur removal processes, and other problems associated with sulfur in coal.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0405, STABILIZING SANITARY LANDFILLS BY INJECTION GROUTING

L.K. MOULTON, West Va. University, School of Engineering, *Morgantown, West Virginia* 26506

The primary objective of the proposed research is to determine the effectiveness of injection grouting in accelerating the stabilization of sanitary landfills so that landfill sites can be reclaimed and put to higher use in the shortest possible time. Particular emphasis will be given to the use of grouts made with waste products such as flyash and bottom ash. The study will include an evaluation of the effect of various grouts on (a) the strength and settlement characteristics of laboratory compacted samples of refuse and (b) the process of biological decomposition with respect to its influence on strength, settlement and gas production. These laboratory investigations will be augmented by a limited field study of the effectiveness of grout stabilization.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0406, TECHNICAL AND ECONOMIC EVALUATION OF PROCESSES TO MANUFACTURE USEFUL PRODUCTS FROM LIMESTONE MODIFIED FLYASH

UNKNOWN, West Va. University, Graduate School, *Morgantown, West Virginia* 26506

Description: Evaluate the technical and economic feasibility of a number of potential new uses for the limestone-modified fly ash that will result from limestone injection processes for the abatement of sulfur oxides which result from the combustion of fossil fuel. Laboratory experimentation will be conducted to determine the feasibility of manufacturing specific products and to evaluate the quality of the products. Pilot-scale units will be set up to further assess process conditions and economics for the most promising utilization schemes.

3. SOLID WASTE MANAGEMENT

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

3.0407, PAPER AND FIBERBOARD PROCESSES
D.J. FAHEY, Univ. of Wisconsin, U.S.D.A. Forest Products Lab., *Madison, Wisconsin* 53706 (FPL3304)

OBJECTIVE: Determine optimum conditions for making paper products from wood; extend use of present fibers and use fibers from unused species.

APPROACH: Study hardwood pulps for products, chemical additions on wet and dry webs, prediction of rate of water removal on paper machine wire, effect of restraint during drying on paper dimensional stability, ways of obtaining building fiberboard quality improvement, chemicals to reduce loss of paperboard strength when exposed to moisture, heat treatment and cross linking to improve paper dimensional stability. Study paper machine variables, paper chemical combinations, paper wood composites, paper and other materials such as films and other reinforcements.

PROGRESS: Further studies have confirmed earlier findings that gyratory refining reduces the tendency of the short, wide, barrel-shaped vessel elements present in oak pulps to cause picking problems both in manufacture and in printing of paper. The resistance to printing pick was also greatly improved with a potato starch applied to the surface of a low moisture sheet. Corrugating runnability was shown to be strongly related to the sheet properties of stretch, folding endurance, and ring crush. Shives were detrimental and some long fiber pulp was necessary with hardwood semichemical furnishes. This information assists the corrugating industry in achieving maximum production from their present facilities. Studies showed the importance of certain headbox variables such as consistence in achieving more of the potential strength of papermaking furnishes. The better strength will allow a reduction in weight of paper thus more efficiently utilizing the fiber and also reduce the transportation cost.

SUPPORTED BY U.S. Dept. of Agriculture

3.0408, PROJECT B - CONVERSION OF OIL SHALE AND SHALE OIL - PART 2 - IN SITU RETORTING OF OIL SHALE
H.C. CARPENTER, U.S. Dept. of the Interior, Bureau of Mines, *Laramie, Wyoming*

This project is concerned with studying methods for converting the organic portion of oil shale to shale oil and other useful products by retorting the shale in place. Typical of the research that is being conducted are studies of both nuclear and nonnuclear techniques for fracturing oil shale to induce permeability and studies of the basic factors inherent to recovering the shale oil from the fractured mass by in situ retorting. These factors include igniting the shale, determining air flows and requirements, and recovering the oil. The research also includes a study of the retorting characteristics of ungraded oil shale such as that which might be expected to exist as rubble in a nuclear chimney. A large part of this study is being carried out in an internally fired batch retort having a nominal capacity of 150 to 200 tons of oil shale.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0409, SUPPORTING RESEARCH FOR IN SITU RESEARCH
A.W. DECORA, U.S. Dept. of the Interior, Bureau of Mines, *Laramie, Wyoming*

The objective of this research is to support the in situ oil-shale retorting research by obtaining fundamental knowledge of the kinetics and mechanisms of the reactions occuring during the in situ retorting of oil shales and during the conversion of the initial crude product to usable end product. Intermediate objectives are the determination of reaction parameters for thermal reactions, photochemical reactions, and oxidation reactions on oil shales and shale oils. To apply these parameters to the processes used to produce shale oils and to the processes for conversion of shale oils to end products. This project is reviewed and revised yearly.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

3.0410, CHARACTERISTICS OF CRUDE OILS
J.C. MORRIS, U.S. Dept. of the Interior, Bureau of Mines, *Laramie, Wyoming*

Each year 50 to 100 selected samples of crude oils from the Rocky Mountain area and Alaska are analyzed by the Bureau of Mines method. The samples are selected from among the new fields and new production in older fields on the basis of their geologic, geographic, and/or economic significance. The analyses are placed in open files for use by the public, and selected data from the analyses are coded on punch cards for machine computation. Correlations of geological occurrence with composition are being made for fields in Utah, Alaska, and Wyoming.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

DESCRIPTION OF RESEARCH TASKS

4. PESTICIDES

A. AIR OR WATER ENVIRONMENTS Aerial Drift, Atmospheric Contamination, Or Aquatic Environmental Cycling of Pesticides.

4.0001, ENGINEERING TECHNOLOGY FOR APPLICATION OF AGRICULTURAL CHEMICALS
W.T. DUMAS, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00242)

OBJECTIVE: Improve agricultural chemical application equipment to increase efficiency of application and use of chemicals in cotton production in the Southeast. Evaluate and improve machines, practices and combinations of practices for more efficient weed control in cotton in the Coastal Plain area of the Southeast.

APPROACH: Conduct laboratory and field studies to determine optimum number and arrangement of nozzles per row and optimum volume of spray solution required for most efficient application and utilization of agricultural chemicals. Measure penetration, distribution and drift by use of dyes, fluorescent tracers, chemically sensitive cards and by plant response. Mechanical and flame cultivation practices will be studied in combination with herbicide applications to determine relationship between mechanical, flame and chemical systems of weed control in cotton. Develop an economical system of weed control for the Southeastern Coastal Plain area.

PROGRESS: All nozzle arrangement treatments have resulted in good boll weevil and bollworm control and have yielded almost twice as much seed cotton as the untreated check. Five different ULV formulations of insecticides were applied with the John Blue mist blower and one formulation with the Span Spray Row Crop Sprayer. All treatments resulted in good insect control and significant increases in yield when compared to the untreated check. Span Spray plots yielded somewhat more cotton than the John Blue plots, however, the differences were not significant. Tests were conducted to compare the relative resistance of an ULV and EC formulation of an insecticidal spray to 'wash-off' by simulated rainfall. Data on boll weevil and bollworm infestations indicate that both insecticidal treatments resulted in good control. Insecticide treatments yielded more cotton than the untreated check. Cotton treated with the ULV applications yielded more than that treated by conventional EC applications. Gas chromatographic analysis of residue samples has been initiated.

SUPPORTED BY U.S. Dept. of Agriculture

4.0002, ENGINEERING SYSTEMS FOR COTTON PRODUCTION
W.T. DUMAS, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00297)

OBJECTIVE: Develop or improve cotton production subsystems, while simultaneously providing information and data for a computer simulation model.

APPROACH: Determine the optimum number and arrangement of nozzles per row and the optimum volume of spray solution required for most efficient application and utilization of agricultural chemicals. Measurements will be made of penetration, distribution and drift by the use of dyes, fluorescent tracers, chemically sensitive cards and by plant response.

PROGRESS: See regional project S-69 progress report.

SUPPORTED BY U.S. Dept. of Agriculture

4.0003, EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT
H.H. FUNDERBURK, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

The following studies will be undertaken: Absorption, translocation, and distribution of a xylem mobile herbicide (fluometuron) in Eurasian milfoil; effect of diquat, paraquat, fluometuron, dichlobenil, and at least 1 additional promising aquatic herbicide on certain metabolic processes of aquatic plants; degradation of diquat and 2,4-DBEE in an aquatic environment (water, plants, soil and fish); effect of promising aquatic herbicide on fish.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0004, EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT
H.H. FUNDERBURK, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-05-0003)

OBJECTIVE: Study absorption, translocation, and distribution of a phloem mobile herbicide (2,4-D) and a xylem mobile herbicide (simazine) in Eurasian milfoil. Study the effect of diquat, paraquat, simazine, dichlobenil, and at least 1 additional promising aquatic herbicide on certain metabolic processes of aquatic plants. Study the degradation of diquat, simazine, and 2,4-D in an aquatic environment (water, plants, soil and fish). Determine the effect of promising aquatic herbicides on fish.

APPROACH: Labeled and non-labeled compounds will be used in laboratory, growth chamber and field experiments. Analysis will use several chromatography methods, qualitative and quantitive chemical analysis, autoradiography and spectroscopy.

PROGRESS: Degradation of 2,4-DBEE was rapid usually within 24 hours to 2,4-D in all systems containing living organisms. The main degradation products were CO(2) and a complex of 2,4-D and an unknown molecule. Degradation was greatest in carboxyl carbon label and least in ring labeled 2,4-D. Absorption and translocation by watermilfoil was greatest with the ester apparently aiding in absorption to structure of the side chain. All plants contained only 2,4-D which was readily translocated acropetally and basipetally as well as leaked out of the non-treated root and shoot. Degradation by UV light may be a factor in degradation of the ester, with 50% degradation in 12 hours to 2,4-D. Degradation of 2,4-D under the conditions of the experiment was not a large amount. The ester apparently hydrolyzed in water solution since 2,4-DBEE steadily broke down to 2,4-D under such conditions. The effect of 2,4-DBEE on watermilfoil was readily observable, since only 0.029 ppm killed witnin 14 days indicating the small amount needed for such results.

SUPPORTED BY Alabama State Government

4.0005, PRELIMINARY STUDIES ON ENDRIN AND OTHER PESTICIDE UPTAKES BY FINGERLING CHANNEL CATFISH
R.L. ARGYLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Marion, Alabama* 36756

Pesticides have been found in the flesh of channel catfish raised for sport and food, and in some instances these chemicals

have been attributed to seriously injuring or even killing fingerling and large fish. Pesticides that contaminate these fish can come from the water supply, soil, feed, and air (wind borne). Studies will be conducted in pools and aquariums to determine the effect that each pesticide source has on the fish. By conducting these studies in pools and aquariums using pesticide-free water, by feeding purified diets, and by using known amounts of the pure form of pesticide, variables and interactions may be avoided that complicate data interpretations. Thus, these findings may be used in designing studies in near-natural situations and interpreting the results.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0006, UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS

R.L. ARGYLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Marion, Alabama* 36756

Objectives: To quantitate the uptake and release of Dalapon in water, fish, soil and plants in earthen ponds.

Procedure: Twelve 0.1 acre earthen ponds will be filled with water and 'sprigged' with cattail plants. After a short period of acclimation, fingerling channel catfish, bluegill sunfish and largemouth bass will be stocked into each pond. Dalapon at 0 and 1/3, and 3 times the recommended amounts will be applied to all ponds. Samples of water, fish, soil, and vegetation will be taken at 0,1,3,7,14, 28, and at each 28th day thereafter until no Dalapon can be detected or the amounts found are stabilized.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0007, CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS

T.N. JOHNSEN, U.S. Dept. of Agriculture, Crops Research Division, *Flagstaff, Arizona* 86003 (0710-04-02)

OBJECTIVE: To develop and evaluate control methods for use on junipers, shrub live oak, and associated species as part of a broad national program to develop principles and practices on control of weeds and brush under various climatic conditions.

APPROACH: Studies include field, laboratory and greenhouse experiments on methods of controlling brush and weed species that are problems on grazing lands and will include studies of herbicides and their ecological, physiological and agronomical aspects as they affect rangeland brush and weed populations and the resulting ecological impact on desirable vegetation. Studies include some aspects of fate of herbicides when applied to watershed areas.

PROGRESS: Picloram injected into a small stream at the rate of 5 ppmw for 50 minutes had downstream picloram concentration peaks of 2.5 ppm at 1/4 mile, 0.9 ppm at 1/2 mile, 0.34 ppm at 1 mile, 0.01 at 2 miles, 0.002 ppm at 4 miles and not detectable at collection points further downstream. Picloram was not detectable from water and soil samples collected downstream of the injection point after 48 hours and during the remainder of 1969. Broadcast burning of chaparral vegetation 2 months after aerial spray treatment reduced the soil picloram content from 1.1 to 0.2 lb/A. Unburned plots had little or no change in picloram content during the same time interval. Damage on vegetation indicated m-(3,3-dimethylureido)phenyl-tert-butylcarbamate has moved as much as 200 feet off of 1/10 acre-sized plots treated with a granule formulation on clay soils. Evidence of herbicide movement from spot applications of this herbicide were less. The herbicide effectively controls shrub live oak, gambel oak and Utah juniper at 4 to 8 lb/A, broadcast on the soil.

SUPPORTED BY U.S. Dept. of Agriculture

4.0008, PESTICIDE APPLICATION EQUIPMENT IN RELATION TO DRIFT OF PESTICIDES AND PEST CONTROL

K.R. FROST, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2014-4155-028)

OBJECTIVE: Evaluate existing ground and air application machinery in relation to pesticide drift; modify equipment and practices to reduce drift of pesticides; develop new equipment and management practices to reduce drift and give effective pest control; and evaluate for effectiveness of insect control.

APPROACH: Present methods and equipment of applying pesticides will be evaluated to determine drift and effectiveness. Tests will be made in the field using two methods or variations in equipment. Changes will be made to improve results and new equipment developed for the same purpose. Both airplane and ground application will be made to compare results.

PROGRESS: Aerial drift tests were run August 4, 1969 on alfalfa 8 miles south of Coolidge, Arizona. Three runs were made in the afternoon using different materials simultaneously with 2 airplanes in 2 fields end to end. The usual data for drift tests, temperature at 32 ft and 8 ft, relative humidity at 1 ft and 5 ft levels and wind velocity at 8 ft were recorded before, during, and after applications were made. Drift collection determination and analysis is not complete for this series. Analyses of the aerial tests run in 1968 using fluorescent dye and thickener were completed and a manuscript prepared. These tests were run using 50 gallons of emulsion spray containing 20 lb of methoxychlor, and 1 lb of brilliant sulpho-flavine (BSF). In addition some applications included thickener and the remaining served as controls. The Cascade impactor sampler collected less drift at most stations downwind for both molasses and dacagin added as thickeners. Results were not conclusive and tests should be run again before use of thickeners is recommended for reducing drift. The BSF fluorescent dye gave interpretive results closely correlated with usual processing of drift on glass plates and represent only 10% of the effort.

SUPPORTED BY U.S. Dept. of Agriculture

4.0009, PESTICIDE APPLICATION EQUIPMENT IN RELATION TO DRIFT OF PESTICIDE AND PEST CONTROL

G.W. WARE, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2014-4161-028)

OBJECTIVE: Evaluate existing ground and air application machinery in relation to pesticide drift. Modify equipment and practices to reduce drift of pesticides. Develop new equipment and management practices which will reduce drift and give effective pest control. When equipment for drift safe application has been developed, it will be evaluated for effectiveness of insect control.

APPROACH: Present methods and equipment of applying pesticides will be evaluated to determine drift and effectiveness. Tests will be made in the field using two methods or variations in equipment. Changes will be made to improve results and new equipment developed for the same purpose. Both airplane and ground application will be made to compare results.

PROGRESS: Spray thickeners and a fluorescent dye were added to aerial applications of methoxychlor made to a 10-acre plot of alfalfa. Dacagin at 0.8%, blackstrap molasses at 24-25% and Cab-O-Sil at 3.5% were each compared with an unthickened control emulsion, and all three resulted in an apparent reduction in drift. Based on cost, molasses would be the most economical additive. Using a fluorescent dye as an indicator is a much faster method for measuring deposits than gas chromatography. 1969 drift studies indicated that only 40% of an aerial spray application reaches the target when applied from a Piper Pawnee, 3:00 PM, 2 MPH winds, RH varying from 45% at 2 ft to 29% at 33 ft, and 105 F. Previous on-target samplings indicate an average of less than 40% reaches the target crop.

SUPPORTED BY U.S. Dept. of Agriculture

4.0010, BIOLOGY AND CONTROL OF INSECTS AFFECTING COTTON IN ARIZONA

T.F. WATSON, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2014-4161-013)

OBJECTIVE: Determine habitats of insect pests, identify parasites and predators and study factors affecting insect pest activity. Investigate life histories of insect pests. Evaluate toxicological and residual properties of chemicals of value in control. Establish criteria for timing pesticide applications and determine effects of insect injury on quality and marketability of cotton.

APPROACH: Determine winter survival of pink bollworms (cage studies). Large plot study of timing and number of insecti-

cide applications on destructive and beneficial insects. Through use of insecticides determine percent of damage caused by various insects. Find insecticides to eliminate 'drift residue problems' from cotton to alfalfa.

PROGRESS: A test was conducted to compare the effectiveness of carbaryl and carbaryl plus molasses, each applied at 3-gal. and 5-gal. total solution rates, against the pink bollworm. Results indicated no difference in using either of the solution rates and no significant advantage to control by adding molasses to carbaryl. An evaluation of 11 acaricides against the spider mite, Tetranychus turkestani, showed that Azodrin, Acaralate, Chlorobenzilate and Galecron effectively controlled this mite. Seven insecticides were compared for control of a late-season infestation of Heliothis zea on cotton. None of the treatments resulted in significant yield increases. A test comparing Azodrin, Bidrin and Dylox for control of lygus in cotton resulted in yield increases, with only the Azodrin treatment being significantly higher. Another experiment was designed to control lygus at three square-damage levels. Bidrin was applied when square damage reached 5, 15, and 25 per cent in the respective treatments. No significant differences were obtained in yields among the treatments, including untreated checks. An experiment was conducted to determine the need for control of late-season pink bollworm infestations in cotton. Treatments consisted of plots receiving none, 2, 3 or 4 applications of toxephene methyl parathion on a 6 to 7 day schedule after the infestation reached 10 per cent. Results indicated that there was no advantage to applying late-season control measures.

SUPPORTED BY U.S. Dept. of Agriculture

4.0011, EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION.
K.H. BOWMER, Comm. Sci. & Indus. Res. Org., *Griffith, New South Wales, Australia*

Object: 1. Atrazine, diuron, fluometuron, trifluralin herbicides. a) Investigate possible hazards of over persistent residues to crops intense rotations (rice, cereals, sorghum, maize, sunflower, soyabean, safflower, cotton). b) Investigate possible hazards of over persistent residues to crops intense rotations (rice, cereals, sorghum, maize, sunflower, soyabean, safflower, cotton). b) Investigate instances of inefficient weed control. c) Investigate less persistent alternatives e.g. thiolcarbamates. 2. Investigate fate of bromacialherbicide in citrus orchard soil.

Approach: Initially, atrazine and bromacil. Monitor residues in soil where history of application is well-documented. Field studies of atrazine activity and persistence under maize. Laboratory studies with contrasting soil types of adsorption, leaching, persistence of herbicides. Effects of clays, organic matter, pH, temperature and water content on rate and pathway of breakdown.

SUPPORTED BY Australian Government

4.0012, DEPOSIT AND DRIFT OF PESTICIDE CHEMICALS
N.B. AKESSON, Univ. of California, School of Agriculture, *Davis, California* 95616

An increased effort will be directed toward the total spray budget concept by 1) fitting past run data into the developing computer model program and 2) by concentrating more specifically on field studies to collect first the spray swath and downwind ballistic fallout pattern to 1000 feet; and second, the airborne or transport pattern from 1000 feet to 5-8 miles. By directing our effort or concentration into two stages the ballistic fallout and the air transport, we hope to increase our sensitivity and accuracy sufficiently to obtain significant correlation and prediction (by means of the statistical model) results. This increases our use of the atmospheric diffusion data as well and will help to develop a significant correlation between downwind transport and diffusion parameters. Some preliminary investigations have indicated that virtual temperature, which combines the effects of temperature and humidity, should be considered in our studies of atmospheric stability as it relates to drift and deposit of pesticides. Data taken this past year will be evaluated for the possible correlation of this parameter and if proven valid will be used in future experiments.

Statistical computer studies have been made on field data of the past to determine, by regression analysis, the functional relationship between drift-deposit level and distance downwind including the application area. More detailed program analysis including extension of the air transport and diffusion model will be used to obtain more complete data for a total spray budget analysis.

The overall objective remains the reduction of airborne pesticide chemical transport to enable safer and lowered levels of pesticide use.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0013, CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST
R.R. YEO, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (0710-02-01)

OBJECTIVE: Develop new or improved chemical, biological, and other methods for controlling weeds, Asiatic clams, and certain other aquatic pests in canals, lakes, reservoirs, and other aquatic situations. Determine the fate of herbicides, molluscicides, and other chemicals used in aquatic situations.

APPROACH: Search for and/or evaluate new and promising aquatic herbicides in greenhouse aquaria and flowing canals, outdoor pools, and closed system canals and in field canals and reservoirs. Conduct life history and ecological studies. Make samplings and analyses to determine the persistence of herbicides and molluscicides in water in natural canals and reservoirs and in small pools under controlled conditions. Evaluate fish, competitive plants, and other agents for biocontrol of aquatic weeds and other aquatic pests.

PROGRESS: Three acetals of acrolein were found to control submersed aquatic weeds in 2 canals for 6 mi at 7.5 to 10 ppm with 4 and 8 hr exposure. The hydrolysis of allylidiene diacetate to acrolein in 2 canals in which aquatic weeds were controlled peaked 2 mi downstream after 8 hrs with water at 19 C and 1 mi downstream after 2 hrs with water at 14.5 C. Acrolein applied at 4 ppm for 4 hrs plus a booster of 2 ppm for 3 hrs dissipated to .1 ppm after 32 mi. Diquat plus copper sulfate at .15 ppm controlled several aquatic weeds in reservoirs. Simazine, chloroxuron, copper metal, copper nitrate, igran, and diuron at 1, .5, 40, 4, .5, and .5 ppm, respectively, controlled Chara and Cladophora in growth pools without harming fish. Copper ion residue studies showed it to dissipate (in decreasing order) to non-detectable amounts fastest with copper nitrate - copper sulfate - cuprose citrate - and copper metal. Copper sulfate circulated continuously with fresh weekly increments of 0.0, .1, 1. and 10 ppm of copper ion in aluminum irrigation pipe for 25 weeks did not seriously corrode the pipe. Slender spikerush was found highly effective in controlling aquatic weeds by competition in two irrigation canals.

SUPPORTED BY U.S. Dept. of Agriculture

4.0014, INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES
F.L. TIMMONS, Stanford Research Institute, *Menlo Park, California* 94025 (0710-02-10(C))

OBJECTIVE: Determine the presence and concentrations of selected herbicides and degradation compounds and metabolites in water, soil, and in greenhouse-grown crops irrigated with water containing known concentrations of each herbicide.

APPROACH: Potatoes, carrots, onions, tomatoes, romaine lettuce, soybeans and milo will be grown to maturity in the greenhouse. Amitrole-T, 2,4-D, dalapon, silvex, dichlobenil, diuron, and simazine will each be applied to two concentrations to irrigation water to be applied by overhead sprinkle and bottom flooding methods to each crop at an early fruiting vs. late fruiting stage. Samples of treated water will be taken at time of irrigation and samples of the soil will be taken a few days later. Samples of edible portions of treated crops will be taken at maturity. All samples will be analyzed by appropriate methods to determine concentrations of each herbicide and of important metabolites. Diquat and endothall may be substituted for diuron and simazine.

PROGRESS: All six crops have been grown, irrigated with treated water, and samples of edible parts taken at normal harvest

time and processed for analyses. Analyses were completed for silvex, 2,4rD, dalapon, and amitrole. Average maximum concentrations (ppm) of 2,4-D residues found in the various crops irrigated with water containing the highest concentration were as follows: potatoes, 0.03 to 0.12; milo, 0 to 0.12; carrots, 0.02 to 0.06; soybeans, none; leaf lettuce, 0.11 to 0.33; onions, all below 0.05. Residues of silvex (ppm) from the highest concentrations of silvex in treated water were: potatoes, 0.03 to 0.3; milo, none; soybeans, 0.09 to 0.17; carrots, none; lettuce, none; onions, none. The residues of dalapon (ppm) from the highest concentration were: potatoes, 0.04 to 2.7; milo, 0.05 to 0.53; soybeans, 0.6 to 1.9; carrots, 0 to 0.81; lettuce, 0.05 to 1.13. No amitrole residues were found in any crop except the 0.09 ppm in milo grain from sprinkler irrigation with water containing 0.44 ppm of amitrole. The highest concentration of each herbicide was much greater than those found after normal applications for weed control. Maximum residues of dalapon or 2,4-D found in any crop were much lower than FDA tolerances on several food crops.

SUPPORTED BY U.S. Dept. of Agriculture

4.0015, NAVY ENVIRONMENT - BIOLOGICAL DEGRADATION OF PESTICIDES IN THE MARINE ENVIRONMENT

H.P. VIND, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Technical Objective: The Department of the Navy is responsible for all pesticides and herbicides it uses. This responsibility includes pesticides and herbicide waste-products which find their way into the marine environment. This effort is directed toward finding means of enhancing the biological degradation of pesticides in order to reduce their adverse effects upon the marine environment and to reduce pollution.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0016, ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER

F.A. GUNTHER, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2407)

OBJECTIVE: Develop dependable, quantitative extraction procedures for removing pesticide residues from samples of water. Develop methods of analysis that will identify and measure the pesticides present, and that are sufficiently sensitive to permit the use of smaller samples than are now required. Automate the analytical procedures as far as practical to achieve maximum output per man-hour.

APPROACH: Carbon columns and other adsorbing media will be investigated, as well as counter-current partitioning procedures. Analytical methods, and particularly instrumental methods that are susceptible to automation, will be developed and adapted to use for water and soil analysis.

PROGRESS: An automated procedure to determine triazine herbicides in soil was developed and a publication is in preparation. The soil sample is introduced into the machine without any preliminary treatment, an important breakthrough for this type of analysis. A similar procedure for determining DDT in soil is approaching completion. A means for distinguishing between DDT and polychlorinated biphenyls was developed and tested on animal tissue samples. There is a striking dissimilarity in responses of the two types of compounds and the method appears a much-needed means for removing doubts about the presence or absence of DDT. Specialized apparatus for extracting pesticides from water was constructed for use in this particular research.

SUPPORTED BY California State Government - Sacramento

4.0017, PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES

P.A. FRANK, U.S. Dept. of Agriculture, Crops Research Division, *Denver, Colorado* (0710-02402)

OBJECTIVE: Improve existing methods available for the control of submersed aquatic weeds, and develop information which may ultimately lead to the use of new and more effective weed control principles and practices. Improve and develop chemical procedures for analysis of herbicides, determine the residues resulting from their use in and near water, and provide data which will facilitate registration and use of the the materials as aquatic-weed herbicides.

APPROACH: Conduct an evaluation program to determine the herbicidal activity and potential usefulness of new herbicides and experimental materials. Arrange preliminary field trials of promising materials. Study absorption and translocation of herbicides and developmental physiology of representative weed species. Treat canals, ponds, and ditchbanks; collect soil and water samples for residue and degradation studies.

PROGRESS: Dissipation of 2,4-D dimethylamine at 133 and 254 ppb in irrigation water, was linear for distances of 6 and 7 mi of water flow. Residues were reduced more rapidly than for other water soluble herbicides tested. Dye used as a model of herbicide dissipation indicated dye cloud elongation rates of 12 to 18 minutes per mile. Reductions in maximum dye concentration between the 0.25 mile and 8 mile stations were 74, 47, and 32% for the 2500, 4400, and 6600 ft treatments, respectively. Studies on dissipation of xylene in irrigation water showed that treatment rates of 550 to 600 ppm were reduced as rapidly as 92% after 4 mi of water flow in 1 canal, to as little at 77% after 10 mi of flow in another canal. Bluegill and trout were killed by the xylene 9 and 10 mi downstream from the treatment sites. Spring time soil samples from ditchbanks treated in the fall with 70 lb per A TCA had residues of 1 to 44 ppm in the surface inch, and 1.3 to 10 ppm in the 2 to 4 inch soil layer. Very low and transitory levels of TCA occurred in water the next spring. Established that loss of the PGBE ester from water is due largely to loss of emulsion with the ester settling to the soil surface. After 4 and 12 hr, loss of silvex from water was 83 and 91%, respectively. Containers of glass, polyvinyl chloride (PVC), high and low density polyethylene (HDP, LDP) were adequate for storing TCA and diquat. BEE of 2,4-D stored well in all but LDP. Only glass and PVC were suitable for storing dichlobenil.

SUPPORTED BY U.S. Dept. of Agriculture

4.0018, HERBICIDE RESIDUES

T.R. BARTLEY, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

It is important to know the level of herbicide that gets into irrigation water either through direct application to the water or through applications adjacent to the water. The amount of herbicide that accumulates in the aquatic plants and the aquatic and agricultural soils is also pertinent to a better understand and use of the weed control method being practiced.

Samples of water and sometimes aquatic plants, aquatic soils, and agricultural soils exposed to herbicide treatments are collected in and along irrigation canals for analysis of various herbicides commonly used for weed control on irrigation projects.

Herbicides such as 2,4-D, 2,4,5-T, xylene and acrolein copper, are being emphasized in this study. The level of herbicide present in samples will be measured through the use of gas chromatographic and atomic absorption spectrophotometric techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

4.0019, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

K.G. DOXTADER, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00242)

OBJECTIVE: Identify the principal degradation products and determine the mechanisms and kinetics of pesticide transformations in soil-water systems.

APPROACH: Pesticides will be incubated with soils of varying chemical, physical, and mineralogical composition. Studies will be made of the influence of temperature, light, aeration, added organic matter, and moisture on pesticide decomposition in these soils. Degradation will also be followed in soil-water suspensions and in columns of soils perfused with pesticide solution. Efforts will be made to determine the kinetics of herbicide decomposition and to identify and characterize major degradation products as well as to isolate the microorganisms responsible for the degradation process. Initial emphasis will be placed on stu-

dying the degradation of three herbicides: 2,4- dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), and picloram (Tordon).

PROGRESS: Rates of decomposition of the herbicides pyrazon and diuron were measured in three different soils. Diuron was found to be extremely persistent in these soils; only very slight degradation was observed over an incubation period of 35 weeks. Significant pyrazon decomposition occurred in these same soils in less than one month. Evidence was obtained which indicated that microorganisms play a major role in the decomposition of pyrazon. In a sterilized soil, the concentration of the herbicide remained nearly constant over a period of several weeks. With the same soil under non-sterile conditions, appreciable pyrazon decomposition was observed. Four different bacterial types isolated from soil by an elective culture technique were found to be capable of degrading the herbicide in pure culture.

SUPPORTED BY U.S. Dept. of Agriculture

4.0020, THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST

L.W. WELDON, U.S. Dept. of Agriculture, Crops Research Division, *Fort Lauderdale, Florida* 33310 (0710-02-03)

OBJECTIVE: Develop methods of controlling aquatic vegetation in waterways, canals, lakes, ponds, and irrigation systems.

APPROACH: Evaluate new chemicals and additives to herbicides to increase effectiveness on elodea, Eurasian watermilfoil, water hyacinth, alligatorweed, and other aquatic plants. Study life cycle of the plants and environmental factors affecting the carbohydrate reserves, plant response to herbicides, and persistence of herbicides in the water, plant, organism, and hydrosoil.

PROGRESS: Ametryne (3 lb/A) applied in combination with 2,4-D (1/8 lb/A) controlled water hyacinth. A granular and slow release pellet of the amine salt of endothall have controlled hydrilla in lakes. The slow release pellet has given longer control in lakes and flowing canals. Cost of control and fish toxicity have been reduced when using slow release pellets. A weighted formulation of the amine salt of endothall has controlled hydrilla in flowing canals. Diquat, endothall, and copper sulfate have been encapsulated into a slow release capsule. Plastic enclosures (25 sq. ft.) have proven to be an excellent research tool for evaluating herbicides on submersed aquatic weeds.

SUPPORTED BY U.S. Dept. of Agriculture

4.0021, ESTUARINE ECOSYSTEMS

G.E. WALSH, U.S. Environ. Protection Agcy., Office of Res. & Monitoring, *Gulf Breeze, Florida* 32561

The purpose of this research is to determine effects of sublethal concentrations of pesticides upon estuarine ecosystems. At present, physical, chemical and biological characteristics of four very similar coastal ponds are being analyzed to learn normal seasonal variations. When these are known, three of the ponds will be treated with pesticide and one will be utilized as a control. Effects of pesticide upon population dynamics and community structures will be studied after contamination.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

4.0022, EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS

E.F. CORCORAN, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

This grant supports investigations of the spectrum of the chlorinated-hydrocarbon pesticides in the water, particulate matter and sediments in the discharge of the Mississippi River into the Gulf of Mexico. The samples analyzed are from transects up the Mississippi River itself, other stations in the river plume and inshore regions of the Gulf of Mexico. Data from these investigations will indicate the extent of influence of the outflow of the Mississippi River on the waters of the Gulf of Mexico as well as the degree and rate of pesticide contamination of the river and adjacent regions of the Gulf of Mexico.

SUPPORTED BY U.S. National Science Foundation

4.0023, EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY

T.S. HOPKINS, Univ. of West Florida, Graduate School, *Pensacola, Florida*

The campus of The University of West Florida is located on the west side at the head of Escambia Bay, a commercially important estuary for the production of oysters, shrimp, and fish. Part of the drainage basin of this estuary, including an embayment or bayou and small stream lies on University property that has been dedicated as a natural conservation area and will remain undeveloped.

The Faculty of the Department of Biology and Marine Sciences plans to initiate a continuing study of this habitat to determine the ecological relationship. Concurrently, a similar habitat on the east side of the bay that is not protected from man's encroachment will be studied in comparative detail to determine the effects of pollution. It is anticipated that the program will serve as a training program for graduate students in the field of marine biology.

An initial 12-month program is proposed that has the following objectives: 1. A physical, chemical, and biological inventory of the two bayous adequate to provide an understanding of the resident plant and animal communities; and, 2. An analysis of migratory fauna and their 'input' into the ecosystem; and, 3. A periodic surveillance project will monitor the water, bottom deposits and biota for pesticide residues. (These are anticipated because of the routine use of these chemicals in the drainage basin).

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

4.0024, PESTICIDE KINETICS

C.W. MILLER, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Sabine Island, Florida* 32561

Investigate, under field conditions, the occurrence and distribution of insecticides in tidal areas associated with an estuary. Samples of water, soil and selected biota will be collected immediately prior to application of the test material to establish a base line indicative of previous commercial treatments. The persistence, localization and possible degradation of the test chemicals will be followed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0025, RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS

M.T. HUISH, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO00392)

OBJECTIVE: Study is to provide answers to problems of the relationship of pesticides and farm pond ecosystems.

APPROACH: Most of Georgia's farm ponds are constructed on piedmont clay or sand. These two major soil types will be employed in the experimental design which will test Dieldrin and Lindane. Known concentrations of the pesticides will be introduced into fiberglass containers and the resulting concentrations in the two soil types, of flowing and nonflowing water systems, as well as concentrations contained in fishes and plants will be determined by use of gas chromatographic methods.

PROGRESS: During the report period the results of the first phase of the project were compiled in the form of a PhD thesis, 'Magnitude and Distribution of Insecticide Residues in Artificial Ecosystems and in a Farm Pond', by Wendell Joseph Lorio. The study will continue with another student, and will consist of pesticide applications to additional series of aquatic systems. The previous work on this project consisted of applying two pesticides (Lindane and Dieldrin) to three series of aquatic systems each of which included twelve forty-liter containers having selected soils, aquatic plants and fish. Water was static in 50% of the systems and flowing in the others. The pesticides were introduced at concentrations sublethal to the fish used. Samples of each component of the systems (fish, plant, soil and water) were taken. These were

then subjected to standard extractive techniques to recover the Lindane and Dieldrin residues. Gas chromatographic methods were employed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0026, PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST

M.J. LEWALLEN, U.S. Dept. of Agriculture, Agricultural Engineering Div, *Watkinsville, Georgia* 30677 (901-032-B606)

OBJECTIVE: Develop methods for excluding or removing pesticide pollutants from farmstead water supply systems.

APPROACH: Studies will be made of pesticide pollution of farmstead domestic water supplies and to identify sources and routes of contamination. The relation of susceptibility of water supplies to pesticide contamination with susceptibility to other contaminants such as bacteria or nitrate will be determined. Studies will be made of well construction techniques to determine level of protection needed to eliminate pesticide contamination. Determination will be made of the performance of pesticide removal equipment, devices and techniques to effect a safe economical water supply. Investigations will be conducted to outline the requirements for a disposal system for waste water collected from the cleaning of application equipment or from the disposal of excess persistent pesticides.

PROGRESS: Continued investigation of a shallow, bored well contaminated from a non-leached source with DDT and Toxaphene shows little change in contamination level after 3 years' observation. Pesticide level in the water remains stable (DDT less than ppb, Toxaphene few ppb) while levels in well sediment remain in the high ppm range. Level of contaminants in soil surrounding the well is generally lower than was the level during the previous year. Soil samples taken in increments of 4 inches indicate levels of several ppm in the surface 4 inches while only low ppb levels are found below 4 inches. Two commercially available charcoal filters were dependent on the flow rate when evaluated for the removal of lindane (low ppm range) from water. Removal efficiency varied from approximately 75 percent at 1 GPM to approximately 30 percent at 5 GPM. Water from 27 local wells was sampled for bacterial contamination and nitrate level. Approximately 30 percent exceeded the permissible nitrate level of 10 ppm NO(3)-N. Maximum NO(3)-N measured nearly 50 ppm.

SUPPORTED BY U.S. Dept. of Agriculture

4.0027, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

R.E. GREEN, Univ. of Hawaii, Agricultural Experiment Sta., *Honolulu, Hawaii* 96822 (HAW00141)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system; develop mathematical model(s) which will provide semi-quantitative prediction of pesticide movement in soil-water systems; measure pesticide transport through and over soil in the field or in lysimeters.

APPROACH: The kinetics of adsorption-desorption reactions of carboxylic acid herbicides will be studied using selected soils; a mathematical model will be developed which will describe the effects of pesticide adsorption, degradation and hydrodynamic dispersion using available input data; movement of picloram with infiltrating water will be studied under field conditions on the Molokai soil.

PROGRESS: (1) Adsorption isotherms for four s-triazine herbicides which are important to Hawaiian agriculture were measured on four soils having a wide range of organic matter contents and different mineralogies. The relative magnitudes of adsorption were nearly the same on all soils: ametryne, sumatol (GS-14254), atrazine, simazine. Soil acidity and O.M. content are both positively related to triazine adsorption. (2) A procedure was developed to allow determination of the distribution of triazines between adsorbed and solution phases as hydrolysis proceeded. Distribution coefficients for atrazine increased several fold during a 60-day period; this implies decreased mobility of the residual parent compound. (3) An adsorption method, consisting of continuous flow equilibration of soil with a pesticide solution followed by sebsequent displacement with an appropriate organic solvent was developed and tested with two herbicides (atrazine and diuron) on four soils. This method provided high precision on all adsorbents, avoided destruction of aggregates, and was useful in measuring adsorption reversibility.

SUPPORTED BY U.S. Dept. of Agriculture

4.0028, PESTICIDE MONITORING PROGRAM LAKE MICHIGAN

B.J. LELAND, State Dept. of Pub. Instruct., *Springfield, Illinois* 62706

A pesticide monitoring project involving Lake Michigan and tributaries in Illinois is proposed as part of the Four State Enforcement Conference. The prime objective is to determine whether substantial amounts of persistent chlorinated hydrocarbon insecticides are reaching the Lake. A second objective is to evaluate present levels of residue in sediments and in organisms representing the aquatic food- chain.

Since herbivorous organisms within streams consume large quantities of periphyton and since persistent insecticides are cumulative, the levels found within periphyton (algae) to a large extent dertermine the levels found in organisms higher in the food chain. Fresh-water mussels may be useful detectors of slug discharges. They are practically immobile organisms which pump large volumes of water and feed upon the particulate matter. Minor changes as well as major changes within different sections of the stream would be revealed in body tissue of the clams. An evaluation of levels of insecticides found within sediments is part of the monitoring program. Insecticide analyses will be performed on the whole bodies of fish native to the location.

All sampling will be in the eastern portion of Lake County, Illinois and along the shore line of Lake Michigan in Lake County. Analyses will be made in the Diagnostic Laboratory of the Illinois Department of Public Health at Chicago.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

4.0029, THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT

G. SPRUGEL, State Natural History Survey, *Urbana, Illinois* 61801

Objectives: 1. To conduct laboratory and field investigations with methoxychlor, diazinon, and Furadan, to analyze the long- and short- term, subtle, direct, and chain reaction responses of these pesticides in the living and non-living constituents of the aquatic environment. 2. To develop and improve analytical and biological techniques and methodology essential to investigations on the disposition and fate of pesticides in the aquatic environment.

The objectives were developed on two assumptions, namely, that pesticides either directly or indirectly enter the aquatic environment and that the future use of pesticides is dependent in part upon the action of these chemicals in the aquatic environment. The research proposed and the plan of operation will involve a team approach by entomologists, aquatic biologists, chemists, and consultants expert in the taxonomy of aquatic organisms, environmental biology and toxicology.

The plan of procedure will utilize simple food chains already existing in our laboratory, such as filamentous algae to Tilapia and filamentous algae to tadpoles to large-mouth bass, but the movement, disposition, and ultimate fate of the insecticides and their metabolites will be determined in non-living components such as clays, silts, and debris as well as living components of experimental aquatic systems. Field tests will utilize lysimeters and artificial and natural release into manipulated and natural aquatic systems and ponds in the field. Radioisotopes will be used to trace movement and in some instance the metabolic pathways in the living organisms.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0030, CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS

R.E. KALLIO, Univ. of Illinois, School of Life Sciences, *Urbana, Illinois* 61801

It is proposed to establish the amount of substitution, halogen or other substituent group, which can be appended to aromatic rings and still leave them degradable by normal microflora in natural waters and soils. An analysis of the kinds of microorganisms capable of degrading such substituted aromatic rings will be undertaken and it will be established whether the enzymes required for the degradation are inducible. Such induced enzyme systems will be studied to see whether their range of aromatic ring cleavage potentials are greater than simply rupturing the ring of the inducer substrate. These data will be correlated with the ground rules required for pesticide (insect or plant) toxicities. Synthesis of molecules containing an inducer, as well as a pesticide active moiety, will be undertaken and tested in the enzyme system.

SUPPORTED BY University of Illinois

4.0031, RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS

H.V. LELAND, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

The objective of this study is to evaluate ecological effects associated with the use of several insecticides currently recommended as suitable replacements for the more persistent chlorinated hydrocarbon compounds. The degree of persistence and biological concentration of selected organophosphate and carbamate residues in water will be determined at experimental inpoundments. Known amounts of insecticides will be applied under normal operating conditions at prescibed application rates. The toxicity of stable residues to vertebrate and invertebrate aquatic species will be determined by continuous-flow bioassays. Pathways of degradation and persistence of metabolites in these species will be examined using radiolabelled insecticides. Heterocylic compounds are ring-labelled to permit concurrent evaluations of the pathways of metabolism of the insecticide and the stable products of hydrolysis. This project will assist in the development of sound practices relating to the use of insecticides near lakes and streams and will assist in the establishment of water quality criteria for these insecticides.

SUPPORTED BY U.S. National Science Foundation

4.0032, BIOCHEMISTRY OF HERBICIDE ACTION

F.W. SLIFE, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-15-0389)

OBJECTIVE: Study the penetration, translocation, and degradation of herbicides and plant growth regulators in plants; study the effect of these applied compounds on the physiology of plant cells and determine if these effects are related to changes in the particulate matter; study the fate of these compounds in soild and determine their possible contribution to pollution of our water supplies.

APPROACH: Labeled herbicides and plant growth regulators will be used to study penetration, rate of degradation and ultimate fate of the applied compounds. In addition labeled compounds will be used to determine what particular part of the Cell cytoplasm reacts with the applied compounds. This should give valuable leads to the exact mode of action. Field and laboratory procedures will be used to determine, leachable, rate of degradation, and effect of soil applied compounds on soil life.

PROGRESS: Penetration, translocation, and degradation of 2,4-D was studied in climbing milkweed (Ampelamus albidus). Although penetration was low, degradation was also low allowing excellent translocation to meristematic areas and the root system. In approximately 72 hours after 2,4-D application, nucleotide exudation from the root system indicated increased membrane permeability. This suggests that in perennial weeds, the cause of death from 2,4-D is disfunction of the root system. The degradation of atrazine in corn was studied under different environmental conditions. Both the enzymatic and non-enzymatic degradation processes were functional under cold wet conditions, but at a reduced level over corn grown under normal conditions. In addition, the rapid genetration of atrazine into corn grown under cold wet conditions contributed to overloading the detoxification mechanisms and thus severely injured corn. Butylate vapors stimulated germination of grass weed seeds. This herbicide appears to effect dormancy of semi- dormant seeds. Ca adsorption by roots of Cocklebur increased after 2,4-D application to the foliage. It reached a peak in 30 minutes and at 60 minutes retreated to the level of control plants.

SUPPORTED BY U.S. Dept. of Agriculture

4.0033, MONITORING AND ASSAY OF PHYTOTOXIC AIRBORNE PESTICIDES AND VOLATILE POLLUTANTS

C.H. SHERWOOD, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01625)

OBJECTIVE: Monitor representative areas in Iowa for content of pollutants. Identify unknown pollutants that are injurious to plants and other organisms. Determine movement of pollutant pesticide volatiles and aerosols singly and in combination as affected by various environmental conditions. Investigate thresholds of injury regarding pesticide concentration, stage of plant growth, plant maturation, and combinations of pollutants. Chart seasonal plant growth risk areas in Iowa communities.

APPROACH: Collect air samples, plant materials and climatological data. Samples will be assayed (biological and chemical). Movement of pollutants will be determined by tagged pesticides. Meterological factors effecting dispersal of airborne pollutants will be determined. Histological studies will be conducted.

PROGRESS: Detection, evaluation and documentation including photographs accomplished for 2,4-D, representative horticultural plants given controlled exposures. Exposure chambers contaminated with 2,4-D were found permanently contaminated in that solvents, acids, bases and heat plus O(3) and 70 C were inadequate for decontamination. Except for O(3) plus 2,4-D interactions reducing effects of 2,4-D dramatically, combined effects of other pollutants tended to be slightly less than simple additives of the effects as caused by exposures to a single pollutant. Synergistic effect of O(3) plus SO(2) not found. Air sampling by instrumentation at ground level and at 15m height detected 2,4-D, DDE, etc. In rain samples, dieldrin, kelthane & endrin were most common pesticides found. Monitoring limited primarily to Iowa State University campus and Horticulture Farm with good success in respect to 2,4-D and other volatile pollutants. Exposure trials demonstrated interference effect of some pollutants and lack of synergism generally. Also lack of cancelling out of NH(3) and SO(2) exposed simultaneously. Thresholds of injury (minimum for visible symptoms) determined for representative pollutants and horticultural plants. Risks through season not completed but peak amounts of pollutants appeared intermittently throughout the growing season.

SUPPORTED BY U.S. Dept. of Agriculture

4.0034, REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES

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OBJECTIVE: Determine extent and state in which pesticides occur in farm water supplies; evaluate effectiveness of presently recommended farmstead treatment systems in removing pesticide residues; investigate possible application of new techniques and system arrangements to remove pesticide residues from rural water supplies.

APPROACH: Selected farm water supplies will be tested using standard chemical analysis techniques to ascertain the degree of pesticide contamination in these locations. Results will be correlated to the pesticide history of the watershed. The effectiveness of conventional rural water treatment and filtering methods in removing different pesticides will be studied. New or potential methods of removing pesticide residues from water supplies will be studied and evaluated for possible application on the farmstead.

PROGRESS: Twelve fallow plots 3.81 feet square were treated with Aldrin, Dieldrin, and DDT. After waiting for various periods of time (15 minutes, 1 day and 3 days), artificial rainfall was applied. The runoff water, eroded sediments, and soil remaining on the plots were then analyzed to determine the concentration of the three pesticides. At this time the data analysis is incomplete.

4. PESTICIDES

SUPPORTED BY U.S. Dept. of Agriculture

4.0035, ENGINEERING SYSTEMS FOR COTTON PRODUCTION

B.J. COCHRAN, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB00858)

OBJECTIVE: Develop or improve cotton production subsystems while simultaneously providing information and data for a computer simulation model of the cotton production system.

APPROACH: Determine physical properties of weeds and cotton plants that influence heat transfer into the plants. Determine the characteristics of flame required to obtain optimum heat application for maximum weed control. Develop new and improved conventional methods to obtain maximum weed control by the utilization of extended heat exposure, electrical power, vibrations and other sources. Determine the energy required to obtain the optimum conditions for maximum weed control and incorporate the results into the regional model cotton production system.

PROGRESS: Twenty-nine new premergence herbicide treatments were analyzed for selectivity. None of these were added to the list of recommended herbicides, although seven will be retained for further study. Further tests appear to substantiate earlier conclusions that combined preplant and preemergence treatments are somewhat more effective than either single treatment. Both treatments may be necessary for controlled heavy infestations or broad spectra. Experiments indicate that using foam as a carrier of preemergence herbicides offers no benefit other than reduction of the drift, although foam alone may prove to be a valuable post emergence herbicide due to probable substantial temperature increases under the foam. Use of foam as a perishable sealant over injected methyl bromide gel gave excellent weed control as well as control of soil borne organisms. Nineteen treatments, including the common ureas, MSMA plus urea, and two experimental herbicides were included in a uniform post emergence experiment. Excellent results were obtained on a broad spectrum of weeds with all combinations of a urea plus MSMA, the superior treatments being diuron or fluometuron plus MSMA. No significant interactions were observed among herbicides, fungicides, and insecticides with combinations of a fungicide (Demosan), an insecticide (Thimet), and three herbicides (diuron, fluometuron, and norea).

SUPPORTED BY U.S. Dept. of Agriculture

4.0036, WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA

C.H. WILLIS, Louisiana State University, U.S.D.A. Soil & Wa. Cons. Div., *Baton Rouge, Louisiana* 70803 (SWC-024-BBR-3)

OBJECTIVE: Determine the mechanism for and extent of movement of pesticides, plant nutrients and other pollutants over and through the soil in drainage water and develop methods for alleviating the effects of pollutants on water and soil resoruces.

APPROACH: Extent and mechanism of movement of pollutants in surface and subsurface drainage water will be measured in the laboratory and on field plots. Measurement systems will be developed for enhancing chemical or biological degradation and immobilization, and disposal of the polluting materials in soil and water.

PROGRESS: Where endrin was applied to sugar cane for borer control on very dry Mhoon clay loam at Baton Rouge, Louisiana, the concentration in surface drainage water was 1.06 and 0.46 ppb when rain followed the application in 24 and 72 hours, respectively. Concentrations in tile effluent of 0.45 and 0.07 ppb from rains 24 to 72 hours after rain were attributed to the flow of water through cracks in the soil instead of by true percolation to the tile. Endrin found in the soil 6 months after application was 65 and 24 ppb, respectively, where rains came 24 and 72 hours after application. This difference probably was due to the loss by volatilization of the pesticide with the variation in exposure to temperature and other weather phenomena before rain fell. All these results confirm similar findings in 1967 and 1968, and suggest that pesticide content of soil and water will be lessened if the material is applied as long as possible before rain occurs. A method was developed at Baton Rouge, Louisiana for detecting losses by volatilization of pesticides applied to the soil. Preliminary results of studies underway indicate that flooding the soil retarded the volatilization of DDT and DDD, suggesting that this treatment might be used to reduce the atmospheric pollution potential of a pesticide-treated soil.

SUPPORTED BY U.S. Dept. of Agriculture

4.0037, PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST

E.R. JONES, U.S. Dept. of Agriculture, Agricultural Engin. Res. Div., *Beltsville, Maryland* 20705 (901-032-B605)

OBJECTIVE: Develop methods for preventing pesticide contamination of farmstead water supply systems.

APPROACH: Determine design characteristics for farmstead water well construction which will reduce the possibility of pesticide contamination. These studies will include investigations of selected cases of pesticide contamination to learn means of entry, concentration and persistence of contamination. Develop equipment and/or procedures to eliminate or reduce the risk of pesticides entering the system by backsiphonage or cross-connections. Develop methods and techniques for using, handling and storing of pesticides which will eliminate the threat of contamination of the water system. This will include studies of the pesticide equipment servicing area where filling, overflow, spillage, leakage, drainage and washing practices may influence the incidence of pesticide contamination.

PROGRESS: Sediment removed from the bottom of well WA10A contained dead insects, macerated straw, and a greasy substance. By error these were discarded. The sediment was allowed to settle for 48 hours and samples taken of sediment and supernate. The results of analysis were sediment dry weight 1000.0 ppb sulfur, 40.0 ppb DDT, supernate 0.05 ppb DDT. The concentration in the supernate was similar to a water sample obtained 42 days earlier, 0.04 ppb DDT. The ratio of DDT in sediment to supernate of 800:1 is similar to values for surface water. The affinity of free DDT in water for the air water interface and volatilization by codistillation make it quite certain that the major avenue for penetration of chlorinated hydrocarbons below the water table is inadequately protected wells. Concentrations found in contaminated well water are normally less than that reported for rain water. Research well WA10B was constructed 113 feet south of Washington County, Maryland sample well WA10A. The technique used, if further developed and adopted, may reduce the cost of the cased portion of the well 50%. Present costs encourage inadequate depth of casing and grouting. Well WA10B produces water of more uniform quality than well WA10A. Collecting samples after heavy rainfall in Wicomico County resulted in an increase of confirmed pesticide concentrations.

SUPPORTED BY U.S. Dept. of Agriculture

4.0038, MASSACHUSETTS PESTICIDE MONITORING STUDY

W.A. TOMPKINS, State Div. of Fisheries & Game, *Westboro, Massachusetts*

The objective of the project is to define the pesticide pollutants on the major watersheds of the State of Massachusetts through the operation of 100 monitoring stations which will sample aquatic organisms for pesticide residues.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0039, MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS

R. REINERT, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Ann Arbor, Michigan* 48107

A laboratory program designed to compare the relative importance which direct uptake of insecticides from water and biological magnification via the food chain have on the buildup of chlorinated hydrocarbon insecticides in aquatic communities.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

4.0040, THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY

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The proposed research would involve a two-fold study of the effect of herbicides commonly applied to horticultural crops on the ecology of microflora in streams adjacent to the orchard or field. The laboratory phase of the research includes application of herbicides to water samples collected from a stream. Subsequently, measurements of the growth, development and population dynamics of the natural microflora will be made. Growth will be measured via dry weight determinations, quantitative estimation of chlorophyll A, and measurement of photosynthesis and respiration via illuminated manometric techniques. The effect of herbicide application on algal population dynamics will also be measured via per cent estimatation of population components.

The field phase of the research will involve the collection of water samples from streams prior to, during, and after the stream passes an orchard or field. Oceana County, in western Michigan, is proposed as the site for the field work based on two criteria: 1) it is an important fruit production area, using large amounts of herbicides, 2) it has a stream offering two methods sampling. Consecutive sampling in the same stream and comparison sampling between two independent watersheds. One of which drains a fruit area while the other drains a non-cropped area.

Water samples will be collected and concentrated by flash evaporation and analyzed for the following parameters: a. herbicide residues via chloroform extraction and measurement by gas-liquid chromatography. b. total N, by micro-kjeldahl procedures. c. ND sub 3 and other nutrient elements of spectrographic analysis. d. total dry matter.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0041, BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES

N.R. KEVERN, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00940)

OBJECTIVE: Evaluate amount, storage, build-up and releases of pesticides under varying biological and chemical-conditions.

APPROACH: Studies on contamination and levels necessary to produce injury, debility, sterility or mortality will be conducted. The physiological effects of pesticides on energy exchange measured at the cellular level. Direct bioassay and gas chromatography employed to monitor the accumulation of pesticides in aquatic systems. Determine site of damage and identification of effects of detergents, metallic ions, BOD and other chemicals. Rate of transfer, buildup and exchange within the biota of aquatic systmes will be determined.

PROGRESS: The sub-project under this study that has been emphasized this past year dealt with the downstream movement of invertebrate organisms in streams. The nocturnal nature of this movement has been documented in the literature for very small streams. Sampling problems in large streams must be understood before data can have a quantitative meaning. Thus, in order to relate transport of pesticides or other elements via downstream drift, it is necessary to quantify the drift. The purpose of this study was to measure the rate of drift in three contrasting streams and determine what relationship exists between drift rate and degree of enrichment. Additionally an attempt was made to determine how drift is related to current velocity. The three streams chosen for this study were the Jordan River in Antrim County, AuSable River in Crawford County, and Red Cedar River in Ingham County. Two 24-hour series of drift samples were collected in each stream. Samples of benthic invertebrates were collected following each 24-hour drift collecting period. To investigate the relationship of current velocity to drift rate, five series of samples were collected along a transect across the stream at three points where the velocity was different. Although standing crop estimates did not reflect the degree of enrichment in the streams, total drift measurements showed a relationship to enrichment. The relationship between total drift and current velocity was linear, as expected. However, the drift rate of Baetis sp. (may flies) and Simulium sp. (black flies) appeared to be influenced by behavioral as well as physical factors and was therefore non-linear. Methods for sampling drift are discussed with suggestions for standardization of technique.

SUPPORTED BY U.S. Dept. of Agriculture

4.0042, PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN

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Insecticides have been identified as causing problems with reproduction of gulls and raptorial birds in the Michigan portion of the Great Lakes Basin, as well as causing reduction hatchery reproductive success of coho salmon, and by accumulating above FDA tolerances in fish. Objective of this program is to identify the levels of pesticides in tributary streams to the Great Lakes from the State of Michigan, to identify the sources so they may be controlled, and to establish residue backgrounds against which to judge the success of control programs.

Water samples are collected monthly from the mouths of major tributaries to the Michigan portions of the Great Lakes and analyzed by gas chromatography for several insecticides. Freshwater mussels are held in cages for 3-4 week periods near the mouths in the major tributaries and in 60 minor tributaries and then analyzed for several insecticides. This exposure period permits them to accumulate insecticides to measurable concentrations. Stream sediments are also analyzed periodically. As major pesticide-contributing water courses are identified, sampling fans out into the interior to the sources.

Spot sampling is conducted at municipal and industrial wastewater sources and in addition municipal water supplies are checked periodically. Similar programs are underway in Ill., Ind., Minn., And Wisc.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0043, PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN

T.A. OLSON, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

The continued use of persistent insecticides in the Great Lakes System constitutes a potential threat to that Ecosystem and ultimately to the welfare and well-being of man. One of the first steps which must be taken if this hazard is to be met and brought under control is the accurate identification of the sources and avenues of entry which characterize each pesticide. The proposed study of Minnesota Waters of Lake Superior will therefore deal with current pesticide levels in streams along the North Shore of Lake Superior and is designed to determine the importance of these streams and their respective watersheds as sources of insecticide pollution. Captive, living fresh- water clams or other suitable organisms, which can take up and store insecticides, will be employed as concentrators in certain streams. A Water monitoring program which complements the test with living organisms, will be directed toward the major tributaries and will consist of samples collected on a scheduled basis, in some instances over a three day period. The north shore area, with its streams, from Duluth to the Canadian boundary, is to be included in the study.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P

4.0044, A STUDY ON THE FEASIBILITY OF LOW VOLUME APPLICATION OF INSECTICIDES FOR CONTROL OF COTTON INSECTS

M.H. ADAIR, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-3-206-1034)

OBJECTIVE: Determine the most effective swath width to be delivered by the low volume application technique and the distribution of droplets to obtain adequate control of cotton pests. Evaluate the effectiveness of the low volume formulations against cotton pests as compared with the conventional formulations.

Determine the relative drift problem with low volume concentrates compared with water diluted formulations. Evaluate low volume ground application equipment for coverage, efficiency, and effectiveness in controlling cotton pests.

APPROACH: Establish sampling stations using oil sensitive dyed cards across swaths to access spray patterns. Make natural infestation counts and bioassay treatments to evaluate materials. Establish indicator cards outside swath to determine amount and distance of drift. Set up indicator cards in the same manner for evaluating low volume ground machinery.

PROGRESS: During 1968 tests were conducted to evaluate the aerial application of ULV formulations of insecticides for control of pests on cotton. The studies were designed to compare the relative effectiveness of ULV materials when applied at different rates and at approximately the same droplet size using the Micronair system. Strobane T-methyl parathion was applied at a full rate (2-.5 lbs./acre), a 1/2 rate (1-.25 lbs./acre) and a 1/4 rate (.5-.1 lbs./acre). These ULV rates were compared with the same material as a standard emulsifiable concentrate. Results showed that all treatments gave good control, however, the infestation pressure was generally too low for a good evaluation. The different rates of Strobane T-methyl parathion compared favorably with the conventional treatment. There also appeared to be no outstanding difference in control among the various rates. The conventional treatment and the ULV treatments including the low rate of Strobane T- methyl parathion performed equally well.

SUPPORTED BY U.S. Dept. of Agriculture

4.0045, EVALUATION OF LOW VOLUME CONCENTRATE FORMULATIONS OF INSECTICIDES FOR CONTROL OF COTTON INSECTS

M.H. ADAIR, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-8-240-1066)

OBJECTIVE: Determine the optimum droplet size of ultra low volume (ULV) insecticides for control of cotton pests. Evaluate aerial and ground application equipment for control of droplet size, drift control, and insect control. Compare with conventional systems and formulations. Determine most effective swath widths for ULV aerial and ground equipment.

APPROACH: Insecticides will be applied to potted plants and small field plots with a tractor-type spinning disc applicator. The disc speed will be varied to give a range of droplet sizes. Treated plants will be used to bioassay various cotton pests. Aerial equipment will be evaluated for efficiency in control of droplet size and of efficiency of application to the target area. Measurements will consist of bioassay of natural pest populations, counts of droplets deposited, and chemical analyses of deposits in the target area. The effective swath width will be determined in these same tests by recording the deposit across the plots and by bioassay with the field population of pests.

PROGRESS: Aerial conventional low volume and ultra low volume application of methyl parathion indicated a wider swath potential (80- ft) for ULV as compared to conventional LV (40-ft). Based on the wide 80-ft swath for ULV and the 40-ft swath for LV the percent recovery in the swath for both methods of application was comparable. More ULV applied methyl parathion impacted on the ground downwind of the swath. Droplet diameter of ULV droplets impinging on oil sensitive cards ranged from 54 to 138 microns. A comparison of aerial ULV application with Micronair, aerial ULV application with a boom and aerial conventional LV application with a Micronair using a Toxaphene-methyl parathion insecticide mixture indicated no differences in Heliothis control among the different methods of application.

SUPPORTED BY U.S. Dept. of Agriculture

4.0046, DISPOSING OF SURPLUS PESTICIDES AND PESTICIDE CONTAINERS

B.J. STOJANOVIC, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (901-062-AE-CR-1(GR))

OBJECTIVE: Determine the combustion temperatures and the volatile products of selected pesticides. Investigate the use of chemicals and other materials as aids in the decomposition of pesticides and containers. Investigate the use of indigenous soil microflora as an aid in the decomposition of pesticides in soils. Determine the requirements for pesticide containers that are readily combustible. Develop specifications for an incinerator or other device for the disposal of pesticides and containers.

APPROACH: Three general avenues of approach will be followed in the investigations concerning decontamination and safe disposal of selected pesticides, their formulations and pesticide containers: combustion, treatment with chemicals, and exposure to microbial activity in soils. This project is cooperative with CR No.0710-01-32-(Gr. (Accession No. 0017430).

PROGRESS: Incineration of pesticide standards and formulations at 900 C. in air, produced hazardous gases such as hydrogen chloride, chlorine, hydrogen sulfide, nitric oxide and ammonia, whereas the ashes of wettable powders of dalapon, diuron, and zineb contained bromine, arsenic and zinc among other elements. Combustible containers and container closures, burned singly or mixed, were completely incinerated between 550 and 700 C. Aluminum, calcium, iodine, paladium, silicon, sulfur, titanium, and zinc were found in the container ash. Of several chemicals evaluated for pesticides decontamination, 70% calcium hypochlorite substantially degraded dicamba, diuron, DNBP, and 2,4-D. Low temperature heating (200 to 400 C.) partially degraded pesticides to chemically simpler, less toxic materials. Most pesticides applied at the rate of 5 tons of active ingredient per acre to a calcareous soil resisted microbial degradation. Also most pesticides depressed soil bacteria but favored streptomyces. Numbers of fungi were either increased, decreased, or eradicated (by DNBP and PMA). Surveys in Mississippi indicated that users destroy most of the empty glass, plastic and paper pesticide containers by burning. Metal containers were either stored, sold, left in city or farm dump or thrown in stream. A small scale model incinerator was designed and constructed for use in the laboratory testing, and a packed tower was selected for preliminary scrubbing of off-gases.

SUPPORTED BY U.S. Dept. of Agriculture

4.0047, PRECISE PLACEMENT AND DRIFT CONTROL OF INSECTICIDE AND PESTICIDES WHEN ULTRA-LOW VOLUMES

E.D. THREADGILL, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-8-240-0387)

OBJECTIVE: Establish fundamental relationship for predicting microparticle behavior in complex flow fields. Determine optimum placement methods and patterns for ultra-low volume chemical applications. Translate the results of objectives A and B into a practical technology for development of methods and machines for ultra- low volume applications of chemicals.

APPROACH: The project is concerned with the effect of thermal, gravitational, inertial, aerodynamic factors on particle placement and deposition. Recent developments in the fields of aerosol mechanics and particle dynamics will be used in order to determine the influence of vortices, air turbulence, and plant micro-environment on particle movement. The results obtained from the previous investigations will be used to develop methods for imparting energy to spray particles in complex flow fields. Design criteria and specifications for equipment needed in ultra-low volume applications will be developed.

PROGRESS: A model wind tunnel for controlling wind velocity, wind velocity profile, temperature gradient and turbulence intensity has been constructed and tested. Results verified the feasibility of constructing a prototype, which is nearing completion. Through cooperative research with the USDA Boll Weevil Research Laboratory, data concerning the effect of wind speed, turbulence, temperature gradient and relative humidity on the drift controlled size drops of liquids having different physical properties have been collected and are being analyzed. These liquids were applied with ground equipment. Through cooperative research with the Departments of Entomology and Biochemistry, the influence of wind speed, temperature, relative humidity, and application rate on the drift of uncontrolled size drops of aerially applied methyl parathion has been determined. These data, and additional data to be collected by spraying controlled size drops in the wind tunnel, will be used to evaluate the previously developed mathematical model. A device for aerially applying controlled size drops has been constructed and will be

evaluated. A study of motion of controlled size drops within the plant canopy and the deposition of these drops on plant surfaces has been initiated. Liquids having varying physical properties will be used. The drops will be subjected to various atmospheric conditions in the wind tunnel.

SUPPORTED BY U.S. Dept. of Agriculture

4.0048, INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES

B.T. JOHNSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Accumulation, retention and passage of polychlorinated pesticides in a freshwater food-chain are studied. Under controlled laboratory conditions experiments are performed with bacteria, algae, protozoa, crustacea, insects and fish using both labeled and non-labeled chlordane, toxaphene and methoxychlor alone and in combination with the non- pesticidal polychlorinated Aroclor series of compounds. Both simple and complex food-chains are developed. Only environmental levels of the pesticides are used. Residue analysis at various trophic levels are made using several chromatography methods, liquid scintillation, autoradiography and mass spectroscopy. Evidence of biological magnification in the concentration of pesticides is explored.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0049, DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS

D.L. STALLING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The use of plastic films, gel permeation materials (LH-20), and immobilized liquid phases to separate and concentrate low levels of pesticides from water will be studied. Polyethylene films and solvent filled plastic bags have demonstrated an ability to concentrate organochlorine pesticides from dilute water solutions. Various types of plastics will be evaluated. Concentration ratios, equilibration times, and uptake rates will be compared. Concentration of pesticides by partition using water flow through immobilized liquid phases and organic gel permeation resins show promise as simple sampling methods. Extraction with solvents denser than water will also simplify separation of pesticide from water.

Definition of the selectivity and general applicability of each approach will be important factors in selecting techniques for field use.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0050, EQUIPMENT AND PROCEDURES FOR CONTROL OF WEEDS AND BRUSH

C.L. DAY, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00153)

OBJECTIVE: Develop systems and equipment for control of weeds in field crops; equipment for control of weeds and brush on agricultural lands, rights-of-ways and commercial areas; develop more accurate and efficient methods of applying chemical herbicides.

APPROACH: Studies on various combinations of chemical and mechanical methods for controlling weeds in soybeans and corn are planned. A comparison will be made of pre-emergence applications of granular and liquid 2,4-D for weed control in corn. The effect of rainfall (or irrigation) on granular and liquid 2,4-D treatments will be made.

PROGRESS: Evaluation of equipment for incorporating herbicides with the soil was continued. Incorporation with some types of equipment resulted in yield reductions. Soil samples were analyzed with a gas chromatograph. Field studies to evaluate low volume spraying devices were used to supplement studies in the laboratory. A spinning disk type nozzle was found to be effective in reducing drift when compared with conventional and air atomizing nozzles. Field studies on directed spraying in corn were continued.

SUPPORTED BY U.S. Dept. of Agriculture

4.0051, CYTOGENETIC EFFECTS OF HYDROGEN FLUORIDE ON CORN

A.H. MOHAMED, Univ. of Missouri, Graduate School, *Kansas City, Missouri* 64110

Corn kernels of the genotype A sub 1 A sub 2 C super 1 RBWx will be germinated in the greenhouse in polyethylene pots containing a horticulture soil mixture. The seedlings will be fumigated with a concentration of HF too low to induce visible injury. After each period of treatment, the treated plants and their controls will be transplanted in the field. Microsporocyte samples will be collected from these plants at the right stage of development to study the effect of hydrogen fluoride on the meiotic chromosomes. Pollen grains will be collected from these plants and used to pollinate appropriate recessive female parents planted in the field. If hydrogen fluoride is able to induce any gene mutations or chromosomal aberrations, then the selected gene markers will help in identifying some of those events. The F sub 1 plants will be selfed and backcrossed to the appropriate recessive parents for linkage studies to determine the effect of HF on crossing over frequency.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0052, THE OROVADA, NEVADA BASIN ENVIRONMENTAL STUDY

B.R. PAYNE, Univ. of Nevada, School of Agriculture, *Reno, Nevada* 89507

The farming area surrounding the community of Orovada, Humboldt County, Nevada, grows alfalfa and grain for forage and seed, therefore, having occasion to use both chlorinated hydrocarbons and organophosphates for insect control. As defoliation is also practiced in readying the fields for seed harvest, some herbicides are used in the area. This region is a relatively new agricultural area and hence a very accurate account of the total amount of pesticides that have been used thus far could be ascertained.

The physical attributes of this valley for a study of pesticide use is ideal in many respects. The valley is isolated as are the ranches located in this region. The air is clear and uncontaminated from smog or other complicating factors. Due to its isolation, the area would permit good control studies associated with air application of insecticides, particularly in view of the fact that the ranches are also well separated. Irrigation water is obtained from deep wells. Little if any waste water reaches the Quinn River, and intermittent stream flowing through this valley. Therefore, most of the pesticide drift will occur during application or air and dust movement following treatments. The water usage in the valley, along with other attributes already mentioned, thus affords an excellent opportunity to closely estimate the total area of environmental contamination and the final deposition of all pesticides applied.

The proposed study would involve the recording of the total annual pesticide input in this rather compact agricultural area and the environmental drift patterns at predetermined seasonal times and sites. In addition to monitoring the atmosphere, soil samples would be analyzed for deposition of residues from atmospheric movement of soil particles.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0053, THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS

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OBJECTIVE: Study the growth and development of Myriophyllum, Potamogeton, and Elodea in axenic or algae - free cultures as affected by: Chemical variables, physical variables and biological variables and relate the results obtained to the distribution, management and control of the above mentioned genera.

APPROACH: Plants will be grown in plastic lined stock watering tanks with either filamentous algae or planktonic algae

or in tanks kept free. Growth will be measured and observations made on root development, tuber development, flowering, etc. Laboratory test will be conducted on plants grown in various nutrient solutions to determine the effects of varying levels of N, P and K and under different photoperiods to determine the effect of day length on vegetative growth and flowering. Germinating seeds of Potamogeton and Myriophyllum, at different temperatures in germination chambers.

PROGRESS: To determine effects of photoperiod on aquatic plants had no definite conclusions because of algae in the experimental vessels. Copper sulfate has been used to control algae in aquatic experiments but effects of the copper on the rooted plants are not known. Experiments were conducted to determine effects of a range of CuSO(4) 5H(2)0 levels in sago pondweed and Eurasian watermilfoil. Sago pondweed plants were grown in nutrient solution from tubers planted in washed sand. CuSO(4) 5H(2)0 was added at 0, 0.5, 10.0, 50.0 and 100.0 ppm. Browning of leaf tips was observed on all plants with 10 ppm and above at 24 hours. Stunting of plants was evident at 50 and 100 ppm after 5 days and there was no increase in height of plants after 8 days. Plants with 0.5 and 10.0 ppm CuSO(4).5H(2)0 were shorter than controls after 6 days. Root development was inhibited in all plants treated with 10.0 or more ppm. Dry-weight yields were lower in all copper sulfate treatments than they were in the controls. Result with Eurasian watermilfoil were similar although this species did not grow well in the nutrient solution used.

SUPPORTED BY U.S. Dept. of Agriculture

4.0054, GROSS EFFECTS OF HEXADECANOL AND PLASTIC SHEET BOTTOMS ON AQUATIC LIFE IN PONDS
D.B. JESTER, New Mexico State University, Agricultural Experiment Sta., *Las Cruces, New Mexico* 88070 (NM00414)

OBJECTIVE: Determine effects of hexadecanol monomolecular layer on aquatic life in ponds. Determine effects of plastic sheet bottoms on aquatic life in ponds. Determine effects of a combination of hexadecanol monolayers and plastic sheet bottoms on aquatic life in ponds.

APPROACH: Apply hexadecanol to the surface of two ponds, place polyethylene plastic bottoms in two ponds, apply both treatments to two ponds, and use two untreated ponds as controls. Gross effects of these treatments on aquatic life will be determined by use of standard limnological procedures to evaluate changes in physical and chemical factors, plankton quantity and quality, nekton volume and composition, benthos and crawfish populations, insect emergence, and fish survival and production.

SUPPORTED BY New Mexico State Government

4.0055, AERIAL CONTROL OF TREE FRUIT DISEASES
M. SZKOLNIK, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00699)

OBJECTIVE: Adapt aircraft to the control of pome and stone fruit diseases. Investigate aerial equipment for application of dusts, spray concentrates, and ultra low volume. Determine phytotoxicity and compatibility of pesticides. Develop aerial spray programs. Study fungicidal residues and uniformity of coverage. Physical properties and drift of pesticides.

APPROACH: Fungicides will be developed as spray concentrates applied by fixed wing planes and helicopters for disease control without phytotoxicity. Different application equipment including that for ultra low volume (ULV) will be evaluated. Physical properties of sprays will be related to control and to persistence, degradation, and drift of pesticides.

PROGRESS: Aerial spray concentrates of fungicides were applied to mature apple trees by Grummen AgCat plane and Bell G-2 Helicopter, over each row, for the control of apple scab. Applications were made at 70X spray concentrates at 5 gallons per acre on 11 dates between April 20 (green tip) and July 2 (5th cover). The spring weather of 1969 was very favorable for development of the apple scab disease. Captan 80W, Manzate D 80W, and Dikar gave excellent control of scab on both leaves and fruit. The control Cyprex 65W applied by plane, helicopter, or by ground sprayer (at 2X with Speed Sprayer), was poor. This is in sharp contrast to excellent control with this dodine fungicide in many earlier years. Poor control was attributed to the development of tolerance or resistance of the scab fungus to dodine. Loss of this fungicide to the fruit grower would mean a serious setback. A single application of a 'massive rate' (about a sixfold increase per acre) of the fungicide Difolatan 4 flowable by airplane (Grummen AgCat) or by ground air blast sprayer replaced about 6 regular orchard sprays for the control of apple scab. Application was made at the half inch green stage of apple fruit bud development (April 27) and no fungicide was applied until the first cover spray (June 17) when a regular Cyprex spray program was resumed. Scab control in the single 'massive rate' application block was as satisfactory as it was in the block receiving a full spring fungicide spray program at regular intervals.

SUPPORTED BY New York State Government - Albany

4.0056, AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER
P.J. ZWERMAN, State University of New York, School of Agriculture, *Ithaca, New York* 14850

The objective of the project is to develop working approximations of parameters necessary for estimating the contributions of nitrogen and phosphorus from agricultural land to water for two specific purposes: (a) to permit estimation of the contributions from land under selected major land use systems, and (b) to permit identification of farming practices by means of which such contributions may be minimized.

To these ends, the immediate objectives would be to determine the effects of time, rate, and placement of fertilizers along with selected cultural practices, on the forms and amounts of nitrogen and phosphorus contributed to water under conditions of soil and climate representative of very extensive areas of the humid temperate region. In addition pilot analytical studies will be conducted to determine whether or not the major problems of determining organo phosphate and carbonate pesticides in the water samples can be solved adequately to justify the additional cost of monitoring them in the same experiment.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0057, AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT
J. BREZNER, State University of New York, School of Forestry, *Syracuse, New York* 12224 (WO1602)

OBJECTIVE: Provide information upon which to judge the potential of 'Sevin' as an environmental pollutant in forested areas.

APPROACH: A study area established on the Shackham Brook Watershed in central New York encompasses a 'treatment' and 'control' subwatershed. The treatment area will receive an aerial application of Sevin; then samples of soil, water, and aquatic insects will be taken at frequent intervals to be tested for the presence and concentration of Sevin residues.

PROGRESS: During the first two years of the study, preliminary surveys were completed and were followed by spraying operations. Techniques were devised and determined to be adequate. Tests of water and soil samples showed no residues of Sevin. Insect populations were negligibly affected.

SUPPORTED BY U.S. Dept. of Agriculture

4.0058, THE RECOVERY AND CHARACTERIZATION OF AGRICULTURAL CHEMICALS FROM SPENT PULP CHLORINATION LIQUORS
C.W. DENCE, State University of New York, School of Forestry, *Syracuse, New York* 12224 (FS-WO-3404)

OBJECTIVE: Develop methods of isolating and characterizing components of pulp chlorination effluent residues, assess potential as source of chemicals, and reduce pollution.

APPROACH: Prepare spent liquors approximating industrial pulp chlorination effluents. Separate the chlorolignins into its component parts and characterize the fractions. Test these fractions for use as insecticides, germicides, algicides and other chemical applications. Alter chlorolignins to improve their usefulness. Apply findings to reduce pollution. Apply findings to other wood wastes.

PROGRESS: The dissolved solids in a commercial spent chlorination liquor now have been isolated and partially characterized. The same materials were tested for insecticidal and fungicidal activity. The dissolved solids in chlorination liquors contain very little aromatic residue. Phenolic content is estimated at 5 to 10 percent of the solids. The various fractions of the chlorination solids were applied to milkweed bug and houseflies and showed no insecticidal activity. Likewise, the chlorination solids exhibited no fungicidal activity toward Penicillum Expansum, Lenzites Trabea, and Dutch Elm disease. The lack of insecticidal or fungicidal activity is attributed to the low phenolic content.

SUPPORTED BY U.S. Dept. of Agriculture

4.0059, PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS

R.C. AXTELL, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

This project will investigate the threat to estuarine animal life of pesticide residues drained from the state's farm lands by the rivers and streams.

The proposed project will have three main phases: (1) to determine present levels and distribution of pesticides in representative sites in sounds and estuaries along the coast and in streams and lakes of the Coastal Plain; (2) to study experimentally the breakdown or chemical alteration of pesticides in natural waters: and (3) to study the transfer and accumulation of pesticides in food chain organisms, particularly the common and economically important estuarine species.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

4.0060, NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION

J.F. LUTZ, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03261)

OBJECTIVE: Determine direct contribution of fertilizers to nitrogen and phosphorus contamination of surface and subsurface runoff water from soils as affected by form, time and rate of fertilizer application, crop to which applied, soil properties, and meteorological and hydrological conditions. Lateral and vertical movement of several herbicides in soils and herbicide loss in surface and subsurface runoff from soils of different physical, chemical, and mineralogical properties.

APPROACH: Properly equipped, sealed watersheds will be treated with recommended rates of N, P, and selected herbicides and the amount of N, P, and herbicide in the runoff (surface and subsurface) over the flume determined. Losses of N and P in drainage water from other areas will be determined by analyzing water from tile outlets.

PROGRESS: Watersheds 1 and 2 of the Western North Carolina Cooperative Watershed Project at Waynesville were divided into four equal parts. Each of three segments was sprayed with 2,4-D, 2,4,5-T and picloram. A fourth segment was unsprayed. Two lbs/acre were used except on Watershed 4 in 1969 when 4 lbs were applied. When applied at 2 lbs/acre, the flume water contained 3 to 5 ppb 2,4-D but picloram and 2,4,5-T were not detected. When applied at 4 lbs/acre, as much as 48 ppb of 2,4,5-T was found, but 2,4-D and picloram concentrations never exceeded 3 ppb. Concentration in the surface runoff water was considerably greater because of a very heavy rain immediately following application. However, total loss amounted to only .04, .01, and .01% of the applied 2,4-D, 2,4,5-T, and picloram, respectively. Watershed 2 was fertilized with 200 lbs of N and 100 lbs of P(2)O(5) in 1968 and with 100 lbs of N and 100 lbs of P(2)O(5) in 1969. Watershed 1 was unfertilized. Of the total fertilizer applied in both years, less than 11% of the nitrogen and less than 2% of the phosphorus was lost in runoff water. Most of the nitrogen loss was caused by an exceedingly heavy storm immediately following the application of the fertilizer in 1968. 1969 losses were minimal. Only negligible quantities have been lost from the unfertilized watershed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0061, CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS

T.J. SHEETS, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

The movement of DDT, toxaphene, trifluralin, and fluometuron in surface water arising from natural rainfall in cotton fields will be studied. Cotton will be grown and sprayed with the four pesticides at dosages and frequencies employed by farmers for pest control. Surface water from small plots within large (3 to 5 acre) experimental fields will be collected after each rain during the growing season and analyzed for the pesticides.

Seasonal changes of pesticide residues in a farm pond located within one of the experimental areas will be followed by analyzing water and sediment after each rain.

The persistence of the four pesticides and their movement downward will be studied in two soils (the two experimental sites). Possible contamination of ground water will be investigated by analyzing water from wells located within cotton fields that are sprayed with the four pesticides during each of three years.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0062, FATE OF POLLUTANTS IN GROUND WATER

M.R. SCALF, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

Traditionally, it has been and continues to be the practice of water users in the High Plains area of West Texas and Eastern New Mexico to recharge aguifers with playa lake water. In doing so, the aquifer recharged risks contamination by chlorinated hydrocarbons and nitrates resulting from agricultural practices. It is of concern that chlorinated hydrocarbons, in particular, adsorb to aquifer material in the near proximity of the recharge well and then are released in high concentrations when that well is pumped. This project is being conducted cooperatively by the Robert S. Kerr Water Research Center of the Federal Water Pollution Control Administration and the Southwestern Great Plains Research Center of the U.S. Department of Agriculture. The experiment will be at the latter's installation at Bushland, Texas.

The scope of this project will be to determine the distance which pollutants travel in a fresh water aquifer under recharge conditions and the temporal distribution of these concentrations when that same well is pumped.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0063, DRIFT CONTROL OF PESTICIDES

L.O. ROTH, Okla. St. Univ., Agricultural Experiment Sta., *Stillwater, Oklahoma* 74075 (OKL01264)

OBJECTIVE: Measure and evaluate drift potential of liquid pesticides drops as this drift potential is affected by atomizing devices and physical characteristics of liquid; build, test and evaluate prototype liquid pesticide applicators which have a low drift potential.

APPROACH: Photographic assessment equipment and methods will be used to measure drop sizes generated by three general atomizing devices- -laminar flow orifices, mechanical choppers and pulsed wave generators. Physical properties of different liquid pesticides will also be studied to determine effect of viscosity, surface tensions and particulating agencies on drift potential of generated drops. Prototype liquid pesticide applicators will be built, tested and evaluated. Field studies under varied conditions will be made to determine degree of drift control achieved.

PROGRESS: Major effort has been devoted to evaluation of a method of introducing wettable powders into a spray system downstream of the pump. The output of the system as a function of rotor speed was nonlinear over the range of 0.1 to 1.2 lbs/min. Magnetostriction as a means of drop size control continued as an important research activity. Apparently rod-orifice plate clearance is not as critical as first observed. Control of drop formation using magnetostrictive devices is possible in such ordinary

atomizers as cone or fan nozzles. Satellite drops seem to appear under some regions. This phenomenon must be further investigated. Air stripping of small drops with a counterflow air stream was effective at air velocities above 10-12 fps. Field equipment was developed for using electrostatic stripping and dispersion and this equipment was used in field application of 3 sized drops--100, 200 and 300 micron diameter.

SUPPORTED BY U.S. Dept. of Agriculture

4.0064, PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES

C.E. WARREN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00693)

OBJECTIVE: Developing standards for the use of toxic substances that are adequate to protect the productivity of fresh waters for organisms of value to man. Obtain understanding of how toxic substances influence the various biological functions of the individual organism; and obtain understanding of how toxic substances influence food relations in biological communities.

APPROACH: Pharmacological and bioenergetic approaches will be used in studies of the influences of toxic substances on the biological functions of aquatic organisms; food chains in simplified biological communities will be studied to determine the influence of toxic substances on food relations.

PROGRESS: Recently initiated studies have to do with the influence of pesticides on the population dynamics of fish in ecological systems that provide the fish-food resources. Working with Lyle Clavin of our Statistics Department we hope to develop models of population growth that contain environmental variables including pesticides. Preliminary experiments have demonstrated the population densities of fish which may develop when space is limited, but food is not. Other preliminary experiments have been conducted that show the extent of toxicity from dieldrin imparted to the fish from water, from food and from the two sources combined. This information has provided us with a basis for selecting experimental dieldrin concentrations in the population studies, and the sizes of aquaria to be used. Our previously reported toxicological investigations have included studies at the enzyme, whole animal, and simplified ecological levels. To provide information at the cellular levels the effects of the important industrial toxicant pentachlorophenol on tissue cultures of embryonic cells from Oncorhynchus kisutch have been studied in media containing agamma calf serum. Threshold effects are obtained with 40 mg/l of pentachlorophenol. With 80 mg/l the number of cells is reduced as is the nitrogen, fat, and dried weight of cells developing. However, the individual cells have a larger volume, and contain more nitrogen and have a higher dried weight than control cells.

SUPPORTED BY U.S. Dept. of Agriculture

4.0065, TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE

C.E. OLNEY, Univ. of Rhode Island, School of Agriculture, *Kingston, Rhode Island* 02881

There is virtually no information on the extent of environmental contamination by pesticides in the state of Rhode Island and this project is aimed at filling this gap in our knowledge.

Samples of water, sediment, and aquatic life from selected streams and ponds in the state will be collected at regular intervals and analyzed for chlorinated hydrocarbon and organic phosphate pesticides. Watersheds, both rural and urban, where pesticides have been used as well as those where chances of direct contamination are remote will be sampled.

Should biologically significant residues be found, an attempt will be made to trace the source of the pesticide.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch

4.0066, FISHERIES UNIT

R.L. APPLEGATE, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00914)

OBJECTIVE: Research various problems of fish and aquatic habitats in South Dakota.

APPROACH: Partial contribution by University to M/U between U and Cooperative Fishery Unit between U. S. Sport Fisheries and Wildlife and S. D. Department of Game, Fish, & Parks. Work program varies according to the annual agreement of the coordinating committee.

PROGRESS: This project is part of the University's contribution to the Cooperative Fishery Unit as per memorandum of agreement. Projects included: fish population of Lake Poinsett as indicated by the catch of four types of gear; food selectivity of bigmouth buffalo in Lake Poinsett; survey of chemical biocide levels in Lake Poinsett; population dynamics of Daphnia pulex in Lake Poinsett.

SUPPORTED BY South Dakota State Government

4.0067, CHEMICAL BIOCIDES IN LAKES

Y.A. GREICHUS, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00471)

OBJECTIVE: Determine the levels of chemical biocides in the ecosystem of a prairie lake (Lake Poinsett). Study the effects of these chemicals on the ecosystem of this lake.

APPROACH: Plant and animal species of the food chain of the lake fish will be collected at the inlet and outlet areas, the littoral zone, the transition zone and the settling basin zone. The species will be identified and analyzed for pesticides. The fish, also, will be analyzed for pesticides.

PROGRESS: All samples collected for this study have been analyzed and the data are now being processed. Several samples (of both sexes in most cases) of 12 species of fish were examined for 11 insecticides on both a tissue and fat basis. In addition, the water and some components of the food chain have been examined. Some work on fish-eating birds has also been undertaken.

SUPPORTED BY South Dakota State Government

4.0068, IMPROVED DISTRIBUTION AND PLACEMENT OF CONCENTRATE PESTICIDE MATERIALS

J.A. MULLINS, Univ. of Tennessee, School of Agriculture, *Knoxville, Tennessee* 37916

The Research: A concentrated team effort in research is needed to develop these promising application techniques for pest control. Engineers would develop field test equipment for specific placement of chemicals on plant parts and biological scientists would make bio-assay studies. Comprehensive evaluations would be made as to the importance of rate, distribution placement, timeliness and physical properties of a chemical on biological control. Considerable emphasis should be placed on determining drift to adjacent rows, fields and into the atmosphere.

SUPPORTED BY Cotton Incorporated - Raleigh, N.C.

4.0069, CONTROL OF FIELD BINDWEED, BLUEWEED, ETC.

A.F. WIESE, Southwestern Great Plains Ctr., *Bushland, Texas* 79012 (TEX00686)

OBJECTIVE: Develop and improve chemical and cultural practices for efficient and economical control of sub-humid perennial broadleaf weeds under a wide range of climatic and cropping conditions.

APPROACH: Determine the effect of root and foliage carbohydrate level in blueweed, bur ragweed and alkali mallow on 2,4-D toxicity; factors affecting toxicity and breakdown of TBA, PBA and fenac; the feasibility of the combined use of tillage and soil sterilants for bindweed control; and study spray drift and evaluate new herbicides.

PROGRESS: Good control of silverleaf nightshade from June to August was obtained with 2,4-D, MCP, each at 1 lb/A, picloram at 1/2 lb/A, picloram 2,4-D at 1/2 1 lb/A, and VCS 438 at 2 lb/A. Diuron and MSMA at 1 and 3 lb/A gave good control. The 6- and 9-in. stage of the weed was more susceptible to herbicides than the 3-in. or bud stage. MSMA has proven good for control of woollyleaf bursage. Woollyleaf bursage and blueweed roots were traced to 21 and 14 ft. deep. Silverleaf

nightshade roots were observed to 7-1/2 ft., but terminated at 3 ft. Bindweed roots were observed in the bottom of 8 foot holes. Woollyleaf bursage roots weighed 1800 lb/A. Blueweed roots weighed 2600 and 1380 lb/A from non-cultivated and cultivated fields. Bindweed produced about 1200 lb/A on both cultivated and non-cultivated fields. All weeds except woollyleaf bursage had about 50% of their roots in top 2 ft. of soil. Woollyleaf bursage roots were evenly distributed through the top 4 ft. of the soil profile. Bindweed roots contained 460, 270, and 120 lb/A starches, sugars, and protein. Blueweed and woollyleaf bursage had smaller amounts of stored foods. Perennial weed studies cover over 1.5 million acres.

SUPPORTED BY U.S. Dept. of Agriculture

4.0070, EFFECTIVENESS OF WATER-IN-OIL EMULSION SPRAYS FROM THE BIFLUID SYSTEM FOR WOODY PLANTS

R.H. HAAS, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01509)

OBJECTIVE: Determine the effectiveness of water-in-oil emulsion sprays from the bifluid system in controlling woody plants on rangelands and industrial rights-of-way; determine the size and distribution of droplets deposited by the bifluid system from helicopter and fixed-wing aircraft; the influence of various emulsifiers and oil:water ratios on the characteristics of water-in-oil emulsion sprays deposited from the bifluid system and their relative effectiveness for woody plant control; and the influence of emulsifiers and oil:water ratios used with the bifluid system on the absorption and translocation of herbicides by woody plants.

APPROACH: Field and laboratory studies will be established to determine the effectiveness of invert emulsions for the control of mesquite, post oak, and mixed hardwood species. Appropriate tests will be made to determine the size and distribution of droplets deposited by the bifluid system and the influence of droplet size on spray effectiveness.

PROGRESS: Data were summarized from studies with hydroxyethyl cellulose, used as a spray thickening agent. These studies show the presence of an appreciable number of large droplets in the thickened spray deposit. Spray deposit patterns with thickened sprays are more variable and droplet counts per unit area are less than those obtained with conventional sprays. Nozzle arrangements used for conventional sprays are usually not adequate for good distribution of thickened sprays with maximum drift control properties. Research from this project shows that substantial drift control can be obtained through the application of thickened spray solutions. A general characteristic of all thickened sprays is the production of a broad spectrum of droplet sizes. The very small, most driftable droplets are not eliminated from fixed-wing spray deposits, but may be substantially reduced under proper application conditions. The successful use of thickened sprays depends upon the use of correct concentrations of the thickening agents, proper nozzle design, placement and orientation. Applied under less than optimum conditions, any one of the thickened solutions can produce sprays containing considerable drift susceptible droplets.

SUPPORTED BY Texas State Government - Austin

4.0071, INVESTIGATION OF PESTICIDE DRIFT IN THE LOWER RIO GRANDE VALLEY OF TEXAS

H.A. DEAN, Lower Rio Gr. Res. & Ext. Ctr., *Weslaco, Texas* 78596 (TEX01521)

OBJECTIVE: Introduce, mass-rear and distribute beneficial insects and predaceous mites. Determine toxicity of various agricultural chemicals to beneficial and injurious insects of citrus. Evaluate beneficial insect. Investigate methods of selective chemical control. Determine pesticide levels in the atmosphere.

APPROACH: The quantity of drift will be measured under variable climatic conditions. Pests will be studied as to means of lessening their relative importance, but brown soft scale will be given priority in initial investigations.

PROGRESS: Project held open for write-up of publication on pesticide drift with Mr. W. G. Hart of Entomology Research Division as senior author. Related work on brown soft scales is being done on State Project 848.

SUPPORTED BY Texas State Government - Austin

4.0072, PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN

D.B. JOHNSTONE, Univ. of Vermont, Agricultural Experiment Sta., *Burlington, Vermont* 05401 (VT00155)

Objective: Obtain an ecological evaluation of the various types of microorganisms present in the waters of Lake Champlain. Determine the influence on microorganisms of pesticides in an aquatic environment. Determine the influence of pesticides on the number and distribution of microorganisms in an aquatic environment.

Approach: The aquatic microbial ecology in areas adjacent to the shoreline and relatively free of agricultural chemicals will be examined by standard microbiological precedures for culturing and enumerating microorganisms. This will be correlated with basic limnological data such as dissolved oxygen, temperature, etc. obtained by other investigators. Special emphasis will be placed upon those groups of bacteria that are active in organic matter decomposition such as nitrogen transformations.

Progress: Macro-environmental studies were conducted in the southern portion of Lake Champlain from Whitehall to Burlington. Bacterial populations were correlated with various limnological parameters. This data may become useful in evaluating the pollution by the paper mills as well as thermal pollution by a proposed nuclear power generating station in this area. A new device was designed and built to collect water samples aseptically at various depths. The taxonomy of certain bacteria is being studied by polyacrylamide gel electrophoresis of proteins. An investigation of the nutritional characteristics of representative yeast isolates from Lake Champlain was completed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0073, DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS

M.L. YATES, U.S. Dept. of the Interior, Geological Survey, *Arlington, Virginia* 22209

The effect of extensive use of organophosphorus pesticides on the water quality in many areas of southern Florida needs to be evaluated. Over 268,000 lbs of organophosphates were employed from July 1966 to July 1967 in Dade County alone. National Pesticide Monitoring Program includes a need to evaluate residue levels of many organophosphates in water systems, but little data has so far been produced. If a serious residue problem exists then programs to reduce or eliminate the use of certain materials may be required.

Compounds to be studied, based on amount of use in given areas, include malathion, parathion, guthion, dimethoate, delnay, ethion, tedion, and trithion. Data on the amount and types of organophosphorus residues in water, sediments and probably plant life will be obtained. Degradation and resistance studies on specific compounds will be run. Parameters such as pH, Eh, D.O. and temperature of the water environment will be included. The results will aid in evaluation of the source, transport and ultimate fate of these compounds in the hydrologic cycle. The pesticide analyses will be carried out in the laboratory using techniques of extraction, cleanup and instrumental analysis developed in conjunction with other Survey labs.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0074, HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER

F.L. TIMMONS, Battelle Memorial Institute, *Richland, Washington* 99352 (0750-09-09(C))

OBJECTIVE: Determine the presence and concentrations of selected herbicides and degradation compounds or metabolites in crops and soils irrigated with water containing known concentrations of each herbicide.

APPROACH: Acrolein and copper sulfate will each be applied to a typical irrigation canal at a known concentration and determinations of concentrations remaining in the water, suspended material, and bottom soil will be made at various

distances and time intervals after application. Acrolein, 2,4-D, silvex and two other herbicides will each be applied in three different concentrations to irrigation water which will be applied by overhead and furrow irrigation methods to corn, soybeans, and sugarbeets grown in field plots. Samples of treated water and irrigated soil will be taken at the time and one week after the irrigation. Samples of edible portions of the crops will be taken at maturity. All samples will be analyzed by appropriate methods to determine the presence and concentrations of the herbicide and of important degradation compounds or metabolites.

PROGRESS: Acrolein applied at 0.7 ppm during a period of 6 hours 20 minutes in an irrigation canal. The volume of water flow was 135 cfs and the water temperature was 48 F. Water samples taken at nine locations downstream, 1, 3, 6, 9.5, 12.5, 16, 19, 22.5, and 27 miles below the point of application during 30 hours after treatment, showed a progressive reduction in concentration of copper ion in the water from 0.710 ppm at Mile 1 to 0.269 ppm at Mile 27. The concentration was reduced more rapidly during the first 9.5 miles than during the subsequent 17.5 miles. The total dissipation of applied copper was 44.1% after 9.5 mi. and 62.6% after 27 mi. All fish in live boxes below the acrolein application were killed even at the station 27 mi. below. Volatility of acrolein according to measurements with volatilimeters showed that volatilization accounted for only a small proportion of the reduction in concentration at the unusually low temperature. In an earlier experiment conducted in a similar canal in August 1966 when the water temperature was 63-64 F losses by volatilization were 50% in the first 3 mi. and 90% in the first 10 mi. that treated water flowed down the canal.

SUPPORTED BY U.S. Dept. of Agriculture

4.0075, TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES

G.M. BOUSH, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The objectives of this project are to determine the metabolic fates of persistent chlorinated hydrocarbon insecticides, particularly DDT and dieldrin, in microorganisms isolated from the waters of Lake Michigan and associated tributaries. The study is designed to measure the biological effects of such microbial conversion of pesticides in selected aquatic environments.

The experimental approach first consists of isolating microorganisms from various locations, and then incubating the candidate radio-labeled 14C insecticides with pure cultures of the microbial isolates. When the general tendencies of the metabolic capabilities of the microorganisms have been established, efforts will then be made to study the presence of such metabolites under natural aquatic situations.

To date, a number of microorganisms have been isolated from water and lake bottom silt from Lake Michigan and related water systems. The majority of isolates convert DDT, under laboratory conditions, to DDD (TDE). Only four isolates produced DDE from DDT. Several cultures which further metabolic activities were observed from isolates obtained from the Fox River-Green Bay area.

SUPPORTED BY Wisconsin State Government - Madison

4.0076, CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER

G.F. LEE, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

The occurences of chlorinated organic contaminants in the Milwaukee River system and western Lake Michigan has been investigated. Mass spectrometric analyses have verified the presence of mixtures of chlorinated biphenyls, and semi-quantitative GLC analyses based on commercial mixtures as standards have described the relative concentrations of the chlorinated biphenyls in fish and water throughout the study area. However, the lack of suitable standards results in the inability to adequately correlate environmental data because of the many isomers which comprise the mixtures.

The proposed study is an investigation of the aqueous environmental chemistry of the chlorinated biphyenyls. The initial objective is the development of analytical conditions and standards which enable quantitative analyses of individual or groups of isomers to be made. Subsequently, the fate of the chemicals in the environment will be determined through evaluations of the relative significances of sorption on sediments and planktonic communities, and stabilities of the chlorinated biphenyls toward biological and chemical degradation.

SUPPORTED BY Connecticut State Government

B. SOIL ENVIRONMENT

4.0077, INTERACTIONS OF SOIL MICROORGANISMS AND HERBICIDES

E.A. CURL, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-05-0004)

OBJECTIVE: Study effects of atrazine, cotoran, and trifluralin on growth behavior and interactions of specific soil microorganism. Determine the role of soil microorganisms in degradation of cotoran, trifluralin, and diquat.

APPROACH: Growth-related responses of phytopathogenic fungi (Sclerotium rolfsii, Rhizoctonia solani, Fusarium vasinfectum, and others) to herbicides will be determined with regard to mycelial growth, sporulation, sclerotium production, spore and sclerotium germination, adaptation and nutrient uptake. Also effects on populations and antibiotic production by pathogen-inhibiting organisms (such as Trichoderma viride) will be studied. The interrelations of herbicides and C/N balance as affecting microbial behavior will be given special attention. For degradation studies, microorganisms found by enrichment culture to predominate and persist in herbicide-treated soil will be studied individually for utilization and breakdown of herbicides. Pathways of degradation will be studied by isotope and manometric techniques.

PROGRESS: Effects of herbicides on plant pathogens were determined in soil culture, and microbial degradation of herbicides was studied. Growth (CO_2 evolution), oxalic acid formation, and sclerotium production by Sclerotium rolfsii were inhibited by 12 ppm active atrazine in soil, this effect being greatest in soil of high C:N ratio. Saccharase and polygalacutronase activity in the soil also decreased. Growth of Trichoderma viride (antagonistic saprophyte) was stimulated but spore production delayed; stimulation was enhanced in soil of low C:N ratio. Atrazine in soil at 20-80 ppm stimulated CO_2 production by Fusarium oxysporum f. vasinfectum and increased the ratio values of C evolved/NO_3-N consumed and C/glucose consumed. Prometryne at 20 ppm in soil stimulated respiratory activity, NO_3-N uptake, and chlamydospore production by F. vasinfectum, but germination of spores was directly inhibited by increasing prometryne; this inhibition pattern fluctuated according to kind of saprophytic organisms pre-grown in the soil. The research suggests a possible relation to plant disease and biological control. In degradation studies, five microorganisms degraded diquat in C-labeled medium.

SUPPORTED BY Alabama State Government

4.0078, HERBICIDE EFFECT ON SOIL MICROORGANISMS ESPECIALLY INTERACTIONS WITH PHYTOPATHOGENIC FUNGI

E.A. CURL, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-05-0018)

OBJECTIVE: Determine concentrations of herbicides necessary to effect changes in soil microbial populations and production of fungitoxic metabolites. Determine effect of herbicides on the natural fungistatic and lytic properties of crop soils. Determine effect of selected herbicides on survival growth, and reproduction of specific phytopathogenic fungi.

APPROACH: Herbicides involved will include atrazine, trifluralin, paraquat, and EPTC. Primary phytopathogens for study will be Sclerotium rolfsii, Rhizoctonia solani, Fusarium vasinfectum and Pythium ultimum, with special tests provided for Helminthosporium spp. and Sclerotinia trifoliorum. Standard procedures will be used for testing herbicide effects on microbial populations. Direct methods of Lockwood will be employed for

fungistasis studies, and growth and survival will be studied by standard or modified manometric and enzymatic procedures.

PROGRESS: Effects of technical grade herbicides on soil fungi (primarily plant pathogens) were determined in vitro. Atrazine in nutrient solution culture, at levels of 10 ppm or more inhibited mycelial production of Rhizoctonia solani and Sclerotium rolfsii. Atrazine in sterilized soil substrate at 8 ppm caused increased CO(2) evolution by S. rolfsii. Higher levels were inhibitory. The antibiotic saprophyte, Trichoderma viride, was stimulated by atrazine. Paraquat in excess of 6.35 ppm inhibited growth of R. solani in liquid culture and S. rolfsii in soil. Trifluralin in liquid culture at 10- 100 ppm inhibited S. rolfsii but in soil at 6.25 ppm CO(2) production increased; higher levels in soil inhibited the fungus. EPTC in soil at levels above 5 ppm caused an increase in saccharase and phosphatase activity; lower levels had no effect. These effects on fungi were accompanied by similar effects on nutrient utilization and (for S. rolfsii) oxalic acid production. Trifluralin at low levels (0.6-10 ppm) enhanced chlamydospore production and germination by Fusarium oxysporum f. vasinfectum in soil. Whole microbial populations increased. EPTC, prometryne, and cotoran in soil cultures inhibited sclerotium production by S. rolfsii, while diuron and paraquat had least effect. During the course of these studies enzymatic methods were developed for assessing growth of single and mixed cultures.

SUPPORTED BY Alabama State Government

4.0079, INACTIVATION AND LOSS OF PESTICIDES FROM SOIL

A.E. HILTBOLD, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00200)

OBJECTIVE: Determine inactivation and loss of pesticides from soil by volatilization, microbial degradation, non-microbiological degradation, movement of water through or over soil, for the purpose of identifying primary loss processes, relating these processes to soil properties, and predicting pesticide persistence.

APPROACH: Relative biological and non-biological breakdown of atrazine will be determined by measurement of hydrolysis of labeled atrazine in soil samples incubated with normal microflora and in autoclaved samples of these soils. Volatilization and microbial degradation of fluometuron and trifluralin will be determined in soil samples with C labeled herbicide during incubation in controlled air streams. Field experiments will provide bioassay data on persistence of preplant applications of atrazine, trifluralin and nitralin. Analysis of field plot soils and harvested crops will provide information on movement and uptake of arsenic from methanearsonates.

PROGRESS: Processes of retention and loss of benefin (N-butyl-N- ethyl-alpha,alpha,alpha-trifluoro-2,6-dinitro-p-toluidine) were investigated. Benefin was placed at precise depth in Orangeburg, Greenville and Dothan loamy sands in the field, then soil samples were obtained at intervals during the season. During the first 2 weeks the original 20 ppm of benefin decreased to 10 ppm while the untreated soil above and below acquired 1 ppm of benefin. Despite 19" of rainfall benefin was not found deeper than 1' below its position of placement. A monodealkylated degradation product appeared in deeper soil layers late in the season. Laboratory incubation of these soils containing (C)-labeled benefin showed slow biodegradation of benefin. Increasing microbial activity with added organic matter stimulated benefin degradation. Primary loss process of benefin was found to be volatilization to the atmosphere. Leaching played little or no part except to move degradation products downward. At normal use rates for weed control in peanuts, benefin did not persist into the fall and residues in the soil were nonphytotoxic.

SUPPORTED BY U.S. Dept. of Agriculture

4.0080, INFLUENCE OF SELECTED HERBICIDES ON THE NATURAL PROCESSES OF SOIL MICROORGANISMS

P.C. KEARNEY, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (0750-08-06(GR))

OBJECTIVE: Determine the effects of several herbicides on natural fungitoxic and fungistatic properties of crop soils and the effects of herbicides on survival, growth, reproduction, population density, and kinds of specific phytopathogenic soil fungi.

APPROACH: Herbicides will be applied at rates above and below recommended rates and major groups of microorganisms will be isolated and enumerated by standard dilution procedures. Effects of herbicides on the production of substances toxic to soil-borne plant pathogens will be studied in crude soil systems and in pure cultures. The quantitative and qualitative nature of fungitoxic substances produced by individual isolates as influenced by herbicides will be sought by attempting to identify chemicals responsible for fungistatic and lytic effects, to determine the ability of phytopathogenic soil fungi and pathogen- inhibiting microorganisms to utilize as carbon sources those herbicides that interact, and determine effects of herbicides on growth.

PROGRESS: Effect of the herbicide atrazine on growth of Fusarium oxysporum f. vasinfectum was studied in liquid and soil cultures containing 0, 8, 20, 40, and 80 ug of technical grade atrazine per milliliter of medium or per gram of soil. In liquid cultures of the fungus significantly lower mycelial production occurred at the two highest concentrations of herbicide 6 days after inoculation than in other treatments. This difference was accompanied by significantly higher amounts of residual glucose, nitrate-nitrogen, and inorganic phosphate in the medium (lower utilization). Conductivity values for the liquid-culture filtrate at 6 days were highest for the 40- and 80-ug treatments. No significant differences between treatments were evidenced for any variables at the last sampling date 10 days after inoculation. Atrazine significantly increased CO(2)-carbon production in soil cultures of the fungus at concentrations of 20, 40, and 80 ug/g. This stimulation was first evident 6 days after inoculation and remained so until the last sampling 14 days after inoculation. No significant differences in nitrate-nitrogen consumed were found between soil treatments, when analyzed at 14 days. The ratio of amount of carbon evolved to nitrate-nitrogen consumed was significantly highest for the 3 highest herbicide treatments.

SUPPORTED BY U.S. Dept. of Agriculture

4.0081, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

G.R. DUTT, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2020-4151-018)

OBJECTIVE: Identify the physical-chemical properties of pesticide- soil-water systems. Develop a mathematical model which will provide semiquantitative predictions of pesticide movement in soil-water systems.

APPROACH: Carbon 14 labeled Picloram, 2,4-D, 2,4,5-T will be solubilized in aqueous solutions of different ionic composition and concentrations over a range of temperatures. Using data from other cooperation stations and the above, a system analysis model will be developed.

PROGRESS: A model for calculating the distribution and soil solution concentration of atrazine was altered to take into account the change in solubility of atrazine with solutions of electrolytes, the difference in sorption and desorption isotherms, and the change in distribution coefficient with different ratios of Na, Ca, and Mg. The data from leaching studies are being compared with theoretical results. These correlations seem to confirm that the above findings are responsible for the tailing off of breakthrough curves.

SUPPORTED BY U.S. Dept. of Agriculture

4.0082, REACTIONS OF TRIAZINE-HERBICIDES WITH SOIL COMPONENTS

G.R. DUTT, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-5901-155-844)

OBJECTIVE: Study the reactions of atrazine herbicide in calcareous soils.

APPROACH: By necessity, the approach was made to develop analytical methods for quantitative detection of atrazine in soil systems. The methods investigated included thin layer chromatography, gas liquid chromatography, colorimetry, U.V. spectroscopy and radioactive isotope techniques. The most satisfactory method involved the use of radioisotopes. Bonding mechanisms were investigated. Quantitative recovery of atrazine in aqueous soil extracts indicates a relative weak bonding. Atrazine bonding with organic matter constituents is real and important in the retention of the herbicide in soil.

4. PESTICIDES

PROGRESS: This project was supplemental to (ARIZ-9010-155-591, Accession 00001010) and was discontinued 30-06-68. The distribution coefficient was studied as a function of exchangeable ions (Ca, mg and Na). It was found that atrazine was not as strongly held by Na-soils as on Ca and Mg-soils. The solubility of atrazine was found to be a function of ionic strength. Solubility decreases as ionic strength increases. It was found that sorption isotherms are different than desorption isotherms. This seems to explain why there is a tailing off in breakthrough and elution curves.

SUPPORTED BY Arizona State Government

4.0083, RESIDUES OF SELECTED PESTICIDES - NATURE, DISTRIBUTION, PERSISTENCE IN PLANTS, ANIMALS & PHYSICAL ENVIRONMENTS

G.W. WARE, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2020-4161-014)

OBJECTIVE: Metabolism of pesticide residues by animals and plants. Study metabolism and excretion of pesticide residues in mammals, certain invertebrates and in higher plants. Develop specific quantitative methods of analysis to measure metabolites in animal and plant tissues.

APPROACH: Expose test animals to pesticides by standard dosing techniques or through the feed and other routes when appropriate. Excretion and deposition of the pesticide will be followed by using chemical methods or radio-labeled compounds. Pesticide metabolism by animals and plants will be through a search for metabolites using chromatrographic, radiorespimetric, autoradiographic, and other approaches applied to subcellular preparations or the living organism.

PROGRESS: The metabolic pathways of endosulfan I and II, diol, lactone and alpha-hydroxy ether have been explored in sufficient detail in the rat to explain their general routes and breakdown products. Three routes of alfalfa exposure to C -DDT contaminated soil, (1) an emulsion injected around the roots, (2) seed germination and growth in treated soil, and (3) plants surrounded by a layer of treated soil, indicate that DDT translocation from soil to above-ground plant parts is not a route of forage contamination. The half-lives of DDT, DDD and endrin in irrigated soils are estimated to be 24, 20 and 16 months, respectively. Under desert or uncultivated conditions the half-lives are DDT 26 months, DDD 13 months and endrin 10 months.

SUPPORTED BY U.S. Dept. of Agriculture

4.0084, INACTIVATION AND LOSS OF PESTICIDES FROM SOIL

R.E. TALBERT, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00633)

OBJECTIVE: Determine inactivation and loss of herbicides from soil by volatilization, retention and release, and movement of water through soil for the purpose of identifying primary loss processes, relating these processes to soil properties, and predicting herbicide persistence.

APPROACH: The physical-chemical aspects of selected herbicides with respect to their inactivation and loss from soils will be studied; Volatility under controlled laboratory conditions utilizing vapor trapping devices to trap samples for chemical and biological analysis, retention and release using adsorption isotherms and diffusion methods, and movement using soil column techniques.

PROGRESS: The behavior of nitralin and trifluralin in soils was studied. In a field study, the two compounds were similar in residual activity as indicated by bioassay. Approximately one-half of the activity had dissipated after 42 days and three-fourths had dissipated by 172 days. Surface application had dissipated by 42 days. Persistence was greater from 2- and 4-inch incorporation than from 1- inch incorporation. After 1 year, significant activity from both compounds was detected where 2 lb/A had been applied. Where plastic shelters were used to protect plots during periods of rainfall, surface applications of nitralin showed no significant loss in activity during a 22-day period. The use of soil amendments to inactivate trifluralin and nitralin was studied. Powdered activated carbon was approximately 100 times more effective than wheat straw, and wheat straw was approximately 10 times more effective than cotton stalks. In comparing various grades of activated carbons, 3- to 4-fold differences in their efficiency were noted, however, it was difficult to make associations of inactivation efficiency with any property of the carbon. With Darco GFP, 0.177 ppmw nitralin or 0.174 ppmw trifluralin were inactivated by each additional 100 ppmw of carbon added. In other studies, the use of dinoseb to inhibit the microbiological hydrolysis of ester derivatives of amiben was demonstrated.

SUPPORTED BY U.S. Dept. of Agriculture

4.0085, MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS

J.P. MARTIN, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (SWC-024-BELT-12)

OBJECTIVE: Determine the method of movement of chlorinated hydrocarbon insecticides in soils and evaluate the influence of soil properties, temperature, humidity, and soil-water content on movement, particularly vapor-phase movement, and volatilization losses into the atmosphere.

APPROACH: Laboratory experiments will be conducted to evaluate the influence of various soil and environmental factors on movement and volatilization of chlorinated hydrocarbon insecticides. Commonly used insecticides such as DDT, lindane, dieldrin, aldrin, etc., will be added to soils typical of Southwestern semi-arid areas. Rate of movement from a treated to an untreated portion of the soil will be used to calculate diffusion coefficients and predict movement under various field conditions including losses to the atmosphere by volatilization which would occur after application of insecticides in the field.

PROGRESS: A theory was developed to describe the combined vapor and nonvapor' phase diffusion of a volatile insecticide in soils and compared with the diffusion of lindane in a Gile silt loam. At a 10% soil-water content, 50% of the lindane diffuses in the vapor phase and 50% in the'nonvapor' phase. At near saturation, total diffusion is in the 'nonvapor' phase. The diffusion coefficient for lindane in a Gila silt loam is nearly zero at 1% soil-water content and increases rapidly to a maximal value at 3% water content. Decreasing bulk density or increasing temperature raises the diffusion coefficient. The influence of soil-water content, relative humidity, air flow rate and insecticide concentration on the volatility of lindane from soil surfaces is being determined. The influence of soil type on lindane diffusion is being measured. All of the above information will be combined to predict the fate of pesticide residues in soils.

SUPPORTED BY U.S. Dept. of Agriculture

4.0086, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

J.W. BIGGAR, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D0-WSE-2298-RR)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to pesticide transport through the soil in infiltrating water, and pesticide desorption from eroded soil into surface waters. Measure pesticide transport through and over soil in the field or in lysimeters, using well characterized initial and boundary conditions.

APPROACH: The thermodynamics of soil pesticide interactions in water will be studied using equilibrium techniques and radioactive pesticides. The kinetic studies will involve dynamic systems both of a steady state and transient nature. Field investigations involve pesticide movement in well defined plots in which water and pesticide movement are monitored over periods of weeks. In some cases, overland flow may be examined in selected watershed areas. The investigators cooperating on this objective will work closely with those developing models to assure the maximum usefulness of field data. California will be making field measurements with the carboxylic acid herbicides on the soils.

PROGRESS: Work has been extended and now completed on the persistence and recovery of four chlorinated hydrocarbons from five California soils involving six extraction methods which include 12 solvent or combinations of solvents. Hexane 2-propanal (1:1) appeared to give the best all-around extraction.

Pesticide loss appeared to follow a first-order reaction. The Hi-ester-Vermuelen rate model for the displacement and removal of pesticides is being examined as a possible useful predictive model for pesticide behavior. Calorimetric results of last year were reexamined and found to be essentially the same with important differences between the Ca and Na-illite systems. Solubility measurements on six organo-phosphate pesticides at 15, 25, and 35 C. have been completed for ionic solution concentrations of 0.01 and 0.05N CaCl(2) and NaCl.

SUPPORTED BY U.S. Dept. of Agriculture

4.0087, RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT
F.A. GUNTHER, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2296-RR)

OBJECTIVE: Establish, evaluate, and integrate the physical fates of selected pesticide chemicals in soils, soil water, root crops, and small aquatic organisms that are involved in food chains; develop necessary analytical methodology for these measurements and characterizations.

APPROACH: Selected currently important pesticide chemicals will be studied by physical-chemical and biochemical methods in 50 soil types in both field and laboratory in terms of sorption kinetics, effects of microorganisms, light, temperature, aeration; or leachability by water; or migration to root crops via soil water suspensions, and their acquisition from soil water suspensions by algae, small shrimp, small fishes, and amphibians.

PROGRESS: The persistence of the herbicide Planavin in different soil types was studied under aerobic and anaerobic conditions. The herbicide was lost rapidly from submerged Hanford sandy loam soil but very slowly from other soil types. Several degradation products have been detected and efforts to identify them are in progress. Irradiation with ultraviolet light yielded two major photodecompositon products that have been isolated but not yet characterized. The decomposition of endrin on 10 different air-dried soils was studied and found to vary widely from soil to soil although quite rapid in all types. The addition of water to moisten the soil prevented the decomposition during the period of the study (96 hours). Carbon-skeleton gas chromatography of DDT and some Aroclors (polychlorinated biphenyls, triphenyls, or mixtures of these) was investigated as a means of differentiating between p,p'-DDT and the Aroclors. The dissimilarity in responses was striking and the procedure offers a simple and reliable means for removing the doubts that arise in many instances where DDT is indicated by gas chromatographic responses, yet there is reason to doubt its presence. The Schechter-Haller colorimetric test was also compared for DDT and the Aroclors. At the wavelength normally used for determining DDT, interference by Aroclors was negligible. This reaction, therefore, affords a reliable supplementary test for the presence of DDT.

SUPPORTED BY U.S. Dept. of Agriculture

4.0088, REACTIONS OF PESTICIDES WITH SOILS
J.P. MARTIN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2406)

OBJECTIVE: Study the incorporation of pesticides into the stable soil humus; the mechanisms of the occasional temporary toxic effects of pesticide in soil; the mechanisms of pesticide absorption and desorption by soil constituents; mechanisms of increases in soluble or extractable inorganic ions in soil following pesticide applications; absorption, transportation, and accumulation of selected pesticides in plants and the influence on plant growth and metabolic functions, and the influence of soil exchangeable cation ratios and metal salts of selected pesticides on decomposition in soil.

APPROACH: The work will involve plant culture in soils and nutrient solutions in the greenhouse and in growth chambers, and soil treatment and incubation in the laboratory. In addition to the usual analytical procedures, gas chromatographic, carbon 14 analysis with a liquid scintillation counter, and infra-red techniques will be used.

PROGRESS: Studies of lindane diffusion at various moisture contents and ambient pressures revealed that diffusion occurred along four major pathways: air-space, air-water interface, water-water pathway, and water-solid interface. The vapor and water-water pathway components were readily described by normal gaseous equations, and ion diffusion equations, respectively. The quantity diffusing along the air-water interface was proportional to the area of the air-water interface. Volatilization loss of dieldrin from Gila silt loam increased with increasing concentration, air flow rate, relative humidity, soil water content, and temperature. Losses ranged from 4mg/cm/day up to 600mg/cm/day. Maximum dieldrin loss occurred at 100% relative humidity when no water loss was occurring from the soil. Thus water loss is not necessary for dieldrin volatility to occur. The ratio of DDT:dieldrin:lindane loss was 1:5:17 for both 5 and 10 ppm at 30C. The volatility results indicate that potential insecticide losses under field conditions due to volatilization may account for a significant proportion of the total loss. Methods of reducing DDT levels in contaminated agricultural fields are under investigation. In one case, deep plowing to 24 inches has been used to dilute the insecticide and to remove it from the root zone. Soil and crop samples are being analyzed as a measure of the method's effectiveness.

SUPPORTED BY California State Government - Sacramento

4.0089, FATE AND EFFICACY OF SOIL FUNGICIDES
D.E. MUNNECKE, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2086)

OBJECTIVE: Fate of fungicides in soil; factors influencing effectiveness of soil fungicides in controlling plant diseases; nature of fungicide detoxification in soil and effects of various breakdown products on fungi and plants.

APPROACH: Laboratory studies will be made on nature of breakdown products of fungicides in soil. Use will be made of existing equipment such as ultra violet and infrared spectrophotometers, chromatographic techniques, and other specialized apparatus. A constant temperature growth chamber has been built to provide controlled growing conditions. Occasionally, experiments will be conducted in greenhouses and in field.

PROGRESS: U.C. mix infested either with Pythium ultimum or Rhizoctonia solani was fumigated with 600, 1200, or 2300 ppm methyl bromide gas to measure the effects of varying soil moisture on the effectiveness of the fumigant in controlling damping-off of peas. With Pythium best control was obtained in moderately moist soil (12% water), next in the very wet (37%), and least in the very dry (12%) soil. Exposures for 1 day at all 3 concentrations were mostly ineffective. This ineffectiveness carried on into the 2 day exposures for doses of 600 and 1200 ppm, but not for doses of 2300 ppm. After exposures of 5 or 8 days, very steep dosage response curves were obtained, perhaps indicating extreme susceptibility of Pythium to methyl bromide. The control of Pythium in dry (2%) soil was poor. Probably a dose of 18,000 ppm applied for 8 days would reduce damping-off to only 5%. The response of Rhizoctonia was similar. Best control was found in soil containing 10% moisture, slightly better control was obtained in the very dry soil and least was observed in the very wet soil.

SUPPORTED BY California State Government - Sacramento

4.0090, REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST
W.F. SPENCER, Univ. of California, U.S.D.A. Soil & Wa. Cons. Div., *Riverside, California* 92507 (SWC-024-GRI-3)

OBJECTIVE: Determine the magnitude and method of chlorinated hydrocarbon insecticides in soils and to evaluate the influence of soil properties, temperature, humidity, and soil-water content on movement, particularly vapor-phase movement, and volatilization losses into the atmosphere.

APPROACH: Laboratory experiments will be conducted to ascertain the physical and chemical properties of chlorinated hydrocarbon insecticides and other pesticide materials, and evaluate the influence of various soil factors affecting their interactions with soils and waters. Commonly used pesticides will be applied under controlled conditions to semiarid soils. Predictions will be developed from measuring movement, volatilization losses, magnitude of absorption and breakdown products under controlled environmental conditions. Movement, redistribution,

and volatilization of pesticides will be evaluated under actual field conditions to verify these predictions.

PROGRESS: Relationship between soil properties and vapor density of soil applied dieldrin indicated that vapor densities were inversely related to the soil organic matter content, both in wet and dry soils. Ten ppm dieldrin was required to produce a saturated vapor in a soil containing 67% clay. This indicates that clay plays only a minor role in absorption of such weakly polar compounds when sufficient water is present to cover the mineral surface. Vapor-phase desorption isotherms relating soil lindane concentration to relative vapor density were similar to isotherms relating soil lindane concentration to the solution concentration. Dieldrin volatilization was not affected by fluctuating the pressure of the gas flowing over the soil surface. Volatulization rate over a 29-day period indicated that rate of loss was initially dependent on vapor density at the soil surface but rapidly became a diffusion controlled process. Soil samples taken at various depths in plots treated with dieldrin and lindane indicated that lindane moved and disappeared from the soil much more rapidly than dieldrin. Concentration gradients at the surface of irrigated plots indicated that dieldrin and lindane were lost by volatilization from the surface. Lindane was probably also lost by decomposition.

SUPPORTED BY U.S. Dept. of Agriculture

4.0091, INTERACTION OF TEMPERATURE WITH OTHER FACTORS ON RESPONSE OF CANADA THISTLE TO HERBICIDES

J.L. FULTS, Colorado State University, School of Natural Sciences, *Fort Collins, Colorado* 80521 (COL00216)

OBJECTIVE: Determine the relationship of temperature to the action of herbicides as influenced by external factors such as light, moisture, nutrients, the physical and chemical properties of herbicides, and adjuvants; the relationship of temperature to the action of herbicides as it interacts with internal factors such as cellular metabolites and cellular particulates at the tissue and cellular level.

APPROACH: Three selected clones of Canada thistle will be used as basic research material for experimentation by all participating states. Will determine the overall response of resistant and susceptible strains of Canada thistle using temperature x light quality and intensity combinations in growth chambers.

PROGRESS: General difficulties have been encountered in culturing thistle. Other test plants have been used. In a study of pyrazon and its herbicidal residues in the soil it was found that under growth chamber conditions, soil temperatures at 3 and 6 inch depths parallel ambient air temperatures; soil temperatures in the field at the same depths while showing diurnal variations change much more slowly than those in pots in a growth chamber. Under cool moist conditions (17 C) successive plantings of beets in pyrazon treated soil did not result in toxicity but under warm moist conditions (25 C) successive plantings resulted in greatly increased toxicity. Successive plantings of mustard into steamed and raw soil maintained at favorable conditions for plant growth, good aeration and at a favorable moisture level, indicated no evident change in the rate of degradation of pyrazon in either raw or steamed soil up to 3 months. But after 4-1/2 months remarkable differences appeared. In the raw soil pyrazon toxicity disappeared but toxicity persisted in the steamed soil. In a study of dicamba and picloram behavior in soil both proved to be more active in the liquid phase than in the vapor phase. Probably the most important physical characteristic in 15 Colorado soils associated with toxicity of these soil-applied chemicals is organic matter content. Both chemicals are detoxified more rapidly under high than under low temperatures in soil, dicamba detoxifying much more rapidly than picloram when both are originally present at equitoxic concentrations. Dicamba follows a first order rate of dissipation.

SUPPORTED BY U.S. Dept. of Agriculture

4.0092, INSECTICIDE DECONTAMINATION OF COLORADO SOILS BY UTILIZATION OF ANIMAL WASTES

R.E. JOHNSON, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00012)

OBJECTIVE: Examine animal wastes as energy for and source of microorganisms for biodepredation of chlorinated hydrocarbon insecticides in soil.

APPROACH: Chlorinated hydrocarbon insecticides will be added to insecticide-free soil in Erlenmeyer flasks in measured amounts. To these flasks will be added samples of manure and sewage sludge and the flasks stored for various periods of time at the end of which they will be analysed for insecticide content. From samples found low in insecticide, microorganisms will be isolated and multiplied in both and insecticides added, the broth incubated for 96 hours, and then analysed for insecticide content.

PROGRESS: Preliminary studies used a Colorado loam soil treated with 200 ug p,p'0DDT and incubated at various dose levels with cattle manure for periods of 1 week, 1 month and 2 months at two moisture levels, saturated and unsaturated. DDT was converted primarily to TDE with an excellent correlation between amount of manure added and conversion to TDE. With no manure and at the lowest manure rate, there was a negligible to low conversion, respectively. The other levels showed no parent DDT remaining. Moisture level was important only at the low manure level where the saturated condition accelerated the degradation of DDT. At the high manure level for all periods all the DDT was degraded. Several unknown metabolites were found and need to be identified.

SUPPORTED BY U.S. Dept. of Agriculture

4.0093, CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION

F.G. VIETS, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Fort Collins, Colorado* 87101 (SWC-024-DFC-6)

OBJECTIVE: Determine the effects of soil type, temperature, organic matter, pH, aeration, and water content on the persistence, absorption, and movement of chlorinated pesticides in the soil-water system and on plant growth for the development of better systems of soil and water management and decontamination for the Northern Plains.

APPROACH: Chlorinated pesticides are added to natural and amended soils, clay minerals, and soil organic fractions with variables of pH, water content and movement, oxygen supply and other conditions and the absorption, rate of loss, degradation products, and movement under leaching conditions measured by chemical techniques. Mechanisms and rates of volatilization and effects on soil metabolism are measured. Soil and water samples from experimentally treated plots, watersheds and fields are analyzed for accumulation and rates of loss of pesticides.

PROGRESS: Evidence obtained to support earlier findings that adsorption of DDT is strongly influenced by positively charged particles. DDT which remained in the aqueous phase of sedimented soil- DDT systems was directly proportional to the amount of soluble and colloidal soil organic matter which resulted from sedimented soil. Various phenolic compounds which are water-soluble components of soil organic matter, significantly increased solution phase DDT when concentrations 0.1 mug of the phenolic compounds per ml. of water existed. Under aerobic conditions in a lab. study, rate of DDT conversion to DDE was greater at 50 C. than at 30 C. Soluble iron addition had no effect. After 140 days, the amount of DDE resulting from DDT degradation was 7.5 times greater at 50 C. than at 30 C. DDT was converted to DDD in anaerobic soil (submerged). Iron addition had no effect on the conversion process. After 10 days, about half the DDT was degraded at 30 C. and about 90% of DDT was degraded at 50 C. In a field study, no effect of soil mixing or added alfalfa observed in disappearance of dieldrin, endrin, DDD, and DDT from the top 8 cm. of soil during 22 weeks of treatment. Under same conditions, concentration of lindane and heptachlor decreased with time, and more pesticide was lost from soil receiving mixing treatment than from nonmixed soil.

SUPPORTED BY U.S. Dept. of Agriculture

4.0094, MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS

R.S. MANSELL, Univ. of Florida, School of Agriculture, *Gainesville, Florida* 32601

The objective is to determine the influence of soil and carrier solution properties on adsorption, dispersion coefficient and rate of movement of pesticides, detergent surfactants, hydrophobic surfactants and tritiated water in sterilized soil columns at various degrees of saturation and flux.

Soils sterilized by gamma radiation will be set up in columns (10 cm cube, sides enclosed with acrylic plastic) for miscible displacement of tritiated water and radioisotope-tagged pesticides and surfactants. Inflow and outflow will be through porous fritted-glass plates in contact with the top and bottom of soil columns. Filtered gas, under variable pressure, will be admitted through the sides of the container to establish the desired degrees of unsaturation. A Sigmamotor pump will control flux of solutions having different surface tensions.

A flow cell in connection with a three-channel analyzer for beta spectrometry will form a liquid radiochromatography system for the nondestructive detection, analysis and recording of the radioactive chemicals eluting from the soil column.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0095, THE DISPOSITION OF PESTICIDES IN THE SOIL
D.R. ROTHWELL, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-SL-01317)

OBJECTIVE: Determine the physical, chemical, and biological processes, and soil characteristics which are important in the disposition of pesticides in soils.

APPROACH: Emphasis will be on the determination of the effect of pesticides on the growth of soil organisms and their metabolic processes and the effect of soil organisms on the degradation of pesticides. Soils with widely varying properties will be selected and treated with pesticides. Relative number of bacteria, fungi, actinomycetes, algae and nematodes will be determines by dilution techniques. Untreated soils and soils previously treated with pesticides will have known quantities of the same pesticide added to them. The relative rates of disappearance of the chemicals will be followed.

PROGRESS: Several kinds of pesticides are used regularly on shade tobacco throughout the growing season. These pesticides enter the soil either by direct application or as residue from foliage applications. Combinations of these pesticides may affect microbial activity in the soil. Persistence of the pesticides may also be affected. The chemical compounds Zineb, DDT, Parathion, and Furadan have been selected for evaluation singly and in combination. Application rates will be 1.3, 2.0, 0.2, and 10 lbs. per acre, respectively, of the active ingredient applied in 12 weekly applications. The soils will be sampled at 2 week intervals. A randomized block design will be used. These investigations will be conducted under field and greenhouse conditions. Data are not yet available.

SUPPORTED BY U.S. Dept. of Agriculture

4.0096, PRELIMINARY EXPLORATORY CITRUS RESEARCH AT CITRUS EXPERIMENT STATION
J. HERMAN, Citrus Agricultural Expt. Sta., *Lake Alfred, Florida* 33850 (FLA-CS-00001)

OBJECTIVE: Investigate new problems in the citrus industry.

APPROACH: Preliminary surveys, exploratory investigations, and short-term trials will be conducted on citrus industry problems.

PROGRESS: Blight, a tree decline of unknown cause, became much more prevalent in 1967 and 1968. Intensified research to establish the cause failed to associate Blight with bud-transmissible virus disease, fertilizer program, soil salinity, fungi, or nematodes. A severe tree decline peculiar to the Murcott mandarin variety was attributed to an unusual stionic effect whereby the rough lemon rootstock was relatively ineffective in supplying heavy Murcott crops with adequate N and K. Increased N and K fertilization is indicated as a corrective. Residues of Temik systemic pesticide applied to the soil were present to a depth of over 3 feet for at least 31 weeks after application. Maximum concentration of Temik in fruit occurred about 33 weeks after application. Quantitative methods for determination of some carotenoids in peel of citrus fruits were worked out. NAA successfully thinned tangerines in preliminary work.

SUPPORTED BY Florida State Government - Tallahassee

4.0097, DEVELOPMENT OF IMPROVED PRINCIPLES AND CHEMICAL AND COMBINATION METHODS FOR CONTROLLING WEEDS IN COTTON ON COARSE TEXTURED SOILS
E. ELSNEP, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601

Problem & Need: Much of the cotton in the Southeast and some in other parts of the Belt is grown on deep sandy loams, loamy sands, and sands. Because of their low clay content and, oftentimes, low organic matter - the latter being especially true under well drained conditions - these soils have rather low capacities to absorb and retain chemicals such as herbicides. Also, they are often rather deep porous soils which, coupled with high rainfall, makes them subject to rapid leaching of applied chemicals. In addition, these conditions enhance losses in herbicide efficiency through volatilization and photodecomposition.

Presently there is not an efficient and safe chemical practice for controlling weeds in cotton on deep, coarse soils.

The Research: Studies should be undertaken to develop and evaluate preplanting, preemergence, and postemergence chemical weed control practices for cotton in deep, coarse-textured soils, especially those under high rainfall conditions. Special attention should be given to (1) weed control requirements based on ecological, cultural, edaphic and climatic conditions, (2) the use of new forms and formulations such as slow-release type materials, (3) integration of herbicides with other production practices, and (4) the interactive roles of other soil applied pesticides as they affect the behavior of herbicides in coarse soils. Special attention will be required on various aspects of soil behavior of herbicides including adsorption by clay fractions, leaching movements, microbial breakdown, etc.

SUPPORTED BY Cotton Incorporated - Raleigh, N.C.

4.0098, THE DISPOSITION OF PESTICIDES IN THE SOIL
J.E. GIDDENS, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO00382)

OBJECTIVE: Determine the distribution of pesticides in selected soils and their drainage waters using sites to which known amounts of pesticides have been applied. Determine the physical, chemical and biological processes, and soil characteristics which are important in the disposition of pesticides in soils.

APPROACH: By soil perfusion and other techniques, breakdown rate of herbicides as influenced by soil properties and enriched microorganisms will be determined. Herbicidal effect upon rhizosphere organisms and effect of rhizosphere organism on herbicides will be determined. Specific root infecting fungi will be inoculated into the root zone in presence and absence of herbicides and their behaviour studied. Herbicidal effects upon soil processes as nitrification, N- fixation, and S-transformations will be studied.

PROGRESS: Trifluralin volatilization rate was high from moist soils but low from dry soils. Application of water to soil at different bars indicated high trifluralin loss from soil when moisture approached field capacity. Moisture application prior to trifluralin application resulted in greater herbicides volatilization than when herbicide was applied to dry soil then wetted. Further work continued to show the mitotic effect of trifluralin on plants but no effect on oxidative phosphorylations.

SUPPORTED BY U.S. Dept. of Agriculture

4.0099, DISPOSITION OF PESTICIDES IN THE SOIL
R.M. HARRISON, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO00195)

OBJECTIVE: Determine the distribution of pesticides in selected soils and their drainage waters, using sites to which known amounts of pesticides have been applied. Determine the physical, chemical, and biological processes, and soil characteristics which are important in the disposition of pesticides in soils.

APPROACH: The distribution of selected pesticides will be determined by applying them to small, level, fallow, plots located

on undisturbed profiles of differing soils of the Georgia Piedmont. Plots will be enclosed to retain rain which falls on a given plot and to prevent pesticide movement from plot to plot. At intervals, the profiles will be sampled to as much as five feet. Studies will later be extended to cropped soils. The pesticidal effect on mineralization and nitrification in unfertilized samples and in samples fertilized with an ammoniacal source, will be studied in the laboratory.

PROGRESS: Soil samples taken from a two year field study previously described have been analyzed by gas chromatography for trifluralin, Aldrin, and Endrin. No downward profile movement of the three pesticides below a 6 inch depth was found in the well drained Cecil soil site and the imperfectly drained Iradell soil. Trifluralin was previously shown to be absent after 10 months. Over 50 percent of Aldrin and Endrin remained in the soil over the two year period. A major portion of Aldrin was degraded into dieldrin and Endrin was partially altered into a compound not identified. Additional research has not been undertaken as the project has been terminated. A technical paper on the soil extraction of trifluralin is being reviewed for publication and a second paper on the field research is presently being written.

SUPPORTED BY U.S. Dept. of Agriculture

4.0100, PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT

A.W. WHITE, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Watkinsville, Georgia* 30677 (SWC-024-BAW-03)

OBJECTIVE: Determine the important pathways of pesticide loss from soils and waters, including the magnitude of losses by runoff and erosion, volatilization, and decomposition; determine the mechanisms involved and conditions that influence pesticide persistence and losses from soils and waters; and develop methods and field practices for minimizing the polluting effects of pesticides on soil and water resources.

APPROACH: The extent and mechanism of pesticide losses from soils and waters by various pathways will be determined in field and laboratory experiments. Movement of pesticides over and through the soil will be evaluated under natural and artificial rainfall conditions. Environmental conditions and soil factors that influence persistence and loss of pesticides from soils and waters will be determined. The effect of management systems on soil and water quality will be evaluated and new systems will be developed for minimizing the polluting effects of pesticides on soil and water quality.

PROGRESS: Results from 96-day oven incubation studies showed that the chlorinated insecticides lindane and dieldrin disappeared from Cecil soil at appreciable rates under warm dry conditions. The half-life values for 0.5 to 5.0 ppm lindane in dry Cecil sandy loam at 45 and 65 were 50 and 13 days, respectively. Under the same conditions dieldrin was approximately ten times more persistent than lindane. The observed disappearances followed first- and second-order rates, and equations were derived for estimating lindane and dieldrin persistence in soil with time at 45 and 65 . At room temperature no loss of either pesticide was measured. It appears that a significant part of the lindane and dieldrin disappearance in warm dry soils observed in these experiments may be due to catalytic degradation. Significant degradation was found at 45 and 65 in the case of lindane as evidenced by the appearance of pentachlorocyclohexene, a reported lindane degradation product. Further evidence of lindane degradation was indicated by the release of significant levels of chlorides in warm dry soils and clays. Degradation was retarded by small amounts of moisture and by organic matter, and was enhanced by the presence of free ion oxides.

SUPPORTED BY U.S. Dept. of Agriculture

4.0101, HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL

R.E. GREEN, Univ. of Hawaii, Agricultural Experiment Sta., *Honolulu, Hawaii* 96822 (HAW00127)

OBJECTIVE: Relate the adsorption and desorption of organic herbicides to the chemical and physical properties of Hawaiian soil. Determine the importance of microbial degradation of herbicides. Determine the effect of soil pore-size distribution and associated soil- water relations on herbicides equilibria in soils and absorption by plant roots.

APPROACH: Adsorption will be characterized by measurement of herbicide adsorption on soils or soil separates from aqueous solution of the herbicide. An attempt will be made to identify the 'active' fraction of the organic matter or the clay-organic complex and to measure the partition coefficient of this fraction. In the field, particular attention will be given to the longevity of weed control in sugarcane at various rates of s-triazine herbicides. In the laboratory, C tagged herbicides (primarily s-triazine compounds) will be used to study (a) gross degradation of herbicides, and the nature of degradation deaminization, in relation to the availability of energy sources (including plant roots) and water.

PROGRESS: Simazine and atrazine hydrolyzed faster than ametryne and G.S.-14254 (sumatol) at any given pH in four Hawaiian soils. The rate of hydrolysis of triazines was inversely related to the soil pH. The magnitude of the pH-effect was highly dependent on soil organic matter content. The catalysing effect of soil on hydrolysis was quantified by calculations based on dividing the process into two steps -- protonation (pH-dependent) and hydrolysis of the protonated species (temperature dependent). Adsorption on charcoal decreased the rate of hydrolysis while soil organic matter accelerated hydrolysis, an important consideration on sugar cane soils having relatively high quantities of charcoal from cane burning. Adjustment of soil pH by liming may provide a means of manipulating triazine response on some soils. Atrazine was detoxified in soil both by chemical hydrolysis and by microbial removal of the ethyl-chain. The hydrolysis product (hydroxyatrazine) was metabolized, with subsequent evolution of CO(2); the dealkylated chloro-triazine is thought to be persistent. Complete biological breakdown of atrazine to CO(2) must be preceded by chemical hydrolysis at the 2-position. Thus, plant species or soils that bring about rapid hydrolysis at the 2-position will accelerate ring cleavage, i.e. total triazine degradation.

SUPPORTED BY U.S. Dept. of Agriculture

4.0102, SOILS, PESTICIDES AND THE QUALITY OF WATER

G.C. LEWIS, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00516)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to pesticide transport through the soil in infiltrating water, and pesticide desorption from eroded soil into surface water. Identify the principal degradation products and determine the mechanisms and kinetics of pesticide transformations in soil-water systems.

APPROACH: Adsorption-desorption equilibria of organophosphate pesticides in relation to the chemical properties of soils will be studied. The effect of various soil constituents on the degradation of the pesticides will be investigated. Decomposition studies will be carried out in sterile and non-sterile soil systems; degradation rates and end products will be determined.

PROGRESS: The adsorption isotherm of Di-Syston onto a southern Idaho soil (Portneuf Silt Loam) was determined. An S-shaped isotherm was obtained. A gas chromatographic technique was developed to separate and detect Di-Syston and its related compounds. Di-Syston Di-Syston, Di-Syston sulfone, and Systox (both isomers) were separated and detected at one temperature setting, while Di-Syston sulfoxide, Systox sulfoxide (both isomers), monoethyl phosphate, and diethyl phosphate were separated and detected at a different temperature setting. With the development of separation techniques it was possible to follow the rate of degradation of Di-Syston and its metabolites in the soil and determine whether degradation products of significance were formed. The degradation of the Di-Syston in the Portneuf soil was found to follow first-order kinetics and 50% of the added amount was degraded in 6.5 days under the conditions of optimum moisture and temperature. The most notable metabolites were Di-Syston sulfone and sulfoxide. The sulfone persisted for over 69 days while the parent Di-Syston was negligible after about 32 days. This indicated that the breakdown of Di-Syston sulfone was probably the rate limiting step in the conversion of Di- Syston to nontoxic products. The presence and persistence of the sulfone may be quite significant as the sulfone is probably more toxic than its parent compound, Di-Syston. Thus, the total toxicity may not have decreased in direct proportion to Di-Syston disappearance.

SUPPORTED BY U.S. Dept. of Agriculture

4.0103, WEED CONTROL ON THE NON-IRRIGATED LANDS OF IDAHO

C.I. SEELY, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00131)

OBJECTIVE: Devise effective and inexpensive means of eradicating or controlling weeds; Determine the effectiveness of cultural practices, cropping systems, competing crops and additions of commercial fertilizers on the control of weeds; the effects of various chemicals applied under varying conditions and at different rates. Evaluate new methods and materials for weed control; Study the effects of cultural and cropping, cultural and chemical, and cropping and chemical methods on control and time required to effect control or eradication. Determine the effects of the above on the soil, and study the biology of weeds including the storage of root reserves, methods of dissemination, development of seedlings and the destruction of seed in the soil.

APPROACH: The work will use field plots and selected fields infested with important weeds. Preliminary work on new methods and materials will be done in the laboratory and greenhouse before application to field plots. Laboratory and greenhouse tests will be applied in the evaluation of the effects of the treatments on the soil.

PROGRESS: The 1969 season was relatively unfavorable for winter wheat but there was still 300,000 acres treated with diuron and other residual herbicides with an increase of about 8 bu. per acre over 2,4-D applications. Maloran, another substituted urea, shows promise of being an equally good herbicide with greater safety to the wheat. Twelve annual applications of 1 pound of diuron per acre has not shown any residual build up in the soil. Even a 2 pound rate has shown little if any residual chemical present. Applications of diuron to the 1969 Austrian winter pea crop gave good weed control and increased yields by about 25 percent (600 pounds per acre). Tests of corn spurry seed in the soil have shown that after 10 years of cropping without weed seed production, slightly more than 98 percent of the weed had been eliminated. In a wheat-pea rotation of the control of wild oats increases the number of broadleaved annuals present but that the reverse is not true. For maximum production of wheat both wild oats and broadleaved weeds must be controlled in the preceding pea crop as well as the current crop.

SUPPORTED BY Idaho State Government

4.0104, ANNUAL WEED CONTROL IN ROW CROPS

P.J. TORELL, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00526)

OBJECTIVE: Investigate the use of mid-summer fallow treatments as a means to reduce the annual weed seed population in the soil prior to the production of an onion crop. Study the influence of preemergence and postemergence herbicides registered for use in onions on the annual weed population that survives a mid-summer fallow, the influence of preemergence herbicide treatments on the control of annual weed in onion seed crops with special reference to layby weed control; the influence of peemergence herbicide treatments on the control of annual weeds in hybrid sweet corn crops.

APPROACH: The work will be conducted along two lines:For each crop investigations will be conducted to determine the most effective herbicides, rate, time, and method of application for annual weed control. Second, the fate of annual weed seed populations in the soil as influenced by a mid-summer fallow in the year preceding the row crops in question will be studied.

PROGRESS: Some 95 percent of the nation's sweet corn seed is grown in southwestern Idaho. Thus the crop occupies a relatively large acreage and it is important to the economy of the area. Labor costs make control of weeds by herbicides imperative. But the herbicides presently used in corn leave residues in the soil that damage other crops such as sugar beets which follow corn. A new herbicide, alachlor, appears promising as a means to alleviate this difficulty. Soil residue studies conducted in 1968 and those in progress for 1969 indicate that alachlor will not persist beyond the crop year of its use. The chemical gave satisfactory season-long control of annual weeds at rates that did not damage the corn stand, seed yield, or seed germination. Another new herbicide, chloroxuron, gave good control of annual weeds in onion seed crops. The chemical was most effective on weeds and most selective to onions when used with a wetting agent and applied as a directed spray.

SUPPORTED BY Idaho State Government

4.0105, LONG-TERM EFFECTS OF DIFFERENT SYSTEMS OF WEED CONTROL IN CROP ROTATIONS ON ECOLOGY AND CROP PRODUCT

F.R. SLIFE, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-15-0396)

OBJECTIVE: Study effect of rotation herbicides and crops on ecological changes in weed populations; on the fate of herbicides in the soil and on the biological, physical and nutritional status of the soil.

APPROACH: Field plots were established in 1965 and have been managed in accordance with a rotational plan for crops and for herbicides. Data has been taken annually on crop and weed yields. A detailed analysis of weed seed populations, residues, effects on micro- organisms and the yield of crops under each cropping system will be made at end of 1970 harvest when two complete cycles of the three year rotation will have been completed. These studies will continue over a long-term basis.

SUPPORTED BY Illinois State Government - Springfield

4.0106, STRUCTURAL CHEMISTRY OF SOIL HUMIC SUBSTANCES

F.J. STEVENSON, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-15-0339)

OBJECTIVE: Determine the structural arrangement of functional groups in humic acids and related pigments, characterize nitrogenous constituents associated with humic substances.

APPROACH: A study will be made of oxygen-containing functional groups (carboxyl, phenolic hydroxyl, enolic, quinone, alcholic hydroxyl) involved in: base exchange, chelation, and buffering reactions in soil, binding of primary minerals into stable aggregates, and retention of herbicides, insecticides, and pesticides. In addition, free amino groups and structural nitrogen linkages will be determined.

PROGRESS: The humic fraction of the organic matter in select Illinois soils was found to consist of a whole series of acidic, yellow to black colored, moderately high molecular-weight pigments which varied in a systematic way in elemental composition, acidity, degree of polymerization, and molecular weight. The strongly acidic yellow pigments had characteristics similar to those reported for 'yellow complexes' in natural waters. Infrared examination of derivatives produced by methylation (methanolic-HCl, diazomethane, dimethyl sulfate) and reduction (diborane, lithium aluminum hydride) revealed the following: (i) the methods commonly used to estimate COOH, acidic (phenolic) OH, alcoholic OH, and C0O groups in soil humic substances are nonspecific and yield values of questionable accuracy, (ii) the COOH groups of the so-called humic acids originate from side chains of an aromatic ring whereas those of the so-called fulvic acids have been formed largely by partial oxidation of phenolic and/or enolic moieties, and (iii) the greater mobility of fulvic acids than humic acids in soils and sediments is due to a combination of lower molecular weight and higher concentration of acidic functional groups, particularly COOH. Confirmation was obtained for the observation (1968 progress report) that the techniques commonly used to block specific functional groups in connection with studies on the mechanism of adsorption of herbicides and other agricultural chemicals by soil organic matter lead to results which must be interpreted with extreme caution.

SUPPORTED BY U.S. Dept. of Agriculture

4.0107, SOIL FUMIGANT CHEMICALS AND THEIR EFFECTS ON SOIL MICROFLORA

C.B. KENAGA, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01626)

4. PESTICIDES

OBJECTIVE: Microbial selectivity; population dynamics; interaction of dosage rate and inoculum density, and factors influencing the depth of penetration; and mechanism of synergism of fumigant chemicals.

APPROACH: Standardize soil type, moisture and compaction; Use stabilized populations of microflora, among which are, pathogens and antagonists; Use stoppered polyethylene tubes as test containers; and Assay microflora for viable fungi, varying time after treatment and soil depth. Establish vapor diffusion patterns through soil columns for chemicals, alone and in combination, by means of a gas chrommatograph.

PROGRESS: Investigations have been initiated relevant to syngergistic chemical soil fumigants under investigation and pertinent literature has been screened and listed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0108, SOIL INVERTEBRATES INFLUENCE ON CORN RESIDUES

J.V. OSMUN, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01567)

OBJECTIVE: Determine the role of soil invertebrates in the breakdown of corn residues; investigate the interrelations among plant density-crop residue-soil invertebrates; investigate influence of cultivation; relate crop residues to pest populations; observe pest populations under increased plant densities and minimal cultivation; determine influence of crop residues on insecticide persistence.

APPROACH: An experimental site will be developed in an area where corn has not been grown previously and where soil insecticides have not been used. Standard and developing corn growing practices will be undertaken with the variables; cultivate-minimal tillage; differing plant populations; plots defaunted with insecticides - no treatments. The rate of crop residue breakdown will be determined and the role of soil invertebrate will be assessed by periodic sampling.

PROGRESS: The last crop in this three-year experiment was sown and the soil was treated as in previous years to manipulate the soil fauna to determine the effects of insecticides, cultivation and crop density on plants debris build-up in fields continuously in corn. Insecticide and plant residue samples and arthropod counts will be taken until June 1970, the termination date of the project. Available data are with Dr. Clive Edwards at Rothamsted for eventual summary and evaluation.

SUPPORTED BY Indiana State Government

4.0109, CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS

J.L. WHITE, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01224)

OBJECTIVE: Characterize the surfaces of colloidal crystalline and amorphous soil materials.

APPROACH: Infrared and x-ray diffraction techniques will be used to identify crystalline colloids and relate surface properties to structure and chemical composition. The presence, extent and nature of the reactive surfaces of amorphous colloids will be studied by infrared measurements of water and ammonia absorption, and measurement of rate of fluoride complexation of reactive aluminum at surfaces with a fluoride specific ion electrode.

PROGRESS: Infrared studies of hydrogen bonding in clay-adsorbed water in hydronium-saturated micaceous clays have revealed stronger hydrogen bonding; infrared OH stretching frequencies of 1940 cm---1, corresponding to 0-0 distances of 2.47 A., have been observed. Similarities between properties of clay-adsorbed water and those of polywater have been described. Observations provide a better basis for understanding mechanism of bonding of pesticides to soil surfaces as well as the origin of 'surface acidity' which strongly affects the adsorption and degradation of pesticides. A computer library of crystal structure programs for x-ray diffraction analysis of cation positions and water structure in the interlayer region of vermiculite has been developed. Degradation of 12 s-triazine herbicides by montmorillonitic soil clays under natural conditions has been demonstrated by infrared spectroscopy. Highly acidic environment of the clay surface was shown to cause degradation by protonation and chemical hydrolysis. The degraded herbicide is held tightly by the soil colloid so that it is unlikely to enter the ground water to any significant extent.

SUPPORTED BY U.S. Dept. of Agriculture

4.0110, PESTICIDE-SOIL COLLOID INTERACTIONS

J.M. WHITE, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01179)

OBJECTIVE: Study the mechanism of adsorption of pesticides by soil colloids; determine changes in structure and biological activity of pesticides induced by adsorption on soil colloids; examine the kinetics of adsorption and desorption of pesticides on soil colloids; study the relationship between chemical character of pesticides and retention by soil colloids.

APPROACH: The mechanisms of adsorption will be studied by x-ray diffraction and infrared techniques; changes in structure and biological activity of pesticides when adsorbed by colloids will be studied; kinetics of adsorption and desorption will be studied by gas chromatography; the influence of chemical character of pesticides on adsorption by soil colloids will be examined.

PROGRESS: The role of chemical character of herbicide compounds and pH in adsorption of herbicides by montmorillonite has been evaluated for 18 members of herbicide families which include s-triazines, substituted ureas, phenylcarbamates, anilides, phenylalkanoic acids, benzoic acids, and picolinic acids. We have shown that the surface acidity of the clay mineral may be 3 to 4 pH units lower than the bulk pH; the pesticides may be profoundly altered in such an environment and the mechanisms of absorption and degradation proposed to be operative at the bulk pH are not applicable. Infrared studies of the interactions of 3-aminotriazole and the s-triazines with the montmorillonite surface have shown that these herbicides are protonated and converted to cations at the clay surface. These studies have also established the mode of chemical degradation and detoxification of the s-triazines by montmorillonite and montmorillonitic soil clays. An understanding of the mechanisms of adsorption and detoxification of the s-triazines should make possible modifications in mode of application so as to maximize effectiveness and minimize residual effects. Future studies are planned on behavior and movement of cationic forms of 3- aminotriazole and s-triazines in soils, and relationships between electronic structure of herbicides as revealed by nuclear magnetic resonance spectra and the nature of the interaction between the herbicide and the aluminosilicate surfaces.

SUPPORTED BY Indiana State Government

4.0111, EQUIPMENT AND TECHNIQUES FOR WEED CONTROL

W.G. LOVELY, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01815)

OBJECTIVE: Determine distribution, placement, and accuracy of metering, to reduce amount of herbicide needed for effective control and develop the necessary equipment and methods. Develop equipment and techniques for improving weed control with nonchemical methods. Develop an analysis technique to evaluate weed control equipment and methods as part of a crop production system.

APPROACH: Laboratory and field experiments will be conducted. In addition to the standard approach, herbicide distributions will be measured using gas chromatograph, spectrophotometry, and bioassay. Weather data and job completion probabilities will be used for system analysis.

PROGRESS: Timely rotary hoeing and mechanical cultivation on conventionally tilled soil for corn and soybeans gave excellent weed control. Using preemergence herbicides made timeliness less important and eliminated the need for some mechanical operations. Overall applications of early postemergence sprays were more effective than directed sprays. Three flamings with the air-curtain flamer were required to obtain satisfactory weed control. Preplant herbicide applications gave effective weed control for minimum tillage systems. Using shallow cultivating tools with more soil action than rotary hoes 5 to 10 days after weeds emerged gave effective weed control in corn and soybeans. Preemergence spray applications of herbicides at

recommended and 2 X recommended rates gave poor weed control for no-plow tillage systems for corn. Weeds were successfully controlled in continuous soybeans without tillage by using preplant applications of paraquat and preemergence applications of trifluralin, amiben, or alachlor. Movement of atrazine with soil and water was substantially greater for conventional tillage than from ridge planting. Rotary hoeing improved the effectiveness of corn and soybean preemergence treatments. Soil incorporation did not improve preemergence chemicals for corn but did for soybeans.

SUPPORTED BY Iowa State Government - Des Moines

4.0112, INFLUENCE OF CLIMATE AND SOIL ON ACTIVITY AND PERSISTENCE OF SOIL-APPLIED HERBICIDES

P.C. KEARNEY, Volcani Inst. of Agric. Res., *Beit Dagan, Israel* (0750-08-07)

OBJECTIVE: Gather basic information on the behavior of newer herbicides, applied on different types of soil and subjected to varying and extreme climatic conditions.

APPROACH: The activity and persistence of herbicides will be estimated concurrently by bioassay and by chemical analysis. Will develop rapid and accurate methods of bioassay for each herbicide covering the range of concentrations for the doses commonly used. For each herbicide, curves of activity will be established, in relation to soil composition (especailly clay and organic matter content and cation exchange capacity). Leaching of herbicides will be followed in different soil types, with rates of watering in accordance to irrigation practice and average rainfall. Herbicidal activity and persistence will be evaluated under changing moisture conditions, i.e., in soil alternately wet and dried. The persistence of herbicides, remaining on the soil surface, subjected to different temperature and sunlight conditions, will be studied in comparison to artificial u.v. irradiation.

PROGRESS: Screening for suitable test plants for bioassay of diphenamid was carried out on two soils; ryegrass and oat were found to be the most sensitive. A rapid bioassay (2 days) was developed, based on the differential elongation of radicles and coleoptile of oat seeds, placed on a substrate containing diphenamid in petri dishes. Diphenamid, and the volatile carbamate herbicide butylate, dissipate easily from the soil surface through upward water movement. Stronger bioactivity was observed when the herbicides were sprayed on a coarse soil surface than on a fine-structured surface. Adsorption of diphenamid on soil and its bioactivity in soil were strongly affected by organic matter but appear to be unrelated to clay content. Diphenamid is easily moved out of the upper soil layer, the extent of the removal depending on the amount of water applied and the adsorptive capacity of the soil. The persistence of diphenamid was followed in moist soil and sand. In Newe Ya'ar soil, 2 ppm of diphenamid was still active after 3 months at 20 C. Loss of activity was slower in sand than in soil, and at 20 C than at 30 C.

SUPPORTED BY U.S. Dept. of Agriculture

4.0113, ANNUAL AND PERENNIAL WEED CONTROL IN SORGHUM, WINTER WHEAT AND SUMMER FALLOWED LAND

W.M. PHILLIPS, Fort Hays Br. Agri. Expt. Sta., *Hays, Kansas* 67601 (0710-01-10)

OBJECTIVE: Develop more effective chemical, cultural, mechanical, and combination methods of weed control in winter wheat, sorghum, fallowed land, and in other crops grown in rotation, with emphasis on field bindweed.

APPROACH: Comprehensive field studies are conducted to evaluate herbicides, mechanical methods, and combinations of the two for weed control in the crops of major concern. Greenhouse experiments supplement the field herbicide studies. Detailed bioassay studies in the greenhouse are used to characterize persistence of herbicides in soil.

PROGRESS: Although we have halted research on the use of herbicide-zero tillage for fallow prior to sorghum production until more satisfactory herbicides are developed, we are continuing research on the herbicide-minimum tillage concept of weed control in a wheat-sorghum- summer fallow rotation. In 1969, plots which received an application of atrazine after the 1968 wheat harvest, and were tilled once in the summer of 1968 and once before seeding sorghum, became infested with weed grasses. Nevertheless, these minimum tillage plots yielded substantially more grain than the plots which were tilled conventionally. Combinations of herbicides, applied preemergence, showed considerable promise for controlling both broadleaf and grass weeds in sorghum without causing undue crop injury. Obeservations were continued on previously treated for field bindweed (Convolvulus arvensis L.) control. Picloram and 2,3,6-TBA are for extended periods. Persistence of 2,3,6-TBA has been previously documented, but persistence of picloram was further studied in 1969. Bioassays showed that it can persist for more than 5 years, although there is a gradual disappearance. Preliminary observations indicated the herbicide may move down in the soil profile through deep cracks which develop during periods of drought.

SUPPORTED BY U.S. Dept. of Agriculture

4.0114, MECHANISM OF ACTION AND METABOLIC FATE OF FUNGICIDES

M.R. SIEGEL, Univ. of Kentucky, School of Agriculture, *Lexington, Kentucky* 40506

The mechanism of action of the fungicide folpet and the systemic activity of Benlate will be studied.

Research will be continued on the action of folpet (N-trichloromethylthio-phthalamide) with high molecular weight cellular constituents. Specifically, the investigation will include studies on: a) nature of the reaction of folpet with nucleic acids and nuclear proteins, and b) effect of the toxicant on the enzymes associated with nucleic acid replication.

A detailed study on the systemic activity of Benlate (1- butylcarbamoyl) 2-benzimidazole carbamic acid, methyl ester) will include: a) the mechanism of uptake and transport in higher plants; b) metabolic transformations of the fungicide by higher plants and microorganisms, and c) persistence of Benlate in crop residues and soil.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0115, ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS

H.T. BARR, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01408)

OBJECTIVE: Determine slope of land in connection with length of row for adequate drainage for various soils and crops grown in Louisiana.

APPROACH: Land will be graded to provide various gradients and lengths of rows. Crops will be planted and amounts of water flow will be measured at ends of fields. Work in cooperation with ARS Soil and Water Conservation Service, Line projects SWC 6-b2 and SWC 6-b1.

PROGRESS: LA-23: Row Length Versus Grade Study, LSU Ben Hur Farm, using 32 plots totaling 88 acres, where 4 grades and 4 row lengths are under study. Six years of data have been analyzed and a prediction equation for runoff is being developed. LA-28: Fate of Applied Pesticide Study, LSU Ben Hur Farm. Three years' data on the disposition of endrin applied to 12 plots have been analyzed with regard to persistence, degradation, volatilization and contamination of runoff. LA-29, LA-30: Drainage Requirements of Crops, LSU Ben Hur Farm. Three years' data from a study of sugarcane yield as affected by 4 water table depths and two flooding treatments are being analyzed. LA-34: Nitrogen- Sulfur Ratios in Sugar Cane, LSU Ben Hur Farm. The effect of various N/S ratios on sucrose production has been studie ' for three years. LA- 35: Irrigation of Sugarcane, LSU Ben Hur Farm. The effect of two irrigation methods on the yield of sugarcane is being studied.

SUPPORTED BY Louisiana State Government

4.0116, CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND

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4. PESTICIDES

OBJECTIVE: Determine amounts of agricultural chemicals carried in runoff and erosion; determine persistence of agricultural chemicals and leaching losses under intensive cultivation.

APPROACH: Erosion plots at Presque Isle in continuous potatoes and in a 3 year rotation of potatoes, sugarbeets, and peas are treated with the fungicides, herbicides, and insecticides currently recommended by the Maine Agricultural Experiment Station. Runoff and sediment samples are collected and analyzed after each storm. Soil surface samples are obtained before and after each chemical applicaiton. Soil profile samples are collected and analyzed periodically.

PROGRESS: It is important to know the mechanism by which pesticides move from treated agricultural soils. A laboratory experiment was conducted in which Caribou and Marshall silt loams were treated with DDT, methoxychlor and endosulfan. These soils were then fractionated into selected particle size ranges and insecticide in each size range was determined. For both soils, the greatest concentrations were found in the clay fraction and within this fraction the highest concentrations were in the 0.08 to 0.5 Mu size. The lowest concentrations were found in sand fraction.

SUPPORTED BY U.S. Dept. of Agriculture

4.0117, MICROBIOLOGY AND BIOCHEMISTRY OF PESTICIDES IN SOIL

P.C. KEARNEY, U.S. Dept. of Agriculture, Crops Research Division, *Beltsville, Maryland* 20705 (0750-08-02)

OBJECTIVE: Develop methods for controlling the persistence of pesticides in soils by microorganisms. Investigate role of soil organisms and enzymes in degrading various classes of organic pesticides.

APPROACH: Conducts comprehensive studies on the isolation and identification of soil bacteria, fungi and actinomycetes effective in degrading insecticides, herbicides, fungicides and other organic pesticides. Isolates and characterizes enzymes within soil microorganism that initially cleave the pesticide molecule. Studies development of populations of microorganisms effective in degrading pesticides.

PROGRESS: Propanil is metabolized by soil microorganisms to 3,4- dichloroaniline, 3'3',4,4'-tetrachloroazobenzene, propionic acid, and several unknown metabolites. Labeling experiments indicate aniline ring cleavage is slow. 1,3-Bis(3,4-dichlorophenyl)-triazene has been identified as a new major propanil metabolite. The degradation of propanil by soil microorganisms is inhibited by certain methylcarbamate and phosphate pesticides. Specific methylcarbamates act as competitive inhibitors of the acylanilide hydrolyzing enzyme. Addition of some methylcarbamates to propanil in soil significantly reduces the level of TCAB residues formed in soil.

SUPPORTED BY U.S. Dept. of Agriculture

4.0118, MOVEMENT, PERSISTENCE AND INTERACTION OF PESTICIDES IN SOILS

R.G. NASH, U.S. Dept. of Agriculture, Crops Research Division, *Beltsville, Maryland* 20705 (0750-08-01)

OBJECTIVE: Develop methods to study the vertical and lateral movement of all classes of pesticides in soils. Determine the persistence of pesticides in soils when applied individually or in combination.

APPROACH: Conducts comprehensive studies on the lateral and vertical movement in columns and adsorption of pesticides in and on soils. Surveys the persistence and phytotoxic effects produced by single and combined applications of herbicides with insecticides and fungicides by bioassays and chemical methods of analysis.

PROGRESS: Pesticide movement in soils was studied by the soil thin-layer chromatographic method. In general, movement was correlated positively with water flux and soil pH (acidic herbicides), and negatively with field capacity, organic matter and clay contents, and adsorption. A bioassay was developed whereby algae plus agar was sprayed onto a soil plate; triazine and phenylurea herbicides are easily detected at application rates of ca. 1 microgram. Fungicide movement is traced by an analogous technique using soil fungi in the bioassay. The major source of DDT residues in plants arose from vapor movement off of contaminated soil surfaces. Dieldrin, endrin, and hepthachlor residues resulted primarily from root uptake and translocation through stems to leaves and seeds. Soil organic matter negatively affected root uptake and positively affected soil persistence of these insecticides. Several extraction solutions did not remove all insecticide residues from dried plant materials.

SUPPORTED BY U.S. Dept. of Agriculture

4.0119, CHEMISTRY OF PESTICIDES IN SOILS

J.R. PLIMMER, U.S. Dept. of Agriculture, Crops Research Division, *Beltsville, Maryland* 20705 (0750-08-03)

OBJECTIVE: Develop methods of preparing, detecting, and identifying all classes of pesticides and their residues in soils. Investigate and study the chemical reactions that alter pesticides in or on soils.

APPROACH: Conducts comprehensive studies on preparation of volatile derivatives of organic pesticides and accurate detection of minute amounts of these materials using modern techniques in organic and analytical chemistry. Surveys the changes in pesticide molecules caused by oxidation, reduction and photochemical reactions.

PROGRESS: Twelve laboratories reported finding 78 21% of chlorinated hydrocarbon residues added to three soils. Acid forming fertilizers (N, P, and K) decrease arsenic phytotoxicity by influencing Fe and Al availability. Beans (green and lima) are more susceptible to As residues than spinach and cabbage. Fertility level directly influences the toxicity of As residues. Prometryne affords 4,6- bis(isopropylamino)-s-triazine on photolysis in solution or as a solid. DDE irradiated by wavelengths above 2600A in methanol with oxygen gives 3,6-dichlorofluorenone. Photooxidation of DDT or DDE in methanol gives many products. Of these, 32 were identified by combined mass spectrometry/gas chromatography. Reaction pathways have been proposed. Benzophenone sensitized photolysis of 3,4-dichloroaniline gives 3,3',4,4'-tetrachloroazobenzene and other products. Propanil is decomposed in soil to give a number of condensation products and simple dichloroaniline derivatives including 3,4-dichloroformylanilide. 3,3,4'-Trichloroazobenzene is formed in soil from 3,4-dichloroaniline and 3-chloroaniline in addition to 3,3'-dichloroazobenzene and 3,3',4,4'-tetrachloroazobenzene. Ultraviolet irradiation may reduce or destroy the biological activity of herbicides. Amiben is protected fro the action of light by N-benzoylation.

SUPPORTED BY U.S. Dept. of Agriculture

4.0120, BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS

A.W. TAYLOR, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Beltsville, Maryland* 20705 (SWCW8-AB-7)

OBJECTIVE: Study factors affecting accumulation, movement, and persistence of pesticides and pollutants in soil and water and their uptake by plants.

APPROACH: Laboratory, greenhouse, and field experiments will be conducted on the chemistry and microbiology of chlorinated hydrocarbon insecticides, selected herbicides, and the heavy-metal pollutants in soils and water. Analytical methods will be developed for determining these compounds in soil, water, and plants. Greenhouse and field experiments will be conducted to evaluate the accumulation, movement, and persistence of selected chlorinated hydrocarbon insecticides and certain metal pollutants in soils and water and the accumulation of thess compounds in the plants.

PROGRESS: Three years' measurement of dieldrin concentrations in storm-runoff water from small agricultural watersheds show concentrations decrease steadily to about 30% of their initial values by the third year. No dieldrin was found in a stream draining the general area that contains the treated plots. Field studies on aerial movement of dieldrin indicate that volatilization is the main pathway by which dieldrin leaves the soil. Compounds derived from alfalfa distillates accelerated the anaerobic decomposition of DDT in soil. Studies show the adsorption of amitrole and prometone on montmorillonite and soil organic matter is dependent on the surface proton supply. Bromegrass takes up Cd

more readily than Pb, or Zn. Plant uptake of Pb increases very slowly with increasing Pb content of the soil, but is sensitive to pH changes. Studies on phosphate and nitrate losses in water draining woodlnad and agricultural areas have been initiated. Preliminary data show small but measurable amounts from both sources.

SUPPORTED BY U.S. Dept. of Agriculture

4.0121, CONTROL OF PESTICIDES IN SOIL AND WATER
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OBJECTIVE: Study factors affecting accumulation, movement and persistence of pesticides in soil and water and their accumulation by plants.

APPROACH: Laboratory greenhouse and field experiments are conducted on the chemistry and microbiology of chlorinated hydrocarbon insecticides and selected herbicides. Greenhouse and field experiments will be conducted to evaluate the accumulation, movement and persistence of selected chlorinated hydrocarbon insecticides in soil, air and water and their accumulation in plants. Laboratory experiments will be conducted on the chemistry of pesticides and herbicides in soil and water. Analytical procedures for the determination of these compounds will be developed where necessary.

PROGRESS: Field studies demonstrated that volatilization is the principal pathway by which dieldrin and heptachlor are lost from soil to the general environment. The concentrations of the insecticides in corn leaves exposed to the vapors are in the order of 1 ppm, while the concentrations in the kernels remains less than 0.02 ppm. The total amount of pesticide in the plant is about 1 gram per acre. Dieldrin remains stable on the leaves, but most of the heptachlor is degraded to heptachlor epoxide. Laboratory studies have confirmed the existence of natural compounds in green plant tissues that may be mistaken for dieldrin in routine chemical analyses. Procedures for overcoming the analytical difficulties when these compounds are present have been developed. Research on analytical methodology needed for the identification and determination of pesticides in the environment is continuing.

SUPPORTED BY U.S. Dept. of Agriculture

4.0122, NEUTRALIZATION REACTIONS IN ACID SOIL AND CLAY SYSTEMS AND THEIR EFFECT ON PLANT GROWTH
J.H. BAKER, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01002 (MAS00219)

OBJECTIVE: Study the influence of chemical properites of acid soil and clay systems on the rate of reaction of liming materials, the effect of application of liming materials on the chemical composition of plants.

APPROACH: Acid soil and clay systems will be treated with liming materials and the progress of the reaction studied by measuring changes in exchangeable aluminum and pH and diffusion of Ca-45 into the system from $CaCO_3$ particles. The chemical composition of the soil solution and plants grown in acid soil and clay systems will also be measured as a function of time after application of liming materials.

PROGRESS: Preliminary studies using ion exchange resins and a calcium sensitive electrode indicate that about 20% of the calcium in soil solutions extracted from field moist soils by pressure ultrafiltration or by displacement with salt solution is in some form other than simple calcium ions, perhaps an organic complex. Presence of complex forms of calcium in the soil solution would be expected to influence calcium availability to plants, movement of calcium in soils and the apparent solubility in soil moisture of such calcium compounds as carbonates and phosphates. Studies of atrazine sorption and desorption from acid and limed soils indicate that atrazine sorption is not completely reversible and that increasing soil pH although decreasing atrazine adsorption does not increase the reversibility of the reaction.

SUPPORTED BY U.S. Dept. of Agriculture

4.0123, PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS
K.H. DEUBERT, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01002 (MAS00251)

OBJECTIVE: Study of pesticides in relation to accumulation and persistence, movement to water, final destination and concentration of pesticide chemicals used on cranberry bogs.

APPROACH: Investigations on the chlorinated hydrocarbons, similar studies on organic phosphates. Soil samples at varying depths taken in cranberry bogs, ditches and reservoirs. Perennial vegetation, algae and water animals will be collected and analyzed.

PROGRESS: Work on this project had been interrupted for several months in consequence of personnel changes. The distribution of dieldrin and DDT (detected as p,p -DDT) in soil was closely studied using both gas-liquid-chromatography and thin-layer chromatography. Approximately 75% of dieldrin residues and 85-90% of DDT residues in the 1-4 inch layer of soil are present in the top two inches. Leaching experiments showed that over 0.4% of dieldrin residues in soil (containing 2.3 ppm of dieldrin) can be removed with water corresponding to 10 inches percolated through two inches of soil. Dieldrin and DDT residues in drainage ditches and canals were generally higher (0.4-0.7 ppm) than in 1965 (0.092 ppm). The field experiment with parathion reported last year was repeated. Amounts of residues detected in drainage water were slightly lower than the amounts detected the year before.

SUPPORTED BY U.S. Dept. of Agriculture

4.0124, TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS
K.H. DEUBERT, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01002 (MAS00293)

OBJECTIVE: Determine translocation of pesticides from cranberry bogs and relationship of organic matter.

APPROACH: Actual bog conditions will be studied and simulated in the laboratory. Interaction of pesticides and organic colloids will be determined. Determinations will be made of cation exchange capacity, pesticide residues, exchangeable bases and carbon content of soil.

PROGRESS: Monitoring studies on dieldrin and DDT in bog soil and drainage canals were continued. Most important result: ratio of translocation of DDT on a cranberry bog--2 ppm about 120 feet in 12 years. Correlection between pesticide residues and cation-exchange capacity, total exchangeable bases, exchangeable Ca , K , Na and base saturation are caused by the correlation between amounts of pesticide residues and organic matter in the soil. Pesticide residues (dieldrin and DDT) in flood water were about 10% above the residue levels in fresh water used for flooding. Copper of copper sulfate applied at a rate of 4 lbs./acre/foot water disappears from flood water from about 0.6 ppm Cu (double dosage) to 0.02 ppm Cu and less within 10 days.

SUPPORTED BY U.S. Dept. of Agriculture

4.0125, INSECTS INFESTING FIELD AND TRUCK CROPS
G.E. GUYER, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00194)

OBJECTIVE: Evaluate the biology, economics and possible avenues of control of major insect populations of vegetable and field crops.

APPROACH: Special attention is directed toward the emerging resistant population of soil maggots infesting onions and cruciferous crops; the developing of the emerging soil insect control problem resulting from the elimination of hydrocarbon materials from control schedules. Special attention is directed to the wireworm and grub problem on potatoes; concentrated effort is being devoted to the improvement of the systemic insecticidal control technique to reducing numbers of sprays and to provide a more economic control program with a minimum of hazards; cooperative studies have been initiated with the processing indus-

try to follow the concentrated residue problem resulting from residue buildup in our major organic soil areas. Ways of living within the register-tolerance problem are being formulated; the magnitude and implications of insecticidal drift resulting from application as well as soil contamination.

PROGRESS: Organophosphate insecticides still provide excellent control of the onion maggot. Field research has evaluated numerous compounds and formulations. Seed corn maggot activity indicates a potential problem to vegetable and field crops. Preliminary work on granular treatments may lead to alternate control techniques for this insect. The cabbage maggot caused total loss to unprotected rutabaga plantings; however new materials when labeled through assistance of pesticide research center will provide excellent control. Twenty-three experimental and commercial formulations of insecticides were evaluated for the insect complex on potatoes, celery, cabbage, peppers, snap beans and muskmelons. Many of these show promise and will be further studied. Seventeen granular or low volume applications of soil insecticides were evaluated on nematodes and foliar insects on potatoes and beans. Only light infestations of insects developed but nematode control was observed. The role of nematode control in cash crop rotations was further studied. Increased yield was obtained after applications of fumigants and granular nematocides. This project will continue since grower interest is high. The European corn borer caused extensive damage to many crops, especially snap beans, peppers and potatoes so emphasis will be placed on this insect in 1970.

SUPPORTED BY Michigan State Government

4.0126, RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS

G.E. GUYER, Michigan State University, Graduate School, *East Lansing, Michigan* 48823

The movement, degradation, and concentration of pesticides in the soil ecosystem was investigated. Special attention was directed to the sorption phenomenon as it relates to clay minerals and organic matter. Selected pesticides were followed through the various trophic levels of the soil ecosystem for the purpose of evaluating possible avenues of pesticide concentration as well as degradation.

Comparable investigations were associated with the movement, concentration and elimination of pesticides in the aquatic environment. The physiological and morphological effects of pesticides on selected aquatic vertebrate and invertebrate organisms was determined. Special attention was directed to the evaluation of the pollution related stress effects on electrophysiology of selected nerves.

Research was also associated with the absorption and metabolism of biologically active chemicals by leaf and fruit tissue. Herbicides were investigated to determine their effect on plant composition. The research with the effects of herbicides on plant composition has provided a practical means whereby the protein content of the edible portions of plants may be increased in developing countries.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0127, REDUCTION OF HAZARDS ASSOCIATED WITH THE PRESENCE OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT

M.M. MORTLAND, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00927)

OBJECTIVE: Determine the fundamental physical, biochemical, and biological factors influencing occurrence, magnitude, interaction, and persistence of insecticidal chemical residues in soils and raw agricultural commodities.

APPROACH: Adsorption of insecticidal chemicals by clay minerals will be studied using techniques of infrared absorption, x-ray diffraction and chemical techniques to determine mechanisms of bonding. Stability of the resulting complexes will be evaluated in dry and wet environments. The effect of exchangeable cation on the complexes formed will be investigated. Where appropriate, bioassays of the colloid- insecticides complexes will be made to determine the activity of the chemicals in the adsorbed state.

PROGRESS: Alfalfa residues added to soil accumulated pentachloronitrobenzene (PCNB) to levels 6- to 10-fold higher than the concentration in soil. At incubation periods from one to 32 days, colonization of the alfalfa residues by fungi was greater in soil free of PCNB than in soil containing PCNB. Of specific fungi enumerated, *Pythium* and *Fusarium* spp. increased in the presence of PCNB in soil, whereas *Rhizopus stolonifer* and *Penicillium oxalicum* decreased. These changes were correlated with the sensitivity of these four fungi to PCNB. The proportion of fungi insensitive to PCNB increased in alfalfa particles incubated in soil containing PCNB, as compared with those in soil without PCNB. Dieldrin was also concentrated several fold by alfalfa particles in soil. The kind of exchangeable cation on clay is of major importance in determining the energy of adsorption of pesticides to clays. They maybe bound to exchangeable metal cations by coordination or to organic cations by hydrogen bonding. Infrared absorption showed dialkylamides interact with organic cations on clay through hydrogen bonding. Proton transfer reactions involving pesticides at clay surfaces were observed. Binding of aromatic molecules to clays having Cu(II) as the exchangeable cation was found to involve pi elections of the organic material. Bioassay studies on pesticide-clay complexes showed bioactivity depended upon the kind of exchangeable cation on the clay with which the pesticide was complexed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0128, CHEMICAL AND PHYSICAL PROPERTIES OF ORGANIC MATTER OF MICHIGAN SOILS

A.R. WOLCOTT, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00636)

OBJECTIVE: Establish the range of organic C, N, P and S in major soil series and management groups. Characterize the organic matter in representative soils in terms of proximate composition, cation exchange capacity and functional group analysis.

APPROACH: Analysis of soil samples form soil survey activities, field research plots and a significant porportion of farm samples passing through the central soil testing laboratory. Objective 2 will involve detailed studies with a very few soils selected to permit correlation with soil genetic factors.

PROGRESS: Useful adsorption isotherms were obtained when low concentrations approaching true solutions of DDT were used (1 ppb). Calculated distribution coefficients were used to compare plant and microbial tissues with different soils and derived soil fractions. Sorptive capacity of residual soil materials for DDT increased as biologically active fractions extractable with hot water or dilute acid were removed. In the course of these studies, procedures and rationale have been developed for projected investigation of pesticide partitioning among ecologically significant components of soil organic matter.

SUPPORTED BY Michigan State Government

4.0129, ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE

R.S. ADAMS, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-25-074)

OBJECTIVE: Special emphasis will be on organophosphate insecticides and triazine herbicides. Devise and improve sampling, extraction and analytical techniques to facilitate quantitation of these pesticide residues and degradation products in soil, plants and animals. Conduct a regional study of the interaction of these pesticides employed for control of corn pests. Evaluate the influence of regional soil and meteorological factors on the persistence, biological activity and soil movement of these chemicals, singly or in combination and in the presence of other environmental inputs. Examine the action, persistence, degradation and translocation of selected biocides and their metabolites in plants, animals and microorganisms. Describe and evaluate biocide cycling through the soil and water environments particularly in reference to food chains.

APPROACH: Preliminary work will be in laboratoby or greenhouse to ascertain best analytical procedures, soil persistence and mobility of pesticide in soil, adsorptivity of pesticide to soil, interactions between soil factors and pesticides and influences of soil factors in pesticide activity. Field trials will be

established with selection based upon pertinent variables. Each station will cooperate procedures for examining some phase including: effects on crops or succeeding crops, efficiency of pest control, leaching of pesticides effects on soil animals and microbes, interaction effects, influence of weather variability and persistence of the pesticide in soil.

PROGRESS: Bioassays of DDT were completed in 31 soil samples. Because the bioassay procedure had to be modified, the samples had to be divided into two groups for statistical analysis. The group with the aberrant samples included all samples containing interstratified minerals and large amounts of amorphous Fe and Al. Organic matter exerted the greatest influence on the bioactivity of DDT in both groups. The adsorption of lindane from aqueous solution by these same soils (32 samples) was also examined. A regression equation including only organic carbon explained 89% of the variability. Adsorption of lindane from solution varied from 4 to 90%. The absorption of lindane was related to the bioactivity of DDT in the same soils at the 1% level. Lindane adsorption was readily reversible.

SUPPORTED BY U.S. Dept. of Agriculture

4.0130, RESEARCH IN WEED SCIENCE AND WEED CONTROL

R. BEHRENS, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-13-037)

OBJECTIVE: Develop new principles and practices for the control of weeds in agronomic crops. Determine the effectiveness of cultural and chemical methods of weed control. Evaluate the toxicity of new herbicides to weeds and crop plants. Determine the safest, most effective means of applying herbicides to agronomic crops and weeds. Determine the persistence of herbicides in crops and soils. Study factors involved in herbicidal selectivity. Investigate physiological responses of plants to herbicides. Determine the mode of action of herbicides.

APPROACH: Evaluation of new chemicals with proven herbicidal activity will be made in laboratory, greenhouse and the field to determine their possible value for agricultural use by applying these chemicals to agronomic plants and weeds under controlled conditions. The influence of environmental (temperature, light, moisture) factors on herbicidal activity will be studied in growth chambers. Bioassay, radioisotopic techniques, gas, paper and thin layer chromatography, ultra-violet and infra-red spectrophotometry will be used to study the mode of action of herbicides, physiological responses of plants to herbicides and the dissipation of herbicides in plants or soils.

PROGRESS: The long-term persistence of picloram in Minnesota soils was apparent from injury to soybeans seeded in 1969 on plots treated with 2 to 3 lb/A of picloram in 1966. The picloram residue was greatest in areas where soil organic matter was lowest. Repeated annual applications of atrazine, 3 lb/A, for 4 years (1965-1968) did not result in an accumulation of atrazine great enough to seriously reduce yields of flax and soybeans in 1969 though stands of these crops were thinned. Two s-triazine herbicides, SD-15418 and S-6115, show promise for weed control in corn and cause less residual phototoxicity in soil than atrazine. Soil incorporated preemergence applications of alachlor were much more effective for the control of yellow nutsedge than were surface applications when rainfall was low. The tolerance of alfalfa and red clover to 2,4-DB does not arise from a failure of these species to convert 2,4-DB to 2,4-D by the beta-oxidation pathway as has been reported by others.

SUPPORTED BY U.S. Dept. of Agriculture

4.0131, INSECTS ATTACKING WOOD AND WOOD PRODUCTS IN STORAGE AND IN USE

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OBJECTIVE: Develop information on important wood products insects life histories, behavior, nutritional requirements, attractants, regulating mechanisms - use this information to work out methods for their prevention and control.

APPROACH: Study nutritional requirements of Lyctus and Anobiid powder-post beetles, investigate means for depleting wood of required nutrients, study life history and effects of environment on important species of drywood termites, test soil insecticides for preventing attack of subterranean termites; investigate laboratory techniques for determining field effectiveness of soil insecticides.

PROGRESS: Field studies still in progress in sandy loam soil in south Mississippi show 100% protection against native termites with 1% chlordane for 21 years, 0.5% aldrin or 0.5% dieldrin for 20 years, and 0.5% heptachlor for 17 years. The chemicals were applied as water emulsions at the rate of 1 pint per square foot. These formulations are still effective after 10 years in heavy clay soil of the Mississippi Delta and in limestone soil at State College, Mississippi. (No other chemicals are known that will give long-term effectiveness against subterranean termites.) Recent analyses for chemical residues and bioassays of over 300 soil samples taken adjacent to field treatments of chlordane applied in 1948, aldrin and dieldrin applied in 1949, and heptachlor applied in 1952 show that the chemicals have moved only a few inches horizontally and vertically from where they were applied. Five years of monitoring for chlorinated hydrocarbons from a spring and a bog area downgrade from large termite control study plots established in 1956 and 1958 have revealed no detectable quantities of the insecticides. Several carbamate and phosphate compounds were applied in field studies in 1967 to determine their effectiveness against subterranean termites. After 3 years most of these compounds are ineffective.

SUPPORTED BY U.S. Dept. of Agriculture

4.0132, REDUCTION OR ELIMINATION OF ADVERSE EFFECTS OF PESTICIDE RESIDUES ON FOOD AND FEED PRODUCTS

B.F. BARRENTINE, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-3-206-0766)

OBJECTIVE: Study food and feed products with respect to the location and persistence of pesticide residues in market products, and the development of commercial marketing and processing techniques for the detection, removal and/or neutralization of pesticide residue effects.

APPROACH: Samples of soybeans from commercial storage will be selected. Effects on residue reduction by cleaning and washing will be investigated. The location and persistence of endrin residues in soybeans and soybean products produced on endrin contaminated soil will be studied.

PROGRESS: The uptake of pesticides from contaminated soils by the soybean plant has been verified by both field and plot work. The principle pesticides found in soybean oil are DDT, toxaphene, and endrin. Toxaphene and DDT present no problem, as the amounts found are usually well below the tolerance level. The problem with endrin is more critical, since there is no tolerance for this pesticide. It has been reported that the deodorization step in the commercial refining of oils removes much, if not all, of the pesticides in crude oils. A working arrangement was made with a commercial refining plant to study the effect of refining on the pesticides in the crude oil. It has been verified that the deodorization step of refining does remove essentially all of the DDT, toxaphene, and endrin. Much of the pesticides are found in the 'distillate,' a volatile oily fraction which is recovered by the refining industry. It appears very difficult, if not impossible, to relate the amount of pesticides in the distillate to the total quantity of pesticides that was in the crude oil.

SUPPORTED BY U.S. Dept. of Agriculture

4.0133, DETERMINATION OF HERBICIDAL RESIDUES IN PLANTS AND SOILS, AND FATE OF HERBICIDES IN CERTAIN SOILS

A.W. COLE, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-3-206-1454)

OBJECTIVE: Follow residue patterns of herbicides in soils, and in plants grown in succession and in rotation by employing satisfactory methods. Determine the fate of herbicides in certain soils by following the steps involved in degradation.

APPROACH: The investigations will be conducted under field, laboratory and controlled environmental conditions. The field work will employ certain vegetable crops, woody ornamentals and turf species. Establish the pattern of herbicide dissipation

in the soil under diverse conditions, field plots will be established and treated with certain herbicides. The herbicides will be applied at recommended rates and rates in excess of those currently in use.

PROGRESS: Micro-organisms were isolated from soil taken at prime locations in previously treated plots using Acid PDA and Rose Bengal media at inoculation temperatures of 5, 10, 15, 20, 25, 30, 35, and 40 C. Cultures isolated did not vary significantly with location. Cultures were then exposed to herbicides which have had long periods of successful use or are currently being used in large acreage situations in Mississippi. Several of the fungi were found to be inhibited by these chemicals in their growth while some appeared to be stimulated. Using standardized inoculation techniques for liquid growth medium and known concentrations of herbicides, one fungus which is inhibited in plate culture was found to be modified physiologically (at least temporarily) by the herbicide. The degree of modification is consistent with concentration of herbicide. In addition to being modified, the organism also gains the ability to degrade the herbicide present in solution. Measurement of dry weight after a known period of exposure and color variation have shown that these changes occur at concentrations which could be present in soil from normal usage. Field plots for continuous application of the herbicides have been established to determine if this modification is consistent.

SUPPORTED BY U.S. Dept. of Agriculture

4.0134, INACTIVATION AND LOSS OF PESTICIDES FROM SOIL

B.J. STOJANOVIC, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-3-207-0569)

OBJECTIVE: Determine inactivation and loss of pesticides from soil by volatilization, and microbiological and non-microbiological degradation.

APPROACH: Soils representing important land resource areas in the South and pesticides of hazardous and economic importance will be used. The extent and importance of volatilization of pesticides from soils will be determined under controlled laboratory conditions. Products of microbially degraded pesticides and microorganisms responsible for degradation will be identified. Chemical changes in pesticides will be determined in soils void of microorganisms under varying pH, temperature, moisture and mineralogical composition of soils.

PROGRESS: Biodegradeability and persistance of DDT, dieldrin, and malathion was studied in West Point loam, Angie sandy loam and Houston clay. Each insecticide was added at concentrations of 2, 4, 8, and 16 ppm to soil samples alone or to soil samples containing 150 ppm urea-N. Following incubation (56 days) soils were analyzed for insecticide content, microbial numbers, and mineral nitrogen. Malathion dissipation was also studied in sterile and non-sterile soils and aqueous soil dilutions. In these investigations DDT and dieldrin remained essentially unchanged throughout 2-month incubation, regardless of the concentration at which they were applied, the soil type employed, and whether or not nitrogen was applied as urea. DDT-amended Houston clay, however, showed appreciable accumulation of p,p'-DDE. This accumulation was directly related to the rate at which DDT was added and it was substantially greater in samples which contained urea-N than in those without urea. In non-sterile West Point loam and Houston clay malathion was not detectable after 24 and 48 hours incubation. In non-sterile Angie sandy loam there remained approximately 4% of added malathion after 10 days incubation. Non-sterile and sterile aqueous dilutions showed similar patterns of diminishing returns of malathion upon incubation. It is concluded from the data that malathion is degraded chiefly if not solely by soil microorganisms.

SUPPORTED BY U.S. Dept. of Agriculture

4.0135, EFFECT OF PESTICIDE USAGE ON SOIL MICROFLORA IN AGRONOMIC AND HORTICULTURAL CROPS

D.K. BAGGA, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUW-0107)

OBJECTIVE: Investigate the qualitative and quantitative changes brought about in soil microflora by application of pesticides and evaluate the usage of a certain pesticide for a certain crop with regard to microbial populations.

APPROACH: Field soils treated with various pesticides and pesticide combinations for different lengths of time will be used to assay their microflora. Pure cultures of soil microorganisms will be used to study the effect of pesticides in vitro.

PROGRESS: Microorganisms from the soils of Delta of Mississippi were isolated and their frequency determined. Effect of trifluralin on the growth of various soil fungi varied. Trifluralin at 1 ppm incorporated in potato-dextrose agar inhibited the growth of Aspergillus niger. All other fungi tested were not affected by this concentration of the herbicide added. Higher concentrations (1000 ppm) of fluometuron and diuron added to liquid culture medium had an adverse effect on growth of Glomerella gossypii, Pythium deliaryanum, Rhizoctonia solani, and Verticillium alboatrum. Diuron at concentration of 1 to 10 ppm stimulated the growth of soil borne pathogens: P. deliaryanum and R. solani. Addition of diuron, fluometuron, norea, planavin, and trifluralin to soil seemed to increase its microbial population. An interaction between chloroxuron and seedling disease organism R. solani was discovered. Chloroxuron at 3 ppm in unsterilized soil or in the presence of R. solani caused injury to the southern peas, however in sterilized soil there was no apparent injury to the test plants.

SUPPORTED BY Mississippi State Government

4.0136, PERSISTENCE AND DETOXIFICATION OF HERBICIDES IN SOIL

K.E. SAVAGE, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUW-0102)

OBJECTIVE: Investigate herbicide persistence as affected by herbicide combinations, rates, application methods, climatic and cultural conditions.

APPROACH: The persistence of selected herbicides will be studied as related to climatic, edaphic, and cultural conditions. Due to the time involved in persistence research, only those herbicides which are in commercial use will be considered. The studies will consist of field, greenhouse and laboratory studies as well as appropriate analysis of soil samples from field research plots and commercial fields.

PROGRESS: Nitralin and trifluralin persistence was studied as a function of soil and environmental factors in the field, greenhouse, and laboratory. Preliminary results indicate no significant accumulation of either herbicide under field conditions. Soil pH was negatively associated with persistence of both herbicides. Nitralin persisted longer under anaerobic than under aerobic soil conditions.

SUPPORTED BY Mississippi State Government

4.0137, PERSISTENCE OF HERBICIDES IN SOILS

K.E. SAVAGE, U.S. Dept. of Agriculture, Southern Weed Science Lab., *Stoneville, Mississippi* 38776 (0710-01-14)

OBJECTIVE: Determine the persistence of herbicides used in the Southeastern United States in relation to soil properties.

APPROACH: Study the influence of chemical and physical properties of agricultural soils of the Southeast in relation to persistence of specific herbicides and to interaction with other pesticides in the soil. Evaluate and quantitate the movement, transport, and loss of herbicides in and from soils. Investigate methods to decrease or to extend the residual lifetime of herbicides in selected soils of the region.

PROGRESS: Postemergence applications of certain petroleum naphthas effective and economically control many species of weeds in cotton under ideal conditions. Lack of crop tolerance, however, prevents safe use after cracks appear in the bark at the base of cotton stems. Data from 4 years of research indicate that water emulsions of certain aromatic petroleum fractions provide more effective control of the target weeds than unemulsified naphthas and that the cotton remains tolerant at stages of growth that would be injured by unemulsified naphthas. Results of a survey on persistence of nitralin and trifluralin in soils of the Mississippi Delta indicated no significant accumulation of these herbicides in cotton or soybean fields. Nitralin residue was negatively

correlated with soil pH. Trifluralin persistence was negatively correlated with organic matter, soil pH and cation exchange capacity. Greenhouse bioassays indicated that both nitralin and trifluralin persisted longer under acid soil conditions than under neutral or slightly alkaline conditions.

SUPPORTED BY U.S. Dept. of Agriculture

4.0138, EQUIPMENT AND TECHNIQUES FOR CHEMICAL CONTROL OF WEEDS IN CORN AND SOYBEANS
M.R. GEBHARDT, Univ. of Missouri, U.S.D.A. Agric. Eng. Res. Div., *Columbia, Missouri* 65201 (209-056-A112-B)

OBJECTIVE. Improve methods of evaluating weed control practices for field crops and establish criteria for design and use of improved cultivation and herbicide application equipment.

APPROACH. Evaluate effects of herbicide application and cultivation on weed control, crop yields, retention of chemical residues in the soil and contamination of nontarget areas. Develop procedures to objectively measure efficiency of application of herbicidal chemical in sprays, granules, foam and other forms. Determine requirements for mixing of pre-emergence herbicides in the soil, and the influence of various methods of soil mixing on effectiveness of the herbicide treatments. Determine factors affecting design requirements criteria for utilization of cultivation equipment for weed control, for use alone or in conjunction with herbicides.

PROGRESS. Soybean stands were reduced when 1/2 lb/A of trifluralin was incorporated with the disk harrow. Poor weed control was obtained when trifluralin and nitralin were applied at 0.5 and 1.0 lb/A and incorporated with the disk harrow. Incorporation with a powered rotary cultivator resulted in excellent weed control with the same herbicides. Incorporation with a mulch treader resulted in no soybean damage and excellent weed control. A comparison of low volume applications of several preemergence herbicides for weed control in corn showed that the herbicides are as effective at 1 gpa as at 5 or 20 gpa when applied with low volume fan-type spray nozzles. Preemergence herbicides for corn and soybeans showed improved weed control when followed by rotary hoeing at spike stage. Field and laboratory studies of the persistence of trifluralin in the soil when surface applied and when incorporated with a powered rotary cultivator, mulch treader, and disk harrow were initiated this year. Preliminary data indicate that there are differences in herbicide persistence due to method of incorporation. Large variations in herbicide concentrations due to environmental interactions with methods of chemical analysis prevented complete analysis this year.

SUPPORTED BY U.S. Dept. of Agriculture

4.0139, THE USE AND FATE OF BIOREGULANTS
B.G. TWEEDY, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00605)

OBJECTIVE. Interactions of selected plant life and bioregulants, effect of bioregulants upon selected metabolic pathways of microorganisms and vascular plants, biodegradation of pesticides and identify some of the degradation products.

APPROACH. Several different forms of plants will be grown in presence and absence of selected bioregulants under environmentally controlled and natural conditions. Bioregulants to be used in initial studies will include those compounds which are potential nitrogen, carbon or nitrogen and carbon sources for microflora. Pesticides will be incorporated into soil and water and rate of disappearance will be followed by chemical and bioassays. Ecological changes in microflora will be followed. Organisms will be incubated in radiorespirometric flasks which contain selectively labeled metabolic intermediates and the radioactive carbon dioxide evolved will be trapped. Intermediates will include radioactive glucose, pyruvate and acetate labeled in different positions.

PROGRESS. Conidia of Fusarium oxysporum were incubated with thiram and selectively labeled glucose. Thiram at 1, 2 and 4 ppm had little effect, but 8 and 16 ppm were highly inhibitory to the HMP and slightly inhibitory to the EMP pathways. Triazine or substituted urea herbicides used with thiram either reduced or augmented the effect of the fungicide, depending upon the herbicide. Similar effect upon soil microfloral populations were observed when the combinations were applied to soils. Thus, herbicide-fungicide combinations could select the predominant soil microflora. Representatives of the soil microflora showed a wide variation in their ability to degrade herbicides. The fungi degraded 100% of the diphenylether compound but had little effect upon the others. Algae degraded the diphenylether and triazine. Corn seedlings resistant or susceptible to atrazine were incubated with C- ring- or chain-labeled atrazine. None of the ring moiety was accumulated in the mitochondria nor was it incorporated into the nucleic or free amino acids. Cell-free homogenates from the resistant and susceptible lines were found to rapidly hydroxylate atrazine and the reaction was highly dependent upon pH. Thus it is doubtful that the ability to hydroxylate atrazine is the major factor for resistance to this herbicide.

SUPPORTED BY U.S. Dept. of Agriculture

4.0140, THE INTERACTION OF MICROORGANISMS AND PESTICIDES
B.G. TWEEDY, Univ. of Missouri, School of Agriculture, *Columbia, Missouri* 65201

The importance of soil microorganisms in the degradation of representative compounds from the major classes of herbicides with special interest in those containing carbon nitrogen bonds is being investigated. The identification of the degradation products will be attempted with a GC-Mass Spectrometer. The pathways by which the compounds are degraded will be studied when the pursuance of these mechanisms are thought to be feasible. Studies will also be included to determine the effect of herbicides and their degradation products on the populations, metabolism and other properties of soil microflora and seedling plants. The induction of microorganisms to rapidly degrade representative commercial herbicides is being investigated. Combinations of fungicides and herbicides are being applied to soils incubated under field and laboratory conditions to determine the effect of fungicides on microbial degradation of herbicides.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.P.P.

4.0141, SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS
J.C. HUANG, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

The purpose of this research project is to investigate the sorption and desorption reactions of selected chlorinated hydrocarbon pesticides with clay minerals in laboratory-controlled environmental systems. Particular emphasis will be placed on ascertaining the effect of organic matter on the behavior of sorption and desorption and determining the influence exerted by selected other environmental stresses, including pH, temperature and salt concentration of the water.

Pesticide selected for this study include DDT, dieldrin and heptachlor, and clay minerals selected are kaolinite, montmorillonite and illite. Laboratory investigations will include the following studies: (a) Batch and column studies to evaluate the effect of organic matter on the sorption and desorption reactions, and (b) Aquatic model studies conducted under rigidly controlled conditions to ascertain the effect of other environmental factors on the sorption and desorption reactions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0142, SYSTEMS OF WEED CONTROL
O.C. BURNSIDE, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-12-007)

OBJECTIVE. Determine mechanism of seed dormancy and methods of destroying seed in soil. Develop selection criteria for crop competitiveness to weeds. Study factors influencing herbicide phytotoxicity and dissipation. Develop effective weed control systems.

APPROACH. Information gained from seed dormancy studies will be used in attempts to destroy weed viability in soil. Selection criteria on seedlings will be correlated with crop com-

petitiveness to weeds. The influence of herbicide placement, soil texture, climate, and production practices on herbicide phytotoxicity and fate will be studied. Weed control systems will be developed using combinations of mechanical, cultural, and chemical weed control methods.

PROGRESS: Dissipation of dicamba was greater in Sharpsburg silty clay loam than in Anselmo sandy loam and was faster in the topsoil than in the subsoil. A sprayer-flamer for weed research was produced which provided constant rate spraying, logarithmic-dosage spraying, and flaming. C-amiben methyl ester showed greater adsorption and less leaching than C-amiben. Soil texture differences had a greater influence on herbicide residue carryover than did climatic differences across Nebraska during 1962 to 1968. Leaching of herbicides into the soil profile was an avenue of herbicide dissipation. Rotary hoeing of plains prickly pear cladodes just prior to spraying improved herbicide performance. Downward movement of picloram was greater in sandy loam than in silty clay loam soils. Widely varying weed densities that had been desiccated by freezing did not reduce combine efficiency in harvesting corn, sorghum, or soybeans. Sorghum yields were reduced 4, 12, and 18% by delaying weeding of plots 3, 4, and 5 weeks as compared with 2 weeks after planting and each week thereafter. Weeds that did not emerge until 4 weeks after planting did not reduce sorghum yields. Under most Nebraska conditions, atrazine applied to sorghum at recommended rates will not persist long enough to cause yield losses of winter wheat in a wheat-sorghum-fallow rotation.

SUPPORTED BY U.S. Dept. of Agriculture

4.0143, BIODEGRADATION OF HERBICIDES IN TREATED SOILS FOR ESTABLISHMENT OF RANGE FORAGE PLANTS

J.E. MAYFIELD, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00439)

OBJECTIVE: Isolate microorganisms from range soils which are capable of detoxifying s-triazine herbicides, determine the effects of soil type, moisture, temperature, and pH on the rate of herbicidal decomposition in the presence of the selected organism, elucidate mechanisms involved in the degradation of the chemical, utilize information acquired to establish desirable grass species in recently treated range soils.

APPROACH: Microorganisms capable of detoxifying s-triazine herbicides will be selected from arid Nevada rangelands. Rapidly multiplying organisms will be selected and propagated for introduction with the desired grass species to be established on treated rangelands. The organism should create an environment free of the herbicide in the immediate vicinity of the seed, thus allowing a desirable grass to be established in a weed-free environment. Various regimes of temperature, pH, moisture and soil type will be studied determine the rate of chemical decomposition in presence of the test organism. Laboratory studies will be conducted to ascertain the mechanisms involved in microbial detoxification of herbicides.

PROGRESS: Fungi were isolated from atrizine-treated range and field soils. Four isolates of Pennicillium, Aspergillus, Hormodendrum and a filamentous yeast were compared with Aspergillus flavus on mineral media containing atrizine. One isolate of Aspergillus sp. and Hormodendrum sp. were superior to A. flavus in their ability to utilize atrizine as a carbon source. Spores of these fungi were dusted onto the surface of intermediate wheat grass and barley and the seeds planted in atrizine-treated soil. There was considerable inhibition of germination in all seeds treated with the spores of these fungi except A. flavus. Studies are underway to determine the nature of this inhibition since it was not apparent that any of the seeds had been parasitized by these fungi.

SUPPORTED BY U.S. Dept. of Agriculture

4.0144, FATE OF HERBICIDES IN PLANTS AND SOILS

R.D. ILNICKI, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00142)

OBJECTIVE: Determine the fate of herbicides in plants and soil. Ascertain the residual effects of simazine, atrazine, and other herbicides in soil. Compare other herbicides of the phenoxyalkylcarboxylic acid group with 2,4-D on wheat, barley and oats.

APPROACH: Experiments will be designed to establish the residual characteristics of economically important herbicides. Test crops will be planted the following season on previously treated sites to determine the amount of herbicide remaining and to establish the sensitivity of crops that might follow these herbicides. Other bioassay techniques will also be used in greenhouse and growth chamber studies.

PROGRESS: Linuron enters plants passively with water uptake; it is first concentrated in roots which later accumulates in shoots; most accumulates as linuron, it is later degraded through a sequence of reactions to urea and aniline; this degradation is a detoxifying mechanism; and some linuron is retained in a 'bound' form to proteins. Metabolic strides with chlorbromuron revealed the following: the herbicide is degraded to nonphytotoxic compounds in corn; no degradation occurs in cucumber; the difference in degradation explains the difference in sensitivity of these two species. Substituted ureas are recognized as photosynthetic inhibitors explaining in part their herbicidal activity. Studies with linuron, fenuron, monuron, diuron, metobromuron, fluometuron, chloroturon, and chlorbromuron indicate that, with the exception of chloroturon and fluometuron, all increased respiration in plant tissues. This was related to the degree of chlorination in the phenyl ring of the urea molecule. Substitution of one atom effected increases over no chlorine substitution and two chlorine atoms more than one substitution.

SUPPORTED BY U.S. Dept. of Agriculture

4.0145, NEMATOCIDES AND POTENTIAL NEMATOCIDAL CHEMICALS RESIDUES IN PLANTS AND DIFFUSION IN SOIL

W.R. JENKINS, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00415)

OBJECTIVE: Screen new materials for nematocidal activity residues in plants following nematocide applications to soil, and effects on quality of food crops. Factors influencing the diffusion of nematocides in soil.

APPROACH: Greenhouse and field trials of nematocides will be made to determine efficacy. Residues of nematocidal chemicals in food crops will be determined. Long-range studies will be made to determine duration of residual materials in soil. Effectiveness of nematocides under varying environmental conditions will be studied.

PROGRESS: As a result of extensive trials with nematocides on peach trees, it is now recommended that all plantings in land containing *Criconemoides* spp. be treated with dibromochloropropane either before or after planting or dichloropropenes or dibromoethane before planting. Laboratory and greenhouse tests have shown ammonia (as ammonium hydroxide) to give as good or better control of Meloidogyne javanica than dibromochloropropane. Rates as low as 0.05% ammonia gave 100% control in sandy and loamy sand soil.

SUPPORTED BY New Jersey State Government - Trenton

4.0146, CHEMICAL RESEARCH ON INSECTICIDES AND THEIR FORMULATIONS

D.J. SUTHERLAND, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00431)

OBJECTIVE: Improve insecticide formulations through study of physical and chemical properties of carriers, solvents and adjuvants used in the preparation of insecticide concentrates and the effect of these on the stability, dispersal and application coverage of toxicants. Investigate factors affecting the accumulation and decomposition of insecticides on fruits, vegetation and in soils. Investigate the penetration and dispersion of insecticides within the insect body through studies of chemical and biological spreading agents.

APPROACH: Formulation of insecticides will be investigated by small-scale manufacturing. Exposure of formulations to controlled conditions with subsequent insecticide analyses. Field conditions to determine effect on insecticide residues. The effect of spreading agents will be studied by isolating and analyzing insect intercellular constituents and determining the effect of spreading agents on such constituents.

PROGRESS: Project 431 during the past year on insecticides and their formulations has dealt mainly with the insecticide

Abate, as a granule, and factors which influence the efficiency of this insecticide and its formulation. Factors investigated have included size of granule, type of granular carrier, and solvent used to impregnate the insecticide onto the carrier. Evaluation of release has employed a laboratory continuous flow method as well as a bioassay method employing mosquito larvae. Research on the above aspect indicates that all factors mentioned above strongly influence the final efficiency of the granular formulation in the field.

SUPPORTED BY U.S. Dept. of Agriculture

4.0147, FATE OF PESTICIDES IN CLAY AND SOIL SYSTEMS

S.J. TOTH, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ000046)

OBJECTIVE: Determine the factors responsible for the retention of pesticides and herbicides by clay mineral and soils. Determine the nature of the mechanisms involved in the adsorption of these organic compounds by clay minerals and soils. Study and attempt to predict the behavior of these organic chemicals in soils of the Great Zonal Groups.

APPROACH: Clay minerals, kaolinite, illite and montmorillonite will be prepared in homoinic forms (H, Ca, Mg, K and Na) and the adsorption of organic chemicals under standard conditions will be determined. At least two members of each of the Great Soil Zonal Groups will be collected and subjected to the same procedure as the pure clay minerals. The role of organic matter in adsorption will also be evaluated.

PROGRESS: A thesis was prepared by G. MacNamara entitled, 'Adsorption of Some Pesticides on Soils, Clay Minerals and Humic Acid,' which details the four-year study of this problem. The most important findings were: adsorption of linuron, malathion and diphenamid was the lowest on kaolinite clays and the highest in humic acid systems; DDT precipitated on clay surfaces in aqueous solution which explains the persistance of this chemical in soils; adsorption of linuron and malathion by clays or soil was not an exchange reaction; adsorption of linuron and malathion was greater in the A than B horizon samples of N.J. soils; malathion adsorption by humic acid seemed to reduce its decomposition; attempts to remove adsorbed linuron by dilute acid or salt solutions was not successful indicating strong fixation and the bonding of linuron by Ca-montmorillonite was due to hydrogen bonding by the carbonyl group to the clay.

SUPPORTED BY New Jersey State Government - Trenton

4.0148, CROP & WEED RESPONSE TO HERBICIDES, & FACTORS AFFECTING HERBICIDAL ACTIVITY & RESIDUAL SOIL TOXICITY

P.P. ANDERSON, New Mexico State University, Agricultural Experiment Sta., *Las Cruces, New Mexico* 88070 (NM000046)

OBJECTIVE: Determine the effectiveness and selectivity of new herbicides and herbicide combinations in New Mexico, and to compare their effectiveness with herbicides now in use. Determine under controlled greenhouse and laboratory conditions, factors such as dosage, leaching, and site of entry that affect the activity of herbicides, and determine under greenhouse and field conditions, the residual soil toxicity of herbicides and the effect of this residue on crop rotations.

APPROACH: In primary screening tests the crops and weeds will include those of primary concern to New Mexico and be limited to ones that will readily germinate under the field conditions involved; greenhouse and laboratory investigations of highly promising herbicides will be continued, and the soil residual toxicity of herbicides and their effect on subsequent crop rotations and weed populations will be determined by field and greenhouse experimentation.

PROGRESS: In New Mexico, spurred anoda (Anoda cristata) and 'ironweed' (Flaveria repanda), two summer annual weeds are to tolerant to normal treatments of trifluralin and nitralin in cotton fields. Spurred anoda is, at present, the more serious of the two weeds, and it is a major problem in August-planted lettuce fields as well as in April- planted cotton. Early postemergence applications of prometryne or fluometuron as a directed spray has resulted in effective control of this weed in cotton, and there are indications that a new herbicide (RH- 315, trade name Kerb) will selectively control it in lettuce fields. In the laboratory, a 30 minute soaking of the seed of spurred anoda in conc. sulfuric acid was found to be needed in order for the seed to readily germinate. Field tests indicate that Eptam, Casaron, Prefar, CP-53619, SanJoz 6706, and Sinbar appear promising for the control of purple nutsedge, but crop selectivity and active soil-residues may prove to be limiting factors.

SUPPORTED BY U.S. Dept. of Agriculture

4.0149, PERSISTENCE AND TOXICITY OF INSECTICIDES IN SOILS FOR CONTROL OF SOIL-INHABITING INSECTS

G.L. MACK, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00579)

OBJECTIVE: Study the persistence of DDT, dieldrin and chlordane in nursery soils. Study the accumulation of DDT in sweet corn soils from repeated applications over a period of ten years. Determine the DDT content of soils. Determine the decomposition products of DDT in soils.

APPROACH: This will be accomplished by performing pesticide analysis, by chemical and bioassay methods, of soils which have been treated. Analysis will be made after repeated applications to determine the accumulation of pesticides as well as decomposition products.

PROGRESS: Dieldrin has been the most effective and efficient insecticide for the control of European chafer and Japanese beetle. Environmental pollution and the appearance of a Dieldrin-resistant strain of European chafer requires the development of substitute pesticides. Five non-Cyclodiene materials tested over a two year period showed Bayer 37289, a chlorinated organophosphate, to be the most promising. Soil residue analysis indicates that 1 lb. of a 20 lb. per acre application remains after 2 years and gives 100% control. A 10 lb. application gives 100% control for one year but not for two years when the soil residue was reduced to 0.2 lbs. per acre. The effective soil residue of Bayer 37289 appears to be between 0.5 and 1.0 parts per million.

SUPPORTED BY New York State Government - Albany

4.0150, STUDY BIOLOGY AND CONTROL OF EUROPEAN CHAFER AND SCARABAEID SPECIES IN NURSERY INDUSTRY

H. TASHIRO, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00525)

OBJECTIVE: Study importance and nature of European chafer injury. Develop means of control for home owner, nurserymen and for regulatory type certification treatment programs, determine toxicity of old and new compounds to the grubs, and, determine persistence of insecticides in field-treated soils.

APPROACH: Observations on the habits and life history of the insect. Phenological plant development. Assay of toxic insecticidal residues in field treatments.

PROGRESS: Two years after application of 20 lb. AI/A acre, Bayer 37289 produced 100% mortality and Dyfonate 23% mortality of 1st instar European chafer grub. The former at 2.5-10 lb. produced [illegible]% mortality. Eggs of the European chafer and the Japanese beetle were introduced into insecticide treated loam. Rates (lb./A-acre) required to eliminate 1st instar grubs were: dieldrin - 0.8 and [illegible]2, Bayer 37289 - 1.0 and 0.6, Dyfonate - 0.8 and 0.6 and Diazinon - 1.8 and 1.4 for the European chafer and Japanese beetle, respectively. Insecticide field plots initiated in a lawn in June were surveyed after 4 months. Dieldrin at 0.5 and 3.0 lb. AI/acre controlled 97 and 100% of both European chafer and Japanese beetle grubs. Chlordane at 1, 2, 4, and 8 lb/acre controlled 88, 88, 93 and 100% of the former and 53, 82, 85, and 99% of the latter, respectively. (All above studies were in cooperation with ENT., USDA). Insecticide plots were initiated in cooperation with the Cooperative Extension Association on July 3 for control of the bluegrass billbug, Sphenophorus parvulus (Gyllenhal) (C.) in home lawns. Larval reductions of 90 % were obtained with formulations and rates of AI/1000 ft as follows: Diazinon 2G and 14G at 3 oz., Baygon 5G at 3 oz. and carbaryl 80S at 6.4 oz. Over 10 weeks, carbaryl 80S treated lawn was rated highest in absence of damage and general vigor followed by

Diazinon 14G and 2G, and Baygon 50W and 5G. Chlordane was ineffective. Diazinon showed the highest toxicity to larvae and adults in laboratory evaluations.

SUPPORTED BY New York State Government - Albany

4.0151, THE ROLE OF MICROFLORA IN THE PERSISTENCE AND DECOMPOSITION OF PESTICIDE RESIDUES

M. ALEXANDER, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00061)

OBJECTIVE: Identify the intermediates and products formed during the microbial decomposition of pesticides. Investigate the mechanisms of microbial degradation of pesticides.

APPROACH: Herbicide and insecticide degrading microorganisms will be isolated from soil. The ability of these isolates to degrade the pesticide will be examined by use of intact cells and enzyme preparations. Cells or enzymes will also be incubated with suspected or proven intermediates to determine the subsequent fate of the chemicals. The products of the reactions will be identified by paper, thin-layer and gas chromatography, and by IR, UV, NMR and mass spectrometry. Cometabolism as a means of herbicide and insecticide transformation in soil will also be investigated.

PROGRESS: The metabolism of the herbicide 2,3,6-trichlorobenzoic acid (TBA) by a soil microorganism, Brevibacterium sp., was investigated. In the reaction, 1 mole each of O(2), CO(2), chloride and 3,5-dichlorocatechol were produced from each mole of TBA. The catechol was identified chromatographically and by infrared spectroscopy. The data suggest that 2,3,6-trichloro-4-hydroxybenzoate and 2,3,6- trichlorophenol were intermediates in the sequence. The apparent basis for the catechol accumulation and TBA persistence was established. Investigations of the pathway of 2,4-D degradation have continued, and the steps involved in converting the 3,5-dichlorocatechol formed from 2,4-D to the chlorobutenolide and the decomposition of the latter, possibly to chlorosuccinate and then succinate, have been further characterized. Biochemical models for the ether-cleavage reaction in 2,4-D degradation are under study, and discrete steps involved in the enzymatic cleavage of ethers are being defined.

SUPPORTED BY U.S. Dept. of Agriculture

4.0152, FACTORS INFLUENCING HERBICIDE EFFECTIVENESS

R.D. SWEET, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00758)

OBJECTIVE: Determine the influence of soil moisture, clay content, organic matter and temperature on herbicide performance and crop tolerance.

APPROACH: Work will be concentrated on the thiocarbamates because of their potential utility in vegetable crops and because of their extreme variability in the field. Research will be conducted in the laboratory and the field. Clay and organic matter will be studied on both mineral and muck soils as well as in artifical media involving clays, vermiculite, sand, peat, etc.

PROGRESS: Synergism studies yielded gratifying results. Combinations of Atrazine with either alachlor, Daxtron, Diphenamid, nitralin, or 2,4-D in the presence of non-phytotoxic oil gave plant responses 10 to 20 times that expected when applied post-emergence. Corn, however, was not damaged. Dalapon did not give synergism. Several combinations were made in which no atrazine was included. Promising results were obtained with diphenamid plus trifluralin. Synergism also occurred with trifluralin plus linuron. Unfortunately, however, linuron often caused damage to corn. In these studies total quantities of both toxicants in the successful combinations varied from 4 to 8 ounces per acre, or about 1/10 the normal dosages presently used. When developed into practical recommendations this should provide a significant boost to safeguards against any possible soil pollution from herbicides.

SUPPORTED BY New York State Government - Albany

4.0153, INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS

D.C. TORGESON, B. Thompson Inst. Plant Res., *Yonkers, New York* 10701

An investigation of the interactions of soil microorganisms and a group of chlorinated aromatic herbicides will be made. Specific objectives will be: (1) to isolate and characterize microbial species responsible for complete or partial herbicide degradation, (2) to characterize in relatively simple culture media the rates of degradation of this group of structurally related herbicides, (3) to study the influence of environmental factors such as clay, supplemental substrates, oxygen and pH levels and previous adaptation to structurally similar compounds, (4) to identify the routes of degradation and fate of degradation products, and (5) to determine if microorganisms capable of rapidlyy degrading a herbicide can be used to decontaminate soil and water.

Results from these studies should be helpful in the future design of molecules useful as herbicides but which will be degraded rapidly before they have an opportunity to pollute soil and water.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

4.0154, PLANT RESPONSE TO ORGANIC CHEMICALS IN THE ROOT ENVIRONMENT

F.T. CORBIN, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03083)

OBJECTIVE: Develop the principles concerning the uptake of organic chemicals by plant roots. Determine the degree to which herbicide susceptibility varies in the species Arachis hypogea.

APPROACH: Previous work in this laboratory has shown that dark grown excised barley roots do not markedly take up or affect organic chemicals unless they contain an aldehyde group. Attempts will be made to determine the nature of the aldehyde-root interaction. The possibility that acid conversion or microbe breakdown may be involved will first be considered. Next, the possibility of a real uptake phenomena will be pursued. Different types of root systems will be studied to select one which is more responsive to organic chemicals. For the peanut mutant work, a comparison will be made between field and laboratory techniques for estimating herbicide tolerance.

PROGRESS: The influence of microorganisms on the detoxication of 2-methoxy-3,6-dichlorobenzoic acid (dicamba) and 3-amino-2,5- dichlorobenzoic acid (amiben) was investigated. An actinomycete, in monoculture, decarboxylated COOH labeled dicamba in soil and vermiculite media. There is indication for a co-oxidation of dicamba without enrichment of active organisms. Decarboxylation of dicamba by the actinomycete was enhanced by the presence of a penicillium in the growth medium. Dextrose and dextrose containing media decreased the phytotoxicity of Amiben to cucumber seedlings. Phytotoxicity was reestablished when microbes were grown in the media. These studies contribute to our knowledge concerning mechanisms of interactions between herbicides, plants, and microorganisms.

SUPPORTED BY U.S. Dept. of Agriculture

4.0155, MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS

P.C. KEARNEY, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (0710-08-05(C))

OBJECTIVE: Determine the lateral and vertical movement in soils of known physical, chemical, and mineralogical properties of several herbicides differing in physical and chemical properties.

APPROACH: The presence of herbicides in and on soil surfaces caused by lateral and vertical movement will be determined in a well defined watershed with detailed past information on cropping history, fertilizer treatments, soil physical properties, climatic conditions, and hydrological data. Herbicides in soil and water samples will be assayed using appropriate analytical methods, including colorimetric, spectrophotometric and gas

chromatographic procedures. All data will be subjected to appropriate statistical analyses, and correlated with the soil and climatic data pertaining to the areas receiving herbicide applications.

PROGRESS: This project was initiated in 1967 to study (a) movement of picloram, 2,4-D, 2,4,5-T, and dicamba in surface and ground water and (b) distribution and persistence of the herbicides in soil. Water samples collected from flumes at the base of each watershed during and after rain storms in 1967 contained 2,4-D, but concentrations of picloram and dicamba were below the limits of detection. The highest concentration of 2,4-D was 28 ppb. After the 1969 applications, 2,4,5-T was detected in water samples taken at the base of watershed 2 during the first and second storms. The highest concentration was 48 ppb. Herbicides were present in surface runoff water collected at the base of the 0.05-acre plots. In 1968 concentrations in surface runoff at the base of the small plots were 1224, 583, and 229 ppb for 2,4-D, 2,4,5-T, and picloram, respectively. Highest concentrations of the herbicides in surface runoff at the base of the small plots were found in 1969 when the application rate was 4 lb/A. Samples taken after the first storm causing significant runoff contained the highest concentrations. These were 1882, 681, and 4187 ppb for 2,4-D, 2,4,5-T, and picloram, respectively.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0156. INACTIVATION AND LOSS OF PESTICIDES FROM SOIL

S.B. WEED, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC01062)

OBJECTIVE: Determine mechanisms of inactivation and loss of pesticides by/from soil colloids by studies of retention and release, movement of water through soil, non-biological degradation.

APPROACH: Retention and release of selected pesticides by reference inorganic and organic adsorbents studied as functions of adsorbent type, complementary ions and molecules, pH, and solution composition using adsorption isotherms, column chromatography, etc. Analytical techniques include X-ray diffraction, infrared adsorption, and D.T.A. Movement of pesticides studied using soil columns and related to soil properties and pesticide characteristics. Nonbiological degradation of pesticides studied as a function of adsorbent type, chemical environment, moisture content, etc. System will be treated for removal of all biological effects on degradation.

PROGRESS: 1. Diquat adsorbed by montmorillonite is not herbicidally active until the amount absorbed approaches the clay CEC. Inorganic cations (K, Cs, Ca, Mg, Ba, Al) do not effectively exchange adsorbed diquat, and presence of these ions in the growth medium does not increase diquat availability. However, addition to the growth medium of an organic cation (N-(4-pyridyl) pyridinium chloride) capable of desorbing diquat from montmorillonite makes the diquat available to plants. 2. Malathion adsorbed by montmorillonite saturated with polyvalent inorganic cations is readily recovered by extracting the aqueous suspension with CCl_4. Clay saturated with monovalent cations retained part of the malathion, suggesting that bonding directly to the cation is less readily broken than a water-bridge bond. 3. CO and PO groups are actively involved in bonding of organophosphates to montmorillonite. No evidence was found for bonding through the PS group. 4. Adsorption of monuron and fenuron to Ca-montmorillonite decreased but did not prevent their release to dilute $CaCl_2$ equilibrating solutions. Monuron was more readily removed than fenuron. 5. The results suggest that adsorption via coulombic attraction may inactivate organic herbicide molecules, adsorption via less energetic bonds may at most decrease the tendency to move. These findings help explain the fate of pesticides added to soils.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0157. CHEMISTRY OF ADSORPTION OF PESTICIDES ON SOIL SILICATES

S.B. WEED, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC01061)

OBJECTIVE: Determine the effect of site and magnitude of structural charge of soil 3-layer silicates on the adsorption and retention of selected organic pesticides. Determine the effects of inorganic cation population, pH (as related to exchangeable H and Al), and complementary organic molecules on the retention of selected organic pesticides by layer silicates. Determine the nature of the bond between the adsorbed pesticide and the layer silicate. Investigate the catalytic degradation of adsorbed organic pesticides. Determine the relative toxicity of adsorbed vs. 'free' pesticides.

APPROACH: Construction of adsorption isotherms. X-ray diffraction studies of basal spacings of layer silicates as related to amount of the pesticide adsorbed and the ambient relative humidity. Infra-red studies of free and adsorbed pesticides will be made. Determine suitable chromatographic and tracer techniques to be used. Utilize suitable test organisms to evaluate effects of adsorption on activity of selected pesticides.

PROGRESS: Malathion was adsorbed in the interlayer space of montmorillonite saturated with Na, K, Cs, Mg, Ca, Sr, Ba, Al, or Li. The adsorption mechanism for the air-dry systems was bonding directly between the carbonyl oxygen and the monovalent cations, while a water bridge was involved in the case of the polyvalent cations. Malathion in water diffused across a separating fritted glass membrane and was adsorbed by montmorillonite in suspension in approximately a 1:1 molar ratio, calculated on an exchangeable cation basis. Adsorbed malathion was readily recovered by extracting the aqueous clay suspensions with carbon tetrachloride. There was no evidence for degradation of the malathion. Diquat and paraquat were competitively adsorbed on a series of micas and collapsed vermiculites. A positive linear relationship between the equivalent fractions of diquat adsorbed (q/q(o)) and the surface charge densities of the adsorbents was confirmed. A similar study using a series of montmorillonites yielded a positive linear relationship between (q/q(o)) and CEC. The results thus indicate that the relative energy of adsorption as well as the amount of material adsorbed is affected by the clay charge.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0158. PHYSIOLOGY AND CONTROL OF WITCHWEED IN CORN

G.H. EGLEY, U.S. Dept. of Agriculture, Crops Research Division, *Waterville, North Carolina* 28472 (0710-01-17)

OBJECTIVE: Discover more efficient chemical and/or cultural methods of selectively controlling witchweed in crops. Obtain a basic understanding of witchweed physiology, seed germination and seed dormancy so that better witchweed control methods may be developed and effectively used.

APPROACH: Conduct greenhouse and field tests to discover herbicides that control witchweed selectively in crops. Characterize persistence of selected herbicides in the soil. Discover methods of selectively stimulating or inhibiting germination of witchweed seeds. Determine physical and biological factors contributing to witchweed seed dormancy and seed longevity.

PROGRESS: Seed of the angiospermous root parasite, Striga lutea, are normally dormant, but they usually germinate under favorable conditions of temperature and moisture when exposed to exudates from certain plant roots or to ethylene gas. Since seedlings die in the absence of a gramineous host, we are investigating the stimulation of seed germination in the absence of a host as a means of controlling this obligate parasite of corn. Under ideal conditions, as little as 0.1 lb/A of ethylene induces germination of witchweed seed in the greenhouse, and corn, cotton, and garden peas were not injured by injection of 1 to 20 lb/A of ethylene gas into soil before planting the crops, or into soil around 14-day old plants or germinating seed of the crops. One year after applying 8 lb/A of pyrichlor on the soil surface the soil contained herbicide residue injurious to soybeans at depths down to 12 inches at each location. On plots treated with 8 lb/A of picloram, herbicide residues toxic to soybeans occurred in soil from all depths down to 60 inches. In plots treated with 8 lb/a of 2,4-D, no residue toxic to soybeans was found in soil at any depth down to 60 inches.

4. PESTICIDES

SUPPORTED BY U.S. Dept. of Agriculture

4.0159, EFFECTS OF ORGANIC PHOSPHATE INSECTICIDES ON MICROBIOLOGICAL PROCESSES AFFECTING SOIL FERTILITY

B.R. FUNKE, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-H-08-006)

OBJECTIVE: Determine the effects of organic phosphorus insecticides on nutrification, nitrogen fixation, ammonification, etc. Isolate the organisms capable of degrading these compounds and determine: metabolism of the compounds, and possible toxic effects of the metabolites on soil processes.

APPROACH: Nitrification, nitrogen fixation, etc. will be determined by in vitro and greenhouse methods. Effects of insecticide concentrations and various environmental conditions will be investigated. Organisms capable of degrading these compounds will be isolated by enrichment techniques and attempts will be made to identify the metabolites.

PROGRESS: Completed work on survey of nine organophosphate and three carbamate insecticides on nitrification, legume growth, and on growth of pure cultures of several Rhizobium sp. Nitrification: None of the insecticides significantly inhibited nitrification at 5 or 50 ppm. At 500 ppm Dyfonate, Bayer 68138, Bayer 37289, Dursban, Temik and Baygon caused at least some inhibition. Inhibition by Temik and Baygon almost 100% at 500 ppm and nitrites accumulated for several days. Legumd growth: The carbamates Baygon, Furadan, and Temik were strongly inhibitory to legume development, particularly at 50 and 500 ppm. Among the organo-phosphates only Dursban approached them in phytotoxicity. Alfalfa and sweetclover were the test plants, grown in plastic growth pouches. Little significant effect on growth was observed with the remaining insecticides, at least at 5 and 50 ppm. Disc Inhibition: Four Rhizobium species were tested. The most inhibitory insecticides were Baygon, Temik, Bayer 37289, Trichlorfon, Bayer 68138, and Dasanit. The least were Dursban, Carbophenothion, and Diazinon. Began preliminary work to investigate in detail the severe effect of some of these insecticides on nitrification and reasons for nitrite accumulation.

SUPPORTED BY U.S. Dept. of Agriculture

4.0160, ENCAPSULATION OF INSECTICIDES AND VIRUSES FOR CONTROL OF INSECTS

J. BAKAN, Natl. Cash Register Company, *Dayton, Ohio* 45409 (00ENTCO5173709CO)

OBJECTIVE: Determine through research the feasibility of controlling insects using encapsulated formulations of insecticides and virus.

APPROACH: Using established patented encapsulated procedures, prepare insecticide and virus formulations which release their content at a uniform rate over a period of from one to six weeks.

PROGRESS: Studies indicated that formulations involving encapsulation of insecticides and viruses delayed release of these materials under field conditions and gave promise as a technique for use in control of insect pests. Capsules of malathion with slow release rates persisted on foliage of plants up to 4 months with little loss of the malathion. Encapsulated malathion was also maintained in wet soil indoors for almost a year with little insecticidal loss. Tests on ants indicated that control can be achieved far beyond the usual life expectancy of the insecticide. Field tests were conducted against the European corn borer, alfalfa weevil, corn earworm, cotton bollworm, corn rootworm, and grasshoppers. Considerable worthwhile information was obtained on application techniques and behavior of microcapsules under field conditions.

SUPPORTED BY U.S. Dept. of Agriculture

4.0161, BIOLOGICAL SOIL COMPONENTS DETERMINING PERSISTENCE AND DETOXIFICATION OF BIOCIDES

J.Q. LYND, Okla. St. Univ., Agricultural Experiment Sta., *Stillwater, Oklahoma* 74075 (OKL01244)

OBJECTIVE: Determine soil biological parameters governing pyridyl biotoxic transformations and degradations with soil types representative for key soil orders.

APPROACH: Soil microfloral association isolates active in soil pyridyl degradation transformations will be attained through enrichment culture techniques with governing soil biological interactions determined for controls in rates and magnitude of pyridyl biotoxic diminution. Bench mark soil factors and microfloral interactions will be computerized in correlation for projecting soil biological controls to ranges in soil and climate conditions.

PROGRESS: Parameters were identified for soil transformations of chlorinated pyridine phytoxicity to Robinia pseudoacacia. Indicator plant aberrations at threshold herbicide levels were established with Cucumis sativa for the pyridyls. Least squares computerized statistical procedure was developed correlating 'Bench-mark' soil characteristics for establishing soil biological controls determining pyridyl bioactivity and degradation. Four common, ubiquitous soil microfloral associations dominated by the genera: Aspergilli, Trichoderma, Mucor, and Penicillium, significantly altered and degraded bipyridyl biotoxins. Vector magnitudes and rates of bioactivation with eventual detoxification were greatly influenced by soil epipedon characteristics including texture, clay type, pH, organic amendment composition, temperature, and biotoxin concentration. Defined presynthesized growth factors: indole, picolinic acid, tryptophan, and yeast extract ameliorated pyridyl fungitoxicity.

SUPPORTED BY Oklahoma State Government

4.0162, BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

P.W. SANTELMANN, Okla. St. Univ., Agricultural Experiment Sta., *Stillwater, Oklahoma* 74075 (OKL01324)

OBJECTIVE: Determine the effects of climatic and edaphic factors on movement, persistence and toxicity of herbicides in the soil.

APPROACH: Soil characteristics determining the effect of biological decomposition, absorption, volatilization, and leaching on the phytotoxicity and persistence of the herbicides in Southwestern soils will be evaluated. The persistence under field conditions will be determined on two contrasting representative soil types used in cotton and grain sorghum production. Dissipation studies using controlled temperature and humidity cabinets and the greenhouse will include soil variables of moisture tension, organic amendments, pH, temperature, and fertility level. Using basic hydrodynamic and chromatographic models, information will be provided for describing the mixing of the herbicides in a soil-water system. Using field sited and controlled methods for altering the soil-water redistribution a relationship between the volume of water applied and the amount of herbicide moved will be studied.

PROGRESS: A cooperative regional soil bioassay technique experiment was developed and evaluated. No one assay evaluation procedure was uniformly best. The influence of CaCl(2) concentration on the mobility and adsorption of prometryne and fluometuron was studied. Calcium saturated loamy fine sand and loam soils were used. More fluometuron was adsorbed in the presence of 0.01 N than 0.5 N CaCl(2) in both transient and adsorption isotherm systems. Prometryne adsorption was greater in the presence of 0.5 N than 0.01 N CaCl(2) in both soils. Prometryne mobility was retarded, owing to adsorption, in the presence of 0.5 N CaCl(2). The influence of soil textural stratification on the movement of fluometuron was studied. The texturally stratified soil columns showed significant differences in the relative fluometuron concentration distribution. Not all textural stratifications gave a difference and the results did not relate to total porosity differences between the two soils. The greater the pore size range in the second soil of the stratification the greater mixing and early arrival of the herbicide in the effluent.

SUPPORTED BY U.S. Dept. of Agriculture

4.0163, APPLICATION OF AGRICULTURAL CHEMICALS

G.E. PAGE, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00502)

OBJECTIVE: Study factors which influence either drift or proper placement of agricultural chemicals; develop methods and equipment for more effective incorporation of soil active herbicides; develop methods and equipment for more effective control of symphylans, nematodes, and soil borne insects and plant disease; develop and test equipment for application of insecticides and fungicides where a special need exists due to lack of adequate equipment for control on a particular crop; develop equipment for application of polyhedrosis virus for cutworm control.

APPROACH: Laboratory and field tests will be conducted to determine effect of physical properties (viscosity, density, etc.) of spray solutions on drift and distribution patterns. Soil incorporation studies will be continued to determine optimum incorporation equipment for various herbicides and crops. Continue work on soil fumigation practices and equipment with special interest on established crops (mints and berries) in Western Oregon and annual crops in Eastern Oregon.

PROGRESS: The Lilliston rolling cultivator is almost equal to the Howard rototiller for the incorporation of Roneet and Trifluralin herbicides into a prepared seed bed for weed control in sugar beets. The Lilliston rolling cultivator did not work well under light sod conditions for incorporation of Nitralin and Trifluralin in apple orchard. In soil treatments over 20 percent of Zinophos and Dyfonate was lost prior to incorporation into the soil.

SUPPORTED BY: Oregon State Government

4.0164, BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM

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OBJECTIVE: Elucidate the manner in which chemicals behave in various parts of the forest environment and their impact on the biota, in solving problems of environmental pollution connected with forest use of economic chemicals.

APPROACH: Develop information leading to better understanding of the principles of chemical behavior in the forest environment; through the use of mathematical models, predict the behavior of a given chemical in a given environment; and assess the impact of chemicals on living organisms.

PROGRESS: The systemic insecticide, phorate, persists in a forest environment for as much as 18 months. Tannin content of Douglas-fir bark used as a mulch is not harmful to soil microbes. Tree barks have a number of potential uses in agriculture and are chemically and physically adaptable to beneficial utilization. Herbicide residues in fall runoff from treated lands are greatest when the chemicals are applied in late summer and the first fall storms are of high intensity. Relative rates of degradation of phenoxy herbicides and picloram are not influenced by starting concentration. Amitrole, 2,4-D, 2,4,5-T, and picloram are degraded in forest floor material but at markedly different rates. Primary root elongation is inhibited and abnormal lateral root proliferation is observed in two-day-old pea seedlings treated with a variety of herbicides. A soluble cytoplasmic protein associated with zones of meristematic activity or tissue expansion has been found in roots of pea seedlings. A method has been developed to isolate this protein by ammonium sulphate fractionation and preparative scale gel electrophoresis. No appreciable movement of DDT from forest floor to mineral soil was observed after aerial application of the chemical. Picloram herbicide had no significant effect on microbial activities in three soils of different characteristics. Nitrogen in avalanche debris has been shown to develop as a result of nitrogen fixation by Sitka alder.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0165, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

V.V. VOLK, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00873)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to (i) pesticide transport through the soil in infiltrating water, and (ii) pesticide desorption from eroded soil into surface waters. Develop mathematical model(s) which will provide semiquantitative prediction of pesticide movement in soil-water systems based on input data obtained.

APPROACH: Oregon soils with known chemical and physical properties will be leached with water solutions of 2,4-D, 2,4,5-T, and picloram. Upon leaching, the movement of the herbicide will be ascertained through radioisotope assay. As an aid to interpretation of the results of the movement studies, adsorption and desorption isotherms will be prepared for the same soils and chemicals. Having obtained the distribution of a chemical through the soil column as a function of leaching, soil, and chemical variables, an attempt will be made to relate results to a mathematical model used to predict movement. The relative importance of soil and chemical variables considered in the model will be adjusted so that chemical movements in a soil profile may be made.

PROGRESS: The movement and adsorption of 2,4-D acid in selected Oregon soils were studied as a function of pH, organic matter, and the presence of acidic cations. A decrease in the movement and an increase in adsorption of 2,4-D acid could be induced by the presence of Fe , and Cu cations on the exchange sites. The reduced 2,4-D mobility was attributed predominantly to the decreased pH of the soil with acid cation saturation. However, evidence was observed to indicate the formation of a complex between the 2,4-D and the hydrated Fe, Al, and Cu. Equilibration of the natural and the Fe, Al, and Cu saturated soils with 50 ppm of 2,4-D at 25 C for 24 hours showed the 2,4-D adsorption to decrease in the following order: Fe-soils, Al, Cu-soil, natural Lookout silt soil. Water solubility of the 2,4-D salts of Fe, Al, and Cu increased from 195 to 354 to 1069 ppm respectively. The effects of pH and extractable aluminum on the 2,4-D adsorption appeared to indicate that adsorption was directly associated with the degree of dissociation of the 2,4-D acid as governed by the pH of the system.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0166, PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER

J.M. BOLL, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01761)

OBJECTIVE: Observe the response of microorganisms in soil and water to specific pesticides; evaluate microbial activity by product identification; establish mechanism of detoxication.

APPROACH: Microbes from soil and water will be cultured and exposed to specific pesticides. Product identification will be by chromatographic, spectrophotometric and other procedures.

PROGRESS: The decomposition of the pesticide Sevin, 1-naphthyl N- methylcarbamate, was investigated with several microbial isolates from soil. Its transformation was followed periodically by different chemical methods. It could be established that all the isolated microorganisms hydrolyzed Sevin to 1-naphthol. A fungus, identified as Fusarium solani, metabolized 1-naphthol rapidly, whereas one bacteria, a gram negative coccus, degraded the hydrolysis product gradually and a third isolate, a gram positive rod, accumulated it. Since 1-naphthol was identified as a metabolic product, its C-ring labeled form was added to the growth medium and the disappearance of radioactivity compared with that of the side-chain labeled C-Sevin. F. solani decreased the radioactivity of the labeled Sevin almost completely whereas only 20% of the radiocarbon from 1-naphthol disappeared, but the remaining radioactive compound constituted a new product. The bacterial coccus, however, was active in degrading the radioactivity of the ring labeled 1-naphthol but a considerable amount of the radiocarbon from the metabolized Sevin remained in the medium. The mixed culture of the two microbes was very effective in degrading Sevin as well as 1-naphthol and this suggests that complete biodegradation is performed in combined growth. Studies have been initiated in order to determine the microbial decomposition of metobromuron and maloran. Tentative evidence was received that the two ureas are degraded to the corresponding anilines.

4. PESTICIDES

SUPPORTED BY U.S. Dept. of Agriculture

4.0167, PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL
J.K. HALL, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01663)

OBJECTIVE: Relate persistence and movement of herbicides to the physical, chemical and mineralogical characteristice of soil types in Pennsylvania. Determine by bioassay and chemical analyses the effects of soil properties and climatic conditions on the minimum soil solution concentrations of different herbicides which are toxic to crop species. Determine the adsorption of herbicides on the colloidal soil constituents. Determine the effect of herbicide residues in soils on nutrient uptake by crops.

APPROACH: Analysis of herbicide residues in soil, water and plant tissue will be carried out by bioassy, UV-adsorption spectrophotometry, and gas chromatography. Nutrient solutions and clay cultures will be used to grow plants in a growth chamber to determine the minimum soil solution concentrations of different herbicides which are toxic to crop species. Infrared absorption spectrophotometry, x-ray analysis and various chemical techniques will be used to study the adsorption of herbicides by pure and soil clay minerals. Uptake of soil nutrients by plants, grown in soils to which a range of herbicide concentrations have been applied, will be measured in greenhouse experiments.

PROGRESS: Losses of atrazine from a Hagerstown silt loam of 8% slope related to rainfall and rates of application of pesticide. Total atrazine concentrations in runoff water in 1967 were 0, 0.77, 1.54, 1.60, 3.39, 5.65 and 7.78 ppm from plots treated with 0, 0.5, 1.2, 4, 6, and 8 lb./A of atrazine. Concentrations in eroded soil the same year were 0, 0.49, 2.16, 8.57, 14.56 and 19.54 ppm, respectively. Atrazine was detected in three collections (3/9) of runoff water in 1968, total ranging from 0.05 to 0.15 ppm. Concentrations in eroded soil were again higher than runoff water at all rates but less than 1967 values. Soil core samples collected at intervals each year indicated that the percentage of applied atrazine decreased from 87% in June, 1967 to 27% in Sept. 1967, and from 19% in Apr., 1968 to 5% in Sept. 1968. Total losses of atrazine in 1967 were 1.05 lb/A (runoff water) and 0.59 lb/A (eroded soil) which equaled 4.9 and 2.7 percent of the total applied. Losses in runoff water and soil in 1968 amounted to 0.02 and 0.04 percent, respectively.

SUPPORTED BY U.S. Dept. of Agriculture

4.0168, REPLACEMENT OF CULTIVATION WITH CHEMICALS
W.E. LARSON, Coll. of Agriculture, *Wroclaw, Poland* (E21-SWC-12)

OBJECTIVE: Influence of replacement of mechanical tillage with herbicides on crop yields and soil properties.

APPROACH: Five treatments consisting of tillage and weed control chemicals at two levels of fertilizer on four crops at two locations are being studied near Wroclaw, Poland. Visual observations of development of crop plants and weeds, as well as quantitative measurements of emergence, growth and yield of the economic product and foliage and roots of plants will be made. Water content, porosity, soil strength, aggregation, microstructure, and other physical properties of the soil will be made. Assimilable phosphorous, potassium, magnesium, and calcium, nitrogen, organic matter and soil reaction will be made. Soil content of herbicides, free amino acids, azotobacter, papillary bacteria, algae, and soil mesofauna will be determined periodically. Other plant and soil measurements will be made as the need arises.

PROGRESS: The experiment is proceeding according to the research plan. The experimental areas have been well characterized; however, few data will be available for another six months.

SUPPORTED BY U.S. Dept. of Agriculture

4.0169, THE DISPOSITION OF PESTICIDES IN THE SOIL
H.D. DUBEY, Univ. of Puerto Rico, Agricultural Experiment Sta., *Mayaguez, Puerto Rico* (PR00189)

OBJECTIVE: Determine the physical, chemical, and biological processes, and soil characteristics which are important in the disposition of pesticides in soils.

APPROACH: Soil samples from different agricultural regions of the Island will be treated with different pesticides and incubated for varying periods. Effect of pesticides on the beneficial soil microbiological processes will be studied by changes in the relative microbial population, microbial respiration, nitrification, nitrogen fixation, and sulfur oxidation. Influence of physical and chemical soil properties, pH, moisture, and temperature on these processes will be studied in soils treated with pesticides. Pesticides to be studied initially are Di-syston, diuron, ametryne, 1,2-dibromomethane and maneb.

PROGRESS: Effect of fungicides dyrene and manzate alone and in combination (1:1 ratio) at rates from 15 to 960 ppm on nitrification, nitrogen mineralization, microbial population were studied in a lateritic soil and an alkaline alluvial loam, by the incubation method for a period of 16 weeks. Manzate was more inhibitive of nitrification than dyrene. Soil type influenced this effect, inhibition was more pronounced in the slow nitrifying lateritic soil than in the fast nitrifying loam. Inhibition persisted for more than 16 weeks at higher rates of application. There was no synergistic effect on nitrification inhibition when the two fungicides were applied in 1:1 ratio. Persistent effect on nitrogen mineralization was noticed only at 960 ppm, irrespective of soil type. Fungi and actinomycetes were reduced, but bacteria were increased by these fungicides. Soil type influenced the degree of this response, the effect of dyrene was more pronounced in the acid lateritic soil and that of manzate in the alluvial loam. Manzate caused qualitative and quantitative change in the fungal population of the loam. Sugarcane stunting on an alkaline alluvial loam was caused by repeated applications amounting to about 80 lb/A or dyrene, manzate and zineb to the preceding tomato crop. The microbiological equilibrium of the soil was upset, nitrogen mineralization and nitrification were adversely affected, resulting in nonavailability of nitrogen to the crop. By application of mineral nitrogen to the affected soil normal healthy plants were obtained.

SUPPORTED BY U.S. Dept. of Agriculture

4.0170, CLIMATIC AND SOIL FACTORS INFLUENCING HERBICIDE ACTIVITY AND PERSISTENCE
L.C. LIU, Univ. of Puerto Rico, Agricultural Experiment Sta., *Mayaguez, Puerto Rico* (PR00147)

OBJECTIVE: Develop background information on herbicidal activity under various climatic, edaphic and microbial conditions of Puerto Rico.

APPROACH: Studies will be carried on to determine the influence that certain climatic conditions (sunlight, temperature, rainfall, etc.) and different soil properties (texture, organic matter, quantity and type of clay minerals, pH and cation exchange capacity) may have upon the persistence, penetration, effectiveness, toxicity to crop plant and activity of herbicides. Some phases of the above outlines work will be carried in the greenhouse while others will be performed under field conditions or both.

PROGRESS: Two separate studies were conducted to determine the adsorption characteristics of ametryne and diuron in the soil and the persistence of ametryne, diuron, fluometuron, norea, prometryne, and terbacil in a Mabi clay soil treated 13 months ago. The results of the adsorption study indicate that the various soils differed greatly in their capacity to adsorb ametryne and diuron. The Cano Tiburones soil was found to be the most adsorptive and the Toa sandy loam the least. Adsorption by other soils was between these two extremes. In general, diuron was adsorbed to a greater degree than ametryne. In the second study, herbicide residues at the 0-4 inch depth were found to be relatively low in plots treated with 4 pounds per acre of either ametryne, diuron, fluometuron, norea, and prometryne or 2 pounds per acre of terbacil. Residues were found to increase in the 0-4 inch depth as the herbicide rate was raised. Thus, fluometuron and diuron were detected at rather high concentration when applied at 16 and 32 pounds per acre. At the corresponding rates, only small to moderate amounts of ametryne, norea, prometryne, and terbacil were detected.

SUPPORTED BY U.S. Dept. of Agriculture

4.0171, MECHANISM OF ADSORPTION OF VARIOUS HERBICIDES BY SOIL HUMIC SUBSTANCES

G.T. FELBECK, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00008)

OBJECTIVE: Determine functional groups on soil humic substances responsible for adsorption of herbicides, kinetics of adsorption and desorption of herbicides by soil humic substances, and examine effect adsorption has on activity and persistence of herbicides in soil with goal of improving methods of reducing persistance after herbicidal requirements have been met.

APPROACH: Soil O.M. to be fractionated by solubility and chromatographic techniques and effects of various fraction on adsorption and desorption of herbicides determined, using 1 - labeled materials. Kinetics of adsorption to be examined mathematically by adaptation of enzyme systematics. Greenhouse and field experiments based on consideration of 1 and 2 above, to study effects of various O.M. amendments on herbicide persistance and toxicity.

PROGRESS: A study of the chemical hydrolysis of atrazine (Atr) catalyzed by soil organic matter fractions was carried out in 95% ethanol (EtOH) using the EtOH-insoluble fraction of humic acid. The reaction followed first order reaction kinetics for the first 40% of the hydrolysis, with a curvature appearing in the reaction plot as the hydrolysis continued. In equimolar solutions of Atr and hydrolyzed atrazine (AtrOH), the presence of AtrOH unhibited the hydrolysis of Atr to the extent of 16% over pure Atr mixtures in a period of 21 days. Adsorption studies indicated that the adsorption of AtrOH was much greater than Atr by humic acid at equimolar concentrations. Desorption studies with 95% EtOH, aqueous Ca(OAc)2, and aqueous Ba(OH)(2) indicated that all three reagents were about equal in the desorption of Atr, but that the desorption of AtrOH by Ba(OH)(2) was twice that of Ca(OAc)(2). Very little AtrOH was desorbed by 95% EtOH. These data suggest that Atr reacts only with the COOH group of the humic acid complex, but that AtrOH may be adsorbed by both the COOH and GH groups. Further studies to clarify this point are currently underway.

SUPPORTED BY U.S. Dept. of Agriculture

4.0172, TURFGRASS WEED CONTROL

J.A. JAGSCHITZ, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00232)

OBJECTIVE: Develop sound recommendations for selective and safe herbicidal elimination of various weeds from turfgrass stands and to determine the response of germinating turfgrass seed and seedlings to these herbicides. Determine whether herbicide resistant strains of common dandelion exist and to study the growth habits of this plant. Develop bioassay methods for determining the presence and levels of herbicidal soil residues. Investigate effects of soil residues of herbicides on growth of established turfgrass and chemical methods for eliminating harmful or objectionable residues.

APPROACH: Pre- and post-emergence herbicides will be evaluated on fine turf, lawn and utility turfgrass. Inconsistancies in control of common dandelion will be investigated by making detailed studies of the species and its associated growing conditions. Soil herbicide residues will be evaluated at different time intervals by means of bioassay techniques and by studying effects on growth of turfgrass.

PROGRESS: Preliminary studies indicate that in established turf chemical preemergent control of dandelion, mouseear chickweed and broadleaf plantain may be feasible. Preemergent control of crabgrass was obtained with half rates of bandane, bensulide, DCPA, nitralin and siduron in the second year after use at full rates. Results were fair with DMPA and terbutol and poor with benefin. Experimental herbicides which appeared promising for preemergent, crabgrass control were as follows: CP-53619, D-292, NC-5651, M-3251 and RP-17623. Results with MF-415, MF-416 and VCS-438 were discouraging. Good control of annual bluegrass was obtained in putting-green turf after four annual applications of bensulide, tricalcium arsenate and lead arsenate. Ethrel, maleic hydrazide and MF-415. MF-416 are promising chemicals to prevent annual bluegrass seed formation and possibly reduce potential infestation.

SUPPORTED BY U.S. Dept. of Agriculture

4.0173, USE OF FENURON IN CONTROL OF SCRUB OAK

N.B. GOEBEL, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00579)

OBJECTIVE: Ascertain the minimum dosage of fenuron needed to effectively control undesirable hardwoods prior to reforestation.

APPROACH: Fenuron pellets will be broadcast in selected hardwood stands at rates of 5, 10, 20 and 40 pounds per acre, six months prior to fall planting of loblolly pine. Evaluation of kill is recorded for species, density, size as affected by rate of application.

PROGRESS: Fenuron was applied to Piedmont scrub oak stands at rates of 5, 10, 20 and 40 pounds per acre. One year later, and for four consecutive years, loblolly pine was interplanted as a test for presence of residual fenuron in the soil. The effectiveness of the fenuron in controlling scrub oak will be analyzed. Survival counts of the loblolly pine plantings will also be made. Inactive this period. Survival and growth of interplanted seedlings remains to be checked, after which a final report will be prepared.

SUPPORTED BY South Carolina State Government

4.0174, THE DISPOSITION OF PESTICIDES IN THE SOIL

C.E. RIECK, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00822)

OBJECTIVE: Determine the physical, chemical, and biological processes, and soil characteristics which are important in the disposition of pesticides in soils.

APPROACH: Studies will be made of the physical, chemical, and biological processes, together with soil characteristics which are important in the disposition of pesticides in South Carolina soils. Particular emphasis will be directed to soil reaction and the concentration of exchangeable cations on the colloids and in the equilibrium solution as affecting molecular structure, mobility, phytotoxicity, rate of inactivation, and vaporization of important pre- emergence herbicides and foliar-applied insecticides used on Piedmont and Coastal Plain agricultural soils. Since it is virtually impossible to ignore physical and biological soil characteristics, effort will be made to evaluate their interactions with the chemical phase of the problem, when this necessary. Some effort will be directed toward relating extractable soil-contained pesticides with biocidal activity to provide a possible diagnostic tool and to relate fixation and degradation to persistence.

PROGRESS: The effects of soil microorganisms on 4-(methylsufonyl- 2,6-dinitro-N,N-dipropylaniline (Nitralin) were investigated in growth chamber and laboratory experiments. Soil fungi were isolated from several Piedmont soils that had been enriched with Nitralin. These heterotrophic organisms were able to utilize Nitralin as their sole source of Sulfur. They were not able to utilize the herbicides as a carbon source. Soil incubation studies have shown that to obtain maximum phytotoxicity with Nitralin there is an indefinite time period (5-10 days) in which the herbicide must be in the soil. These studies indicate that a metabolite may be more phytotoxic than the parent molecule.

SUPPORTED BY U.S. Dept. of Agriculture

4.0175, WEEDS AND WEED CONTROL

J.F. STRITZKE, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00032)

OBJECTIVE: Develop practical methods of controlling weeds in cultivated land, grassland or other uncultivated land. Improve and develop cultural methods of control, chemical methods of control, develop methods of control that utilize chemicals and cultural practices. Investigate new chemicals that indicate they have herbicidal properites. Study physiological, morphological and agronomic responses of weeds and agronomic crops to herbicides; factors affecting crop yield. Biochemical response of weeds. Determine differences in growth habits, means of propagation and physiological activity of weeds. Study factors affecting activity of vegetative buds, development, maturation and germination of weed seeds.

4. PESTICIDES

APPROACH: Research included studies of combinations of crops, chemicals and cultivation to eliminate and prevent reinfestation of leafy spurge and Russian knapweed; studies on the use of barban and avadex for wild oats control inflax, wheat and barley; studies of chemicals for pre-emergence weed control in corn and soybeans; screening tests of 6 to 8 new chemicals on 7 species of noxious weeds at 3 dates and 21 locations.

PROGRESS: A four-year study on persistence and soil movement of picloram has been completed. Picloram used at 1/2 to 3 lb/A was found to leach through the soil profile vertically and longitudinally and some picloram was present throughout the soil profile 3 years after treatment. Results of a four-year study for wild buckwheat control indicate that excellent control of wild buckwheat is possible in small grains and flax with bromoxynil. The highest yields of barley, oats, and wheat were obtained on plots treated with 4 oz/A of bromoxynil plus 4 oz/A of MCPA. Bromoxynil was effective on many annual broadleaf weeds but not on wild mustard. Dicamba was more effective on wild buckwheat than 2,4-D but not more effective on other common broadleaf weeds. Excellent control of Canada thistle was obtained with post emergence treatments of atrazine plus oil. The most effective treatment was a split application of 2 lb/A plus 1 gallon of crop oil followed in three weeks by another 2 lb./A plus 1 gallon of oil. Flax was more tolerant to atrazine than the small grains and can be used as a rotational crop following the use of atrazine.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0176, FATES OF AGRICULTURAL CHEMICALS IN SOILS

E.M. WHITE, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00518)

OBJECTIVE: To study the fertilizer element, pesticide and herbicide contents in agricultural surface-water runoff; vertical movement in soils of different textures and drainage characteristics; management practices that determine the amount added to surface and groundwater runoff.

APPROACH: Surface water runoff from established plots at Madison, Garden City, Cottonwood, and plots proposed at Presho will be analyzed for fertilizer elements (and other agricultural chemicals if applied) to determine the quantity lost with different management practices and different soils. Additional water samples will be analyzed from areas with other soils when the management practices can be ascertained. Soil profiles will be studied to determine the movement and fate of applied agricultural chemicals.

PROGRESS: This project was initiated July, 1969. Runoff samples were collected from runoff plots at Madison and Garden City for analyses of the plant nutrients. Soils in the plots were also sampled for laboratory analyses to determine the relationship between nutrient levels of the soils and the runoff. Vegetation and soil from the Altamont Prairie were sampled twice this fall to establish the nutrient levels prior to freezing, so sample can be collected in the spring to determine the amount of nutrients which could be lost in snow melt runoff.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0177, BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

L.S. JEFFERY, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00045)

OBJECTIVE: Determine the effects of climatic and edaphic factors on movement, persistence and toxicity of herbicides in the soil.

APPROACH: For a more detailed explanation, see S-18 (Revised) dated July 1965. Soil columns representating several soil types will be constructed in the laboratory. These columns will be treated with herbicides and then varying amounts of simulated rainfall applied. Bioassays will be conducted to determine the depth to which the herbicides are leached in phytotoxic concentrations. Similar studies will also be conducted under field conditions. Establish the pattern of herbicide dissipation in the soil underfield conditions, field plots will be treated at recommended and higher rates. Plots will be sampled and bioassays conducted. These treatments and samplings will be conducted over a period of several years.

PROGRESS: The past project leader left the University of Tennessee in March and the new project leader arrived in July. No unfinished research was in progress. The only research carried during the specific period pertaining to herbicide residue in soil was a bioassay to determine if any residues of herbicides applied while stubble planting soybeans in wheat remained after soybean harvest. Various rates and combinations of alachlor, amiben, DCPA, linuron, naptalam and paraquat were applied as preemergence herbicides on June 13 and linuron was applied postemergence in September. Soil samples from each plot were placed in the greenhouse in November and bioassayed with crimson clover, lettuce and wheat seedlings. The bioassay results for residues were negative.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0178, DISPOSITION OF PESTICIDES IN THE SOIL

L.F. JOHNSON, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00241)

OBJECTIVE: Determine inactivation and loss of pesticides from soil by microbiological degradation for the purpose of identifying primary loss processes, relating these processes to soil properties, and predicting pesticide persistence.

APPROACH: Degradation of pesticides by indigenous populations will be studied in soils. Break down products and the microbial populations primarily responsible will be identified. The effect of soil conditions and ecological factors such as commensalism and antagonism accompanying microbial degradation of pesticides will be investigated. Microbial activity will be modified by suitable treatments in an attempt to alter degradation of pesticides. See S-62 for further details.

PROGRESS: A method for obtaining a suspension of heptachlor granules in isolation media was devised. Growth of 95% of soil bacteria was inhibited by 200 ppm of heptachlor in isolation media. Most of the soil microorganisms resistant to high concentrations of heptachlor were gram negative rods and yeasts. Alfalfa hay and oat straw, finely chopped, were added to soil at rates of 1 and 4% by weight. Heptachlor granules, ground into a powder, were added to residue-amended soils in 250 ml flasks at rates of 20 and 200 ppm. Treated soils were watered and incubated for 8 months. Heptachlor in each flask was extracted with xylene and tested for concentration with a gas chromatograph. More heptachlor was changed to heptachlor epoxide in residue amended soil than in unamended soil. The amount of epoxide present correlated positively with residue amendment concentration. Heptachlor concentration was considerably less in extracts of soils containing alfalfa than in oat straw amended, or unamended soils.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0179, DISPOSITION OF PESTICIDES IN THE SOIL

R.J. LEWIS, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00237)

Objective: Determine the inactivation and loss of pesticides from soil by: volatilization; retention and release; nonmicrobiological degradation; for the purpose of identifying primary loss processes, relating these processes to soil properties, and predicting pesticides persistence.

Approach: Well characterized soils, soil separates, clay minerals and other appropriate organic and inorganic adsorbents will be used. Soil system parameters to be evaluated may include pH, temperature, moisture, mineralogical composition, organic matter, exchangeable cations, air movement, sterility, and method of pesticides application. Pesticide parameters may include such variables as formulation, solubility and vapor pressure. Appropriate analytical methods will be selected from among x-ray diffraction; atomic, infrared, visible, and ultra-violet spectroscopy; paper, thin-layer, and gas chromatography; and radioassay. For further details, see S-62.

Progress: Phorate and demeton were adsorbed by Southern Bentonite resulting in an increase in the basal spacings of Ca or Al saturated clay. The observed expansion of clay occured at pesticide concentrations of 0.15 mM per g of clay and greater. Basal spacings of approximately 17A occurring at higher pesticide concentrations could be reduced to 14.5-15.0A by dialysis with distilled water. The thiono isomer of demeton disappeared completely from aqueous systems in two weeks. Compounds that

have been described as the major plant metabolites appeared at the end of one week. These compounds and the thiol isomer persisted for the entire six week testing period. Soil or clay columns retained 0.3-1.0 ug of thiol isomer per g after leaching with approximately four column volumes of distilled water. Very small quantities of an unidentified degradation product of the thiol isomer were eluted from the column in advance of the major elution peak. Moisture status at time of application had little effect on demeton retention but phorate retention was greatest when applied to dry columns. Soil adsorption of the thiol isomer of demeton from equilibrium solutions increased with increasing levels of O.M. and to a lesser extent with increasing clay content. Ion saturation of the exchange complex had little effect on demeton adsorption by soils or clays.

SUPPORTED BY U.S. Dept. of Agriculture

4.0180, METABOLITES OF ENDRIN IN SOILS & CROPS
H.G. ALLBRITTEN, Memphis State University, Graduate School, *Memphis, Tennessee* 38111

The diene pesticide, endrin, is one of the most widely used and toxic chemicals used in the Mid-South area. Only a small percentage of the applied pesticide is accounted for as a residue in soils and crops or is detected in water run-off from these.

We propose to study the degradation and metabolic product of endrin in soils and crops to determine the unaccounted for part of the applied pesticide. To do this we propose to prepare a number of potential metabolites and establish their identities. We will determine the properties of these compounds necessary for their extraction, purification or clean-up and final quantitative determination if present in a soil of crop. We will then extract and quantitatively determine these compounds in samples of soils or crops, and water run-off from these, which have been exposed to the pesticide endrin.

If time permits we will extend the study to other diene pesticides such as dieldrin, heptachlor and chlordane.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0181, CHEMICAL FALLOW FARMING IN THE SOUTHERN GREAT PLAINS
A.F. WIESE, Southwestern Great Plains Ctr., *Bushland, Texas* 79012 (TEX01340)

OBJECTIVE: Determine the effect of chemical fallow during a wheat- sorghum-fallow rotation on runoff, soil losses, moisture storage, residue conservation, crop yields and other physical microbiological and chemical properties of Pullman silty clay loam soil. Determine factors which may enhance the effectiveness of herbicides on grass weeds under semi-arid conditions and evaluate new herbicides for controlling weeds in continuous sorghum, continuous wheat, wheat-fallow, and wheat- sorghum-fallow rotations. Determine the effect of herbicidal treatment on the water use and weed growth.

APPROACH: A long term experiment will be conducted to determine the effect of chemical fallow on soil moisture storage runoff, crop yield and various physical, chemical and microbiological properties of the soil. Studies will be conducted to locate herbicides for chemical fallow in various cropping systems. Studies will be conducted to determine factors which will enhance the effectiveness of herbicide to grass weeds under semi-arid condition.

PROGRESS: In 1969 the most soil and water loss on dryland runoff plots comparing disking, sweeping, and chemical fallow occurred on the chemical fallow plot in fallow. Residues were low because of a poor sorghum crop in 1968. The next most runoff and soil erosion occurred on the sorghum plots that were sweep plowed. In another chemical fallow study which compared soil moisture from wheat harvested in 1968 to sorghum planting in 1969, chemical fallow plots with heavy irrigated wheat straw stored about 2.5 more inches of soil moisture than disk plots. Preliminary work was conducted to determine if sugar beets could be planted in growing wheat and wheat stubble. We are summarizing data from an old study called Tex B-43. Work on this project could lead to a revolution in tillage and cultivation practices in agriculture. It may eliminate up to 50% of the expense in present tillage practices. It appears that additional water storage could greatly enhance the limited water supply in West Texas.

SUPPORTED BY U.S. Dept. of Agriculture

4.0182, THE LOSS OF HERBICIDES FROM SOIL
R.W. BOVEY, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (0710-04-22(CA))

OBJECTIVE: Determine quantitatively the losses of volatile herbicides from soil to the atmosphere as influenced by soil type, soil manipulation, light, soil moisture, temperature, and wind velocity. Evaluate the potential use of carriers and additives to regulate herbicide loss from soils.

APPROACH: Herbicides and herbicide formulations applied to sandy loam and clay soils will be sampled at intervals up to 24 months after treatment and preserved for herbicide residue analysis. Responses of weeds and other plants will be analyzed concurrently with soil sampling. The amount of herbicide lost from the soil due to such factors as wind, temperature, light, moisture, soil type, degree of mixing in soil, and formulation will be assessed under both laboratory and natural conditions. Herbicide residue content in field and laboratory soil, and in air and dust samples will be quantitatively analyzed by gas chromatographic or other suitable techniques.

PROGRESS: A method was developed of detecting trifluralin vapors in air, sensitive to 8 ppm and which requires less than 5 min per sample. Low volatile oils reduced the volatility of trifluralin in greenhouse studies but neither oils, ultraviolet light inhibitors nor cationic surfactants increased the effectiveness of trifluralin in the field. The volatility of trifluralin was closely related to soil moisture. Nitralin was less volatile than trifluralin. The C-6989 had decreased to about 50 percent of the original amount 3 months after application to a clay or sandy soil and about 10 percent after 6 months. Incorporation increased the persistence. A method of detecting picloram which requires no esterification was developed. The method reduces the time and solvents required. Little picloram is lost from the surface of soils, varying from dry to wet, after one week at wind velocities of 0 to 15 mph. This was true for salt and ester formulations. Ester formulations were much more susceptible to photodecomposition. The reverse was true for leaching.

SUPPORTED BY U.S. Dept. of Agriculture

4.0183, PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS
C.J. SCIFRES, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01822)

OBJECTIVE: Determine the various modes of dissipation of herbicides applied for woody plant control. Establish the relative importance of the various modes of herbicide dissipation after their application for woody plant control. Compare the persistence of promising herbicides for woody plant control in rangeland soils, plants, and soil water.

APPROACH: Bioassay and gas chromatographic analysis will be utilized to characterize the residue potential of herbicides applied for control of brush. Herbicide mobility in rangeland soils and soil water and relative rate of herbicide dissipation will be correlated with topography, soil type, rainfall patterns and existing vegetation. Sequential sampling patterns of the vertical vegetation and soil strata will be correlated with rate of relative herbicide movement downslope from the point of application.

PROGRESS: No progress reported this period (New project).

SUPPORTED BY U.S. Dept. of Agriculture

4.0184, MOVEMENT OF INSECTICIDES IN SOIL AND WATER
G.W. THOMAS, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (SWC-024-BELT-10)

OBJECTIVE: Determine the effects of rainfall amount and intensity on the movement of insecticides through soils and in washoff of soil and water; predict the extent of pollution from typical Blackland farming enterprises.

4. PESTICIDES

APPROACH: Three small watersheds at Riesel will be sampled periodically to determine the distribution with depth of DDT, toxaphene, and parathion in the soil. Runoff water, ground water, and eroded sediment will be collected and analyzed for these same substances. Two instrumented sites, at Riesel and at College Station, will be used to determine the rate of pesticide movement relative to water movement in clay soils.

PROGRESS: Three small watersheds in central Texas, which are adjacent to each other and in a rotation of oats, cotton, grain sorghum, are being used to monitor pesticide residues in soil and loss in runoff water and sediment. The only insecticides which have been applied to these watersheds have been toxaphene and DDT. Soil samples taken to a depth of 5 feet contained very little toxaphene at depths below 1 foot. DDT tended to be higher in the surface 6 inches than at any other depth, but appreciable quantities of DDT were found throughout the 5 foot depth in some profiles. Profile samples from waterways were found to contain very little DDT and almost no toxaphene. A sample of silt collected in one waterway contained only 0.06 ppm toxaphene and only 0.052 ppm DDT. Only about 20% of the toxaphene and DDT applied in the past 10 years could be accounted for in the soil profiles. Insecticide residues in runoff waters were not of significant concentrations with respect to pollution problems. In the runoff following one storm the DDT concentration reached 1.0 ppb. No toxaphene was found in any of the water samples. Water samples collected from a seep indicates that DDT is indeed moving through the soil profile but concentrations are very small. When the seep initially began to flow the concentration of DDT was slightly in excess of 1 ppb but quickly decreased to less than 0.2 ppb.

SUPPORTED BY U.S. Dept. of Agriculture

4.0185, MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER

A. WIESE, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (SWC-024-BELT-11)

OBJECTIVE: Determine movement and fate of herbicides with irrigation and rainfall in and from West Texas fields, playa lakes, and recharge wells. Conditions that favor herbicide removal in runoff water will be determined.

APPROACH: Runoff water from about 50 fields will be sampled to determine if herbicides are being removed. Ponds and lakes will be treated with herbicides to study movement and breakdown, and a recharge well will be treated with an herbicide to determine herbicide movement and persistence in the underground aquifer. Models will be constructed to determine soil moisture, soil type, slope, and rainfall conditions that favor herbicide removal from fields. Adsorption of herbicides in mud in lake water and Ogallala sand will be determined in the laboratory. A model will be developed to study herbicide movement in Ogallala sand.

PROGRESS: On five fields in West Texas only 14% of applied trifluralin remained in the soil 3 months after application. On one field each, only 20 and 8 percent of propazine and atrazine persisted 1 month after application. Runoff samples from these same fields contained a maximum of 0.04, 0.05, and 0.04 ppm of trifluralin, propazine, and atrazine, respectively. At these concentrations there would be less than 1.2 pounds of active ingredient in 100 acre-inches of runoff. Trifluralin, atrazine, and picloram were applied to soil in small basins at 1, 1, and 1/2 pounds per acre, respectively, which were later flooded. Trifluralin and atrazine did not get into the water, but detectable amounts of picloram were in the water. Trifluralin disappeared from the soil in 2 months of flooding. Soil samples for picloram and atrazine have not been analyzed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0186, WEED CONTROL IN VEGETABLES AND EFFICIENCY OF HERBICIDES IN FIELD SOILS

R.M. MENGES, U.S. Dept. of Agriculture, Fruit Veg. Soil & Water Lab., *Weslaco, Texas* 78596 (0710-03-05)

OBJECTIVE: Study relationship between herbicidal properties and microclimate as regards herbicidal activity, movement, and persistence of herbicides in soils and plants, and plant selectivity to develop practices for weed control in vegetables.

APPROACH: Study techniques of herbicidal application in soils and resulting effects on herbicidal effectiveness, movement and persistence in soil; effects on vegetable growth, composition, and quality; use bioassays and chromatographic assays to determine herbicidal activities and controlled environment to program field climatological differentials affecting herbicidal activities and plant growth.

PROGRESS: In hot wet soils, bensulide and trifluralin incorporated to depths of 1 or 3 inches selectively controlled Amaranthus spp. and barnyardgrass in cabbage plantings. Trifluralin was more effective when deeply incorporated into the soil but bensulide was unaffected by depth of incorporation. Despite rainfall, bensulide CDEC, DCPA, and trifluralin remained within the original zones of incorporation in the soil. Trifluralin persisted longer in soil as depth of incorporation was increased but activity had disappeared in 12 months. Bensulide at 8 lb/A persisted in soil for more than 12 months. Bensulide, incorporated at 1 1/2 inches, selectively controlled common purslane, Palmer amaranth, and barnyardgrass in onion plantings. Irrespective of rainfall, the herbicide performed better with soil incorporation. Bensulide, alone or in combination with nematicides 2-methyl-2(methylthio)propionaldehyde O(methyl carbamoyl)oxime or 1,2-dibromo- chloropropane controlled common purslane and Texas millet in 'El Monte' tomato plantings. Only 2-methyl-2(methylthio)propionaldehyde O- (methylcarbamoyl)oxime reduced rootknot. Tomato yields were increased by treating soil with bensulide plus 1,2-dibromo-chloropropane. Chloroxuron controlled ridgeseed euphorbia, redroot pigweed, and sunflower at 2 lb/A, but in combination with many of the 14 surfactants tested, controlled weeds at 1 lb/A when sprayed at 60 gal/A.

SUPPORTED BY U.S. Dept. of Agriculture

4.0187, SOILS, PESTICIDES, AND THE QUALITY OF WATER

R.L. SMITH, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00678)

OBJECTIVE: Identify the properties of pesticides and of soils that controls the extent of movement of pesticides in and through soils. Ascertain the solubility characteristics of pesticides adsorbed on soil particles and hence the effect of suspended soil on the concentrations of pesticides in water.

APPROACH: Adsorption, flow, and thermodynamic properties of a variety of pesticides will be studied in connection with montmorillonitic and kaolinitic types of clays, sand, and complete soil. Specific compounds will be selected to give carboxyl, carbonyl, amine, amide, and double bonded oxygen, sulfur, or phosphorus position that may interact with clay to exchange with cations present in the colloidal complex of soil materials. Thermodynamic properties of systems consisting of various soil materials and water will be studied. Organic pesticides will then be adsorbed onto the soil solids and the thermodynamic properties will again be studied. In this way the change in properties will be evaluated.

PROGRESS: A study of the soil type role and related factors on pesticide movement in surface waters has recently been initiated. Preliminary tests have shown that exchange of phenoxy herbicides is dependent upon pH of soil and water; organic content; concentration of the herbicide. A major effort is being made to define the role of organic matter in this exchange reaction. A major accomplishment of the projects has been the development of a GLC technique capable of routine measurements for concentrations around 0.1 parts per billion picloram. In addition to GLC, fluorescence measurements are simple, highly reproducible and can be performed on considerably more samples in a given amount of time. It will be a valuable analytical and tracer tool. Detailed degradation studies were made on picloram in water under the influence of light, temperature and pH of water. The compound was significantly degraded photochemically and thermochemically. The primary degradation product appears similar in either process and has been tentatively identified as decarboxylated-picloram (product-I). Work is continuing to determine further degradation or stability of product I and its toxicity. Picloram and product I have been separated and purified on alimina columns. Both have demonstrated considerable fluorescence at certain temperatures.

SUPPORTED BY U.S. Dept. of Agriculture

4.0188, TRANSLOCATION AND DEGRADATION OF HERBICIDES IN PLANTS

S.W. BINGHAM, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0616062)

OBJECTIVE: Determine translocation and degradation patterns of herbicides in plants and effectiveness for removal from soil and water.

APPROACH: Plant autoradiography and tracer techniques will be used to evaluate translocation and partial metabolism of the herbicide molecule. Chromatographic methods will be used to partially purify and identify degradation products. Quantitative information of herbicide molecule fate will be determined by radioisotopic counting of fractions. For herbicide removal from environment, radioisotopic labeled herbicides absorbed from soil and water will be evaluated in plants and water through counting techniques.

PROGRESS: DCPA- C was root absorbed and translocated slowly in bermudagrass, the level translocated to stolon nodes was too low for root inhibition. Root applications of simazine at concentrations greater than 1 X 10 M inhibited growth of parrot-feather. Chromatographic analysis of exudates from detopped plants showed simazine was translocated primarily undegraded. A correlation was observed between the simazine absorbed and translocated from roots and transpiration. In 2 hours the roots had accumulated the highest level in the plant, after 192 hours, the top of the shoot contained the largest amount per g tissue. Curly pondweed absorbed and translocated simazine- C applied to the roots did not translocate from the exposed portion. Diquat (0.02 ppmw) inhibited growth of emersed parrotfeather. There was no translocation of diquat after foliar or root applications. Dinitrophenol, did not affect uptake of diquat by the roots or cause a translocation of diquat out of the root. Root treatments with 2,4-D (10 M) inhibited growth of parrotfeather and little acropetal movement was evident. When dinitrophenol was applied concomitantly with 2,4-D- C, acropetal movement of radioactivity occurred. Basipetal translocation in the phloem was evident from mature leaves and 2,4-D- C leaked from roots into the nutrient solution. No movement of 2,4-D- C was evident from young leaves.

SUPPORTED BY U.S. Dept. of Agriculture

4.0189, EFFECT OF CHEMICAL ADJUVANTS USED IN FORMULATION ON HERBICIDE PERSISTENCE IN SOILS

L.L. DANIELSON, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (0710-03-14(GR))

OBJECTIVE: Determine chemical adjuvant effects on herbicide persistence and movement in soils, and means for regulating activity and persistence thru use of adjuvants.

APPROACH: Herbicide classes will include high and low volatility, and water solubility, and different ionic and adsorptive properties. Adjuvant will include nonionic, anionic, and cationic surfactants, phytobland oils, dimethylsulfoxide (DMSO), and other additives. Soils varying in physical and chemical properties will be employed. Herbicides will be applied alone and with different adjuvants directly or as foliar sprays. Spraying and/or incorporation into the soil by drenching or mechanical mixing will be used. Variables will include additive and herbicide concentration, type, application method, treatment time, soil type, irrigation amount and frequency, sterilized and nonsterilized soils. Leaching columns with bioassay of fractions will be used to determine mobility and persistence. Herbicide and adjuvant amounts extracted from soils by plants will be determined by autoradiography. Degradation as influenced by adjuvants will be evaluated by C O(2) evolution, chemical extraction, fractionation, and chromatography. Chromatography will be used to detect residues and purify and identify degradation products. Quantitative information will be obtained.

PROGRESS: The effects of anionic, nonionic, and cationic surfactants, and oil emulsifiers, on herbicide movement in soil were studied using a heavy organic soil as a base for thin layer chromatographic analysis. The order of mobility from greatest to least was dicamba, atrazine, and chlorprophan, respectively, except with cationic Hyamine 1622 where the respective order was atrazine, chlorprophan, and dicamba. Dicamba was affected most consistently by all additives. Precoating the soil with Atlox 109 (a nonionic surfactant) had less effect than adding equivalent amounts to the developing solvent used in the thin layer chromatographic technique. Atrazine and trifluralin persisted longer than dicamba at comparable rates in soil. The activity of dicamba significantly increased by the use of each of the several surfactants. Mixing the surfactants into the soil before applying the herbicides increased their activity.

SUPPORTED BY U.S. Dept. of Agriculture

4.0190, BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

O.E. RUD, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0626101)

Objective: Determine the effects of herbicides on anatomical and morphological responses, seed germination and growth selected metabolic systems.

Approach: Physiological dormant and active seed will be exposed to varying concentrations of the herbicides 2,4-bis (isopropylamino)-6- methylthio-s-triazine and 3-(n-trifluoromethylphenyl)-1,1- dimethylurea. Pregermination techniques will be imposed on the seed. Measurements will be made of rate and total effects on germination and early development. The responses will be correlated with respiration, enzyme activity, membrane activity and other physiological processes. Physical environmental factors will be studied as they effect phytoxicity of herbicides to seeds. Gross effects of herbicides on fate of seeds in soil will be studied by using radiolabeled seeds as a means of recognizing seedlings.

Progress: Solutions of 3- (M-trifluoromethylphenyl)-1, 1-dimethylurea (fluorometuron) and 2,4 bis (isopropylamino)-6-(methylthio)-s-triazine (prometryne) in water, acetone, or ethanol at concentrations of 90 to 0.0001 ppm have been used to imbibe seeds and evaluate the effect of the herbicide on germination. Seeds that have been included are: Abutilon theophrasti (velvetleaf), Ipomea purpurea (morningglory), Cardus nutons, cotton, and soybeans. Low concentrations of the herbicide on all the species of weeds except Cardus nutons has produced more rapid germination than with seeds imbibed with water. Fluorometuron has produced more stimulation to germination than has prometryne. The crop seeds have not responded to inhibition by the herbicide solutions as have weed seeds. Generally, crop seeds have shown inhibition to germination. Oxygen uptake studies have indicated that with representative crop and weed seeds imbibed in solutions containing herbicides, gas exchange has been related to the germination activity which was not necessarily affected by the herbicide concentration present.

SUPPORTED BY U.S. Dept. of Agriculture

4.0191, DEVELOP WEED CONTROL PRINCIPLES AND PRACTICES FOR HORTICULTURAL CROPS IN THE NORTHWEST

A.G. OGG, Irrigation Ag. Res. & Ex. Ctr., *Prosser, Washington* (0710-03-15)

OBJECTIVE: Devise effective chemical, biological, mechanical, cultural, and combination methods of weed control that avoid or minimize herbicide residues in crops and associated soils.

APPROACH: Conduct comprehensive studies of the ecology and physiology of weeds and crops in competitive situations. Determine the physiological and biochemical effects of herbicides on weeds and crops. Integrate results of these studies to develop new and more economical, safe, and effective methods of weed control for these crops.

PROGRESS: The program was activated in June 1969. An initial survey and evaluation of weed problems in plantings of horticultural crops in the Northwest was conducted. Perennial weeds were found to be a universal problem in croplands of this area. The weeds causing the most concern were Canada thistle, field bindweed, Russian knapweed, quackgrass, Bermudagrass, perennial peppergrass, and hoary cress. Weeds are listed in decreasing order of overall importance. A form letter was sent to over 120 weed researchers in the United States and Canada

requesting information about these weeds. Approximately 50% of the inquiries were answered. Although several of these weeds had been extensively researched, satisfactory control measures in croplands were generally lacking. The results of the survey were used to organize the several phases of the research project. Programs were developed to conduct weed control research in 1970 in the following areas: (1) annual weed control in mint; (2) annual and perennial weed control in fruit tree nurseries; (3) perennial weed control in established asparagus and annual weed control in direct-seeded asparagus; (4) annual weed control in potatoes; (5) perennial weed control in grapes; (6) soil persistence of terbacil in peppermint fields; and (7) the use of soil fumigants for perennial weed control in cropland.

SUPPORTED BY U.S. Dept. of Agriculture

4.0192, SOILS, PESTICIDES AND THE QUALITY OF WATER

H.H. CHENG, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01811)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil water system which are pertinent to pesticide transport through the soil in infiltrating water, and pesticide desorption from eroded soil into surface waters. Identify the principal degradation products and determine the mechanisms and kinetics of pesticide transformations in soil-water systems. Measure pesticide transport through and over soil in the field or in lysimeters, using well characterized initial and boundary conditions.

APPROACH: Laboratory studies will include examination of the adsorption-desorption equilibria of carboxylic acid herbicides (represented by picloram) in relation to chemical properties of representative soils, the transport of picloram by moving water in various soil columns, and the degradation of picloram and organophosphate insecticides as influenced by soil and environmental factors, such as soil pH, organic matter content, moisture level, aeration, and temperature. Particular emphasis will be on the role of organic matter in organophosphates breakdown. Field measurement will be made to evaluate the extent to which pesticide transport can be predicted from information obtained from the chemical, physical, and biological studies done in the laboratory.

PROGRESS: The original project was terminated with our final contribution in the form of a M.S. thesis "Distribution and Transformation of Anhydrous Ammonia in Soil and Effects on Wheat and Pea Foot Rot Fusaria" by R. W. Smiley. Under the revised project, the W- 82 Regional Project Committee has selected two soils from Washington as standards for cooperative study. Bulk quantities of these two soils were collected by horizons, prepared, and distributed to committee members. Physical and chemical properties of the two soils are being characterized and data will be distributed also. Initial research has been on the adsorption and desorption of carboxylic-acid herbicides (2,4-D and picloram) in soils as affected by herbicide concentration, time and temperature of equilibration, and pH of soil. Results indicate that adsorption of herbicide by soil reached equilibrium within 15 minutes of contact. The amount of herbicide adsorbed was dependent on pH of the soil, with increasing adsorption at lower soil pH.

SUPPORTED BY U.S. Dept. of Agriculture

4.0193, TRANSFORMATION, MOVEMENT, DISAPPEARANCE OF PESTICIDES AND RESIDUES IN SOILS

H.H. CHENG, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01858)

OBJECTIVE: Study the behavior and fate of pesticides in soils and the effects of soil properties on pesticides transformation, movement, and disappearance. Improve existing methodology or to develop new methods for the extraction, isolation, detection, and estimation of pesticides and their secomposition products in soils. Examine the conditions for pesticide persistence in soil and to devise means to eliminate this persistence.

APPROACH: As a first step to study efficiency of various extraction and clean-up procedures and, if necessary, to devise new and more proficient procedures. A variety of soils and several types of pesticides will be selected. Subsequently, the mode of pesticide transformation and the effects of the nature and content of clay and silt, organic matter, pH, cation exchange capacities, texture, and related factors on the behavior of pesticides in soils will be examined.

PROGRESS: A field study on the movement of picloram in soil under controlled conditions is in progress. A portable sprinkler irrigator calibrated to provide controlled additions of water uniformly to the test plot has been set up. Movement of picloram in soil of different water content, surface preparation, and slope as affected by rainfall is being studied. Picloram in soil and runoff water will be examined. A gas chromatographic procedure has been tested and proved capable of detecting very small amount of picloram. Extract obtained by using the procedure developed for colorimetric determination of picloram in soil required clean-up before it can be analyzed by gas chromatography. A study on the fate of DCPA in soil has been conducted in an irrigated field at the Othello Research Unit. DCPA was applied at three rates in onion and potato fields in April and June, and soil temperature was monitored throughout growing season. Soil samples were collected periodically for examination of movement and degradation of DCPA. Analysis has been hampered by the lack of a rapid and sensitive method for DCPA detection. Existing methods are time-consuming and have not been tested for DCPA in soil. A rapid infrared spectrometric method was tested but found to lack sensitivity. Modification of a gas chromatographic method is being tested.

SUPPORTED BY U.S. Dept. of Agriculture

4.0194, DEGRADATION OF ORGANOPHOSPHORUS INSECTICIDES IN SOILS

L.W. GETZIN, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01821)

Progress: A heat-labile macromolecular enzyme-like substance in soil which degrades malathion to its monoacid was further purified and characterized. A number of carboxyl ester were hydrolized by the active soil fraction which suggests the substance originally served as an esterase in some biological system. Attempts to demonstrate microbial origin of the malathion-catalyzing factor have been unsuccessful. The addition of partially purified enzyme to soil and its subsequent recovery after more than 8 weeks of incubation indicates the catalyst can exist in a cell-free state in soil. Chemical analyses suggest the enzyme is protected by a polycarbohydrate matrix associated with soil clay adsorption. Dasanit and carbofuran were examined in soil under laboratory conditions. Dasanit was rapidly oxidized to the sulfone which had an initial half-life of greater than 20 weeks at 25 C in a silt loam. Small amounts of Dasanit were also reduced to the sulfide in soil. The persistence of carbofuran varied between soils. The time required for 50% degradation was 8 weeks in a clay loam and greater than 24 weeks in a silt loam and an organic soil. Only small amounts of C from radio-labeled insecticide were expired as CO(2). Carbofuran degraded much faster in alkaline soil than in acid soil.

SUPPORTED BY Washington State Government - Olympia

4.0195, DEGRADATION OF ORGANOPHOSPHORUS INSECTICIDES IN SOIL

L.W. GETZIN, Washington State University, School of Agriculture, *Pullman, Washington* 99163

Objectives: 1) determine the role of biological and non-biological factors in the degradation of organophosphorus insecticides in soil, 2) extract, purify, and characterize heat-labile substances that accelerate insecticide decomposition, 3) investigate the mode of action and kinetics of heat-labile substances that accelerate insecticide decomposition.

Persistence curves will be obtained for insecticides in radiation sterilized, heat-sterilized and non-sterilized soils to determine the relative importance of microorganisms, heat-labile substances and other chemical mechanisms upon the decomposition of insecticides. Attempts will be made to extract, purify and characterize non-viable heat labile substances that accelerate the breakdown of some insecticides. The mode of action and kinetics of a proteinaceous substance which is primarily responsible for the

rapid breakdown of malathion in soil will be investigated. Similar information will be obtained for isolated substances which degrade other insecticides.

Ultimately, this knowledge will contribute towards a greater understanding of why and how insecticides decompose in soil, why certain chemicals are more stable than others and what can be done to improve the efficiency and control the persistence of the insecticides.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0196, CHEMICAL PROPERTIES OF ORGANO METALLIC FUNGICIDES

V.L. MILLER, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01509)

OBJECTIVE: Investigate the use of organometallic fungicides in control of bulb and turf grass diseases. Investigate phytotoxicity of various organomercury fungicides in the soil.

APPROACH: The work usually consists of preparation of fungicide solutions, determining fungicide concentrations, and various other work needed to back up Dr. Gould's program. Investigate phytoxicity of mercurial fungicides to bulbs, and would investigate permeability of plants, especially bulbs, and translocations of mercurial fungicides in relation to phytotoxicity. Investigation of the breakdown of mercurial fungicides in soil with emphasis on the mechanisms. Application of work previously done here with mercurial fungicides mixed with soil would be extended particularly in relation to turf disease control.

PROGRESS: Busan 72 2-(thiocyanomethylthio) benzothiazole from Buckman Laboratories, Inc. appears to be a very effective fungicide for the control of both Fusarium and Penicillium caused diseases of bulb crops, based on bioassay and preliminary testing. Odor of the Busan 72 may be a problem in some instances. Thiabendazole is one of the fungicides recommended for use to control both Penicillium and Fusarium caused bulb diseases. A test has been developed that is suitable for bulb growers to use to determine the concentration of the thiabendazole in their bulb treating tanks. Thiabendazole reacts with methylmercury compounds at pH 12 to form an insoluble precipitate. The excess methylmercury compound may be determined in the filtrate by the dithizone reaction. The excess methylmercury is related to the concentration of the thiabendazole in the treating tanks by comparing the color developed with dithizone with permanent standards sealed in glass. Bulb growers may find the test useful in controlling the thiabendazole level in their treating tanks.

SUPPORTED BY Washington State Government - Olympia

4.0197, THE BEHAVIOR AND FATE OF DDT AND ZECTRAN IN A FOREST SOIL

S.P. GESSEL, Univ. of Washington, School of Forestry, *Seattle, Washington* 98105 (WO1603)

OBJECTIVE: Determine the movement, chemical change and resulting distribution pattern of DDT and Zectran applied to Douglas fir soils and the effects of environment, land and forest treatments on such reactions.

APPROACH: During the first 2 years of the 3-year project, the investigators will concentrate on field observations, (1) measuring the relationships between the insecticides and the forest soil and environment, and (2) determining the effect of various land and forest treatments on the behavior of the two insecticides. All work, including analysis and interpretation, will be completed the third year.

PROGRESS: No progress reported this period (active project).

SUPPORTED BY U.S. Dept. of Agriculture

4.0198, MICROBIAL DEGRADATION OF PESTICIDES

G.M. BOUSH, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

A number of present-day widely used pesticides are extremely stable and thus present a major source of environmental contamination. This is especially unfortunate as certain of these same chemicals, correctly used, are important weapons in man's fight against harmful and destructive insect pests. As an example, the chlorinated cyclodiene insecticides resist degradation and thus persist for long periods in soil and water. They also are slow to metabolize in the mammalian system and are little affected by environmental factors such as temperature, moisture or pH. One of the most promising leads in the detoxification of these unwanted contaminants in our ecosystem is by microbial degradation.

This study is designed to investigate the role of microorganisms in the degradation of certain of the more persistent pesticides such as dieldrin, endrin and DDT. In this regard, the following 5 major objectives are planned: (1) Locate, evaluate and identify microorganisms with pesticide-degrading capabilities; (2) Identify metabolites resulting from pesticide degradation; (3) Determine biochemical pathways and enzyme systems involved; (4) Select and develop higher pesticide degrading variants from our most effective isolates; and (5) Investigate the possible role of selected endosymbiotic microflora in the degradaton of pesticides in certain animals.

Pesticide degrading capabilities of all isolates will be determined by incorporation with known quantities of C14 labeled pesticide, followed by extraction, TLC and autoradiography. Bacterial strains ('Pseudomonas spp.' and 'Bacillus spp.') of presently known cyclodiene- degrading abilities will be subjected to mutagenic forces including gamma and ultraviolet radiation, chemomutants and a modified chemostat, together with selection pressure, to develop variants of higher degrading capacities.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0199, IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS.

G. CHESTERS, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01342)

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Wisconsin State Government - Madison

4.0200, SOIL AND PLANT INTERACTIONS WITH PESTICIDES

E.P. LICHTENSTEIN, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The metabolism of some insecticides as affected by subcellular components of higher plant tissues and fungi will be further investigated. Purification of enzymes whose activity has been determined, will be attempted. The mechanism of penetration and translocation of pesticides into roots of higher plants will be studied as well as the metabolism of some insecticides within the plant and in vitro. The study of the persistence and metabolism of some insecticides in soils and water will also be continued.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0201, CONTROL OF PERENNIAL FARM AND RANGELAND WEEDS

H.P. ALLEY, Univ. of Wyoming, Agricultural Experiment Sta., *Laramie, Wyoming* 82071 (WYO15-0069)

OBJECTIVE: Determine potentials and limitations of herbicides and herbicide combinations, in conjunction with mechanical methods, for control of perennial cropland and rangeland weeds. Determine effect of chemical treatments upon soil-plant relationships and effect upon the rangeland ecosystem.

APPROACH: Soil residual characteristics and crop response to chemical treatments determined through actual crop yields and vegetative survey. Atmospheric temperature and soil moisture relationships will be correlated with herbicide response data.

PROGRESS: An area heavily infested with Canada thistle was clean cultivated during the 1968 growing season. In early September various rates of dicamba and dicamba + 2,4-D was applied to the Canada thistle regrowth. Treated areas were crossseeded to several crops in the spring of 1969. Dicamba at 1 and 2 lb/A gave 80 and 93 percent control of Canada thistle, respectively. Dicamba at 1 lb and 2,4-D at 3 lb/A gave a 82 percent reduc-

tion in stand. Phytotoxicity readings indicate that winter wheat is the most tolerant small grain crop followed by corn, oats, spring wheat and barley. Of the broadleaf crops sugar beets was most tolerant followed by alfalfa and dry beans. This study indicates that areas heavily infested with Canada thistle can be cleaned-up and several crops established within eight months after application. Low rates of picolinic acid, 1/4 lb 0 1/2 lb/A remains as the only effective herbicide treatment for effective control of Geyer larkspur. The phenoxy compounds have reduced the stand by only 40 percent after three years of retreatment.

SUPPORTED BY U.S. Dept. of Agriculture

C. ADVERSE EFFECTS ON PLANTS

Includes Nontarget Phytotoxicity, Degenerative, Morphological Effects, and Crop Yield Reduction

4.0202, ADVERSE EFFECTS OF PESTICIDE RESIDUES ON FOOD AND FEED PRODUCTS

R.S. BERGER, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00613)

OBJECTIVE: Study food and feed products with respect to the location and persistence of pesticide residues in market products, effects of pesticide residues on quality characteristics, and the development of commercial marketing and processing techniques for the detection, removal and/or neutralization of pesticide residue effects.

APPROACH: Products with known histories of production and pesticide applications will be subjected to handling and processing treatments such as brushing, washing, defuzzing, hydrocooling, peeling, freezing, and canning and the effects of these treatments on the reduction or removal of pesticide residues will be determined. Pesticide residue analyses will be made by currently accepted methods. Initially, residues of parathion on peaches, malathion on turnip greens, and toxaphene on southern peas will be studied.

PROGRESS: Mustard, turnip, rape, and collard greens were sprayed on harvest day with malathion and parathion. Replicated samples were hot-water blanched and canned by standard commercial procedures. Residues were determined by G.C. analyses. Comparison of results by F ratios and Duncan's Tests showed only inconsistant effects of vegetable type on residue removal. Per cent removal appeared to depend more upon initial residue level. Heat processing removed all malathion and 75 - 80% of parathion residues. Peaches were field sprayed and laboratory dipped with standard parathion sprays. Highest residues determined were only 3 ppm. No further work with peaches was planned since residues on fruit were so low.

SUPPORTED BY U.S. Dept. of Agriculture

4.0203, PHYTOTOXICITY OF 3-AMINO-1,2,4-TRIAZOLE

M. CARTER, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-007-6-813)

OBJECTIVE: Study the formation of 3-ATAL in cell-free extracts. Survey the changes in plant protein following treatment with 3(-over AT. Determine if 3-ATAL is incorporated into protein by bean plants.

APPROACH: Cell-Free extracts of bean plants will be prepared by standard procedures of etiolation, centrifugation, incubation and chromatographing. Extracts will be followed by attempts at enzyme purification by gel-filtration and chromatography on DEAE-cellulose. The action of several inhibitors and cofactors will be investigated. Concentrated proteins will be prepared by standard methods and separated by electrophoresis. Following separation and staining the plates will be scanned and the peaks compared. The terminal growth of treated plants will be harvested, extracted, desalted and concentrated by standard methods. Chromatograms will be exposed to X-ray film. Areas of radioactivity will be located and the presence of 3-ATAL detected.

PROGRESS: Amitrole, pyrichor, and dichromate were found to be inhibitors of Beta-carotene synthesis in higher plants. The chlorosis induced by the three herbicides is believed to result from photo- destruction of chlorophyll in the absence of Beta-carotene. Plants grown in the presence of amitrole in the dark form appreciable chlorophyll when exposed to low levels of light but very little chlorophyll at high light intensities. Carotenoid synthesis may represent the site of action for a number of herbicides.

SUPPORTED BY Alabama State Government

4.0204, BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

D.E. DAVIS, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00233)

OBJECTIVE: Determine the effects of climatic and edaphic factors on movement, persistence and toxicity of herbicides in the soil; investigate the absorption, translocation, accumulation, and degradation of herbicides in plants, and determine the effects of herbicides on anatomical and morphological responses, seed germination and growth, and selected metabolic systems.

APPROACH: Plants varying in resistance to each herbicide will be used in all studies and radiolabelled herbicides in absorption, translocation, accumulation, and degradation studies. Amounts absorbed will be determined by radioassay of the plant and of nonabsorbed herbicide and translocation and accumulation by autoradiography. Degradation will be determined by assay for 14(C)(O)(2) in evolved gases and radioassay of chromatographically separable 14(C)-compounds in plant extracts. Herbicide-treated and untreated plants will be exposed to 14(C)(O)(2) in light and dark. Extracts of these plants will be paper-chromatographed and kinds and amounts of 14(C)-compounds determined. In vivo and in vetro effects of each herbicide on P:O ratio and QO(2)(N) of isolated mitochondria will be manometrically determined.

PROGRESS: Ametryne, 2-(ethylamino)-4-(isopropylamino)-6- (methylthio-(S over -)-triazine, and prometone, 2,4-bis(isopropylamino)- 6-methoxy-(S over -)-triazine, were shown to inhibit state 3 respiration of rat liver mitochondria. Prometone inhibition is markedly less than that of either prometryne or ametryne. Inhibition brought about by either ametryne or prometone can, like prometryne inhibition, be relieved with m-Cl-CCP. Various concentrations of an alkanolamine salt of 2,4-D (2,4-dichloro-phenoxyacetic acid) and ametryne were supplied to corn and soybean seedlings in nutrient solutions. Adding 0.01 ppm 2,4-D to solutions containing 0.1 ppm ametryne increased ametryne absorption and plant injury. Absorption of C-ametryne was determined by measuring C per ml of nutrient solution 0, 1, 2, 3, and 4 days after treatment and per gram of fresh weight of roots, shoots and whole plants 1, 2, 3, and 4 days after treatment. In a study of 9 2,4-D concentrations ametryne absorption increased from 50% of the check for 10 M 2,4-D to about 120% for 10 M.

SUPPORTED BY U.S. Dept. of Agriculture

4.0205, FATE AND MECHANISM OF ACTION OF HERBICIDES

D.E. DAVIS, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-05-0001)

OBJECTIVE: Determine effect of herbicides on carbon fixation, nitrogen metabolism, and activity of certain enzyme respiratory systems. Study degradation of herbicides by susceptible and resistant plants and determine kinds and amounts of metabolites. Determine amounts of herbicide remaining in plants and soils as influenced by various factors. Note: Atrazine will receive primary emphasis in all three objectives.

APPROACH: C-14 labeled CO(2) will be used in carbon fixation studies. Kinds and amounts of C-14 compounds will be determined. Ammonia, protein, and non-protein levels will be determined after various herbicide treatments. In vivo and in vitro effects on mitochondrial respiration will be determined manometrically. C-14 labeled herbicides will be fed resistant and susceptible plants and the radiolabeled materials will subsequently be extracted, separated, radioassayed, and identified. Amounts of herbicides absorbed by plants will be determined chemically and radiochemically. Residues remaining in soils will be determined both by biological and chemical assay.

PROGRESS: Growth regulator-like effects were investigated for ametryne, 2-(ethylamino)-4-(isopropyl-amino)-6-

(methylthio-(s over -)- triazine, atrazine, 2-chloro-4-(ethylamino)-6(isopropylamino)-(s over -)-triazine and prometryne, 2,4-bis(isopropylamino)-6-(methylthio)-(s over -)-triazine. A 10 M atrazine concentration increased both fresh and dry weight of non-green soybean cotyledon callus tissue but higher concentrations were inhibitory. Ametryne and prometryne concentrations from 10 to 10 M were inhibitory. Neither ametryne nor atrazine had any effect on germination of tobacco or lettuce seed in the dark. Atrazine and ametryne were apparently inhibitory or had no effect on rooting of intact black valentine and mung bean coleoptiles but were stimulatory when hypocotyl was decapitated at the cotyledonary node following (s over -)-triazine absorption. Atrazine was inhibitory again in the presence of exogenous IAA. Atrazine concentrations of 10 and 5 x 10 M delayed senescence of corn leaf discs in the dark but this effect was overcome in the presence of kinetin and was not observable when discs were incubated in diffuse light.

SUPPORTED BY Alabama State Government

4.0206, FOREST PRACTICE ALTERNATIVES IN CENTRAL ALABAMA

E.J. HODGKINS, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36[illegible] (ALA-007-0.06)

OBJECTIVE: Scientifically evaluate forest practices in terms of increased productivity of forest land. Determine economic feasibility of applying tested practices to forest lands. Develop recommendations based on research results that have potential of increasing economic value of the forest resource.

APPROACH: Alternative techniques will be developed to seek solutions to problems and field tested. Results will be measured in terms of growth, stocking and quality of the forest following treatments. Comparative costs of alternative treatments will be determined.

PROGRESS: Height growth responses to pre-commercial thinning were found not to be significant, but diameter growth increased more than 50% when soil and roots were not disturbed (significant at 1% level). Measurements will continue for 3 more years. Chemical cultivation of newly established pine plantations (using Atrazine and Simazine) shows significantly better height growth than did mechanical cultivation practices attempted. The use of 2,4-D controlled the weed competition but also apparently injured the pines to such an extent (when applied as a directed spray) to negate the advantage of reduced competition.

SUPPORTED BY Alabama State Government

4.0207, INFLUENCE OF HERBICIDES, FUNGICIDES, & INSECTICIDES ON COTTON GERMINATION & SEEDLING VIGOR

W.C. JOHNSON, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-03-0020)

OBJECTIVE: Determine the interaction of herbicides, fungicides, and insecticides on cotton seedling growth, the influence of pesticides on susceptibility of cotton to fungi, and the influence of pesticides on fungi.

APPROACH: Field, sterile, and inoculated soils will be treated with selected herbicides, fungicides, and insecticides and planted with cotton. Other variables will be temperature, humidity, and pesticide placement. Data will be obtained on germination, growth and root morphology. Comparison of cotton susceptibility to specific fungi as influenced by environment and pesticides will be made. Reaction of fungi in cultures to pesticides will be studied. Cotton tests will be conducted in growth chamber, greenhouse or temperature controlled tanks; fungal tests will be conducted in the laboratory.

PROGRESS: Results from cotton grown in Hoagland's solution showed that trifluralin and diuron caused a reduction in growth especially at the 1 mg/l level. 1-chloro-2-nitropropane(Lanstan) was phytotoxic at the 10 mg/l level, whereas PCNB (Terrachlor) had no effect on cotton. There were few interactions between diuron and various pesticide combinations. Phorate and disulfoton at the 10 mg/l level tended to decrease the intensity of the effect of trifluralin on cotton. Soil temperatures of 70 F or lower slowed severely the rate of seed germination of cotton. Emergence and initial growth was faster at 80 and 90 F than at 60 or 70 F. Plant response to trifluralin was maximal at 70 and 80 F, those temperatures at which growth was favored. Diuron appeared to have little or no effect on the growth of cotton at any temperature tested when applied at the rate of 1 lb/A. Phorate and disulfoton enhanced the growth of cotton over that of the check especially at the 10 lb/A rate. Effect of trifluralin on cotton was reduced by approximately 25% when phorate or disulfoton were applied at the rate of 10 lb/A in combination with trifluralin. Plant height involved several interactions, but there were fewer interactions affecting dry weight. Prometryne inhibits oxidative phosphorylation of the mitochondria, but does not inhibit their ATPase activity.

SUPPORTED BY U.S. Dept. of Agriculture

4.0208, CONTROLS FOR MAJOR COTTON DISEASES IN SOUTHEASTERN U.S. INCLUDING RESISTANCE

A.J. KAPPELMAN, Auburn University, U.S.D.A. Crops Research Div., *Auburn, Alabama* 36830 (0200-02-02)

OBJECTIVE: Search for higher levels of resistance to fusarium wilt and the wilt-nematode complex; transfer resistance to desirable commercial types; determine mode of inheritance of resistance; cooperate in regional seed and soil fungicide studies.

APPROACH: Using recently developed screening techniques, search existing germ plasm sources for resistance factors; cooperating with breeders transfer and combine resistance in desirable breeding stocks; from seedling response determine the most efficacious materials, combinations of materials, and methods of application for seedling disease control and stand establishment.

PROGRESS: Resistance of 10 lines to the Fusarium wilt-nematode complex was evaluated at two locations. A highly significant location x entry interaction indicated the need for establishment of wilt differentials at each location for comparison purposes. Resistance to Xanthomonas malvacearum in segregating populations of fusarium wilt resistant lines was evaluated. Ten lines resistant to X. malvacearum were comparable to Auburn 56 in wilt resistance and were higher yielding with superior fiber properties. Combined disease resistance was transferred to basic breeding stocks for use by breeders in developing improved varieties. Fungicide applications at planting time resulted in significant increases in plant survival at 3 locations and significant yield increases at one location. The effect of selected fungicides, herbicides, and herbicide-fungicide combinations was evaluated in regard to seedling survival and early growth. Fungicides significantly increased seedling survival but did not significantly affect growth. Use of an incorporated preplant herbicide resulted in significantly reduced plant survival, plant height, and dry weight of plants. Use of a surface pre-emergence herbicide did not significantly affect survival, growth, or plant weight.

SUPPORTED BY U.S. Dept. of Agriculture

4.0209, APPLE INSECTS

C.A. KOUSKOLEKAS, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-13-0029)

OBJECTIVE: Identify and characterize major arthropod pests of apples. Study biologies of major pests. Develop control measures.

APPROACH: Sample apple insect and mite populations. Identify major pests. Study biologies of major pests in field and laboratory. Initial emphasis on woolly apple aphid and mites. Evaluate effectiveness of current insecticide spray program. Evaluate existing and new insecticides and miticides against major pests to develop efficient and safe control measures.

PROGRESS: All observations were made in an experimental apple orchard. Inadequate bee pollination may have been a contributing limiting factor in the poor fruit set. The currently followed insecticide spray program was effective. No damage by the woolly apple aphid, Eriosoma lanigerum (Hausman), was detected. A moderate late- season infestation of the European red mite, Panonychus ulmi (Koch), developed. The need for establishing criteria governing the initiation of control measures against aphids and mites was given consideration; this was done in an effort to eventually reduce the number of insecticidal applications.

4. PESTICIDES

SUPPORTED BY Alabama State Government

4.0210, WEED CONTROL IN COTTON AND OTHER AGRONOMIC CROPS UNDER IRRIGATED CONDITIONS

H.F. ARLE, U.S. Dept. of Agriculture, Crops Research Division, *Phoenix, Arizona* 85040 (0710-01-04)

OBJECTIVE: Develop chemical, mechanical, and cultural methods for controlling annual and perennial weeds in cotton and other agronomic crops grown in irrigated areas.

APPROACH: Evaluate known herbicides for effectiveness and crop tolerance under greenhouse and irrigated field conditions. Integrate, through field-plot research, the use of herbicides with other production practices. Characterize the effect of herbicide residues on succeeding crops. Study the interaction of herbicides with other chemicals used in producing cotton and other crops.

PROGRESS: The new herbicide, 4-chloro-5-(dimethylamino)-2- alpha,alpha alpha-trifluoro- m-tolyl)-3(2H)-pyridazinone, applied before planting or after emergence of cotton, effectively controlled annual broadleaf and grass weeds without injuring cotton. Combinations of trifluralin with linuron applied before planting cotton, or trifluralin applied before planting followed by layby application of linuron appear effective and safe for control of many species of broadleaf and grass weeds in cotton. Seedling loss was reduced and yield of cotton increased when both trifluralin and diuron were incorporated in soil before planting as compared with incorporation of diuron alone. The insecticides phorate and disulfoton continued to alleviate the adverse effects of trifluralin or nitralin on cotton in continuing research.

SUPPORTED BY U.S. Dept. of Agriculture

4.0211, RESPONSE OF PLANTS AND PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES

P.G. BARTELS, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2020-4159-004)

OBJECTIVE: Study ultrastructural and nucleic acid modifications in plant organelles induced by herbicidal pollutants.

APPROACH: Methods of electron microscopy and nucleic acid biochemistry will be used to study how pollutants modify plant growth and differentiation. Plants will be grown in chamber having regulated light intensities, photoperiods and temperatures. Cell organelles from various tissues will be examined to determine morphological changes induced by herbicides. Also, embryonic and mature cells will be studied to compare effects of pollutants on two different metabolic states of the plant. Since plants respond differently to pollutants when grown in dark, light, or at different temperatures, we plan to modify environment and observe what ultrastructural changes result. DNA and RNA will be isolated from treated and control plants by procedures developed in our laboratory and DNA will be characterized by cesium chloride centrifugation and hybridization studies.

PROGRESS: An ultrastructural examination of 3-amino-1,2,4-triazole (AT) - X Treated wheat seedlings revealed that plastids lacked internal membranes and ribosomes. Our ultracentrifugal study of AT-treated, light grown plants show that 70S, chloroplast ribosomes and Fraction I proteins were absent while cytoplasmic ribosomes, 80S were abundant. Since ribosomes are absent for chloroplasts, we also determined if chloroplast DNA was missing. We isolated and determined the buoyant densities of both nuclear and chloroplast DNA of control wheat seedlings. We found that both nuclear and chloroplast DNA have about the same densities (1.703 2). We isolated the DNA from deformed plastids of AT-treated seedlings and found that no DNA was present. We did find some DNA in the plastid fraction but it had a density of 1.723 which is like bacteria DNA. An ultrastructural examination of this plastid fraction showed many bacteria were present.

SUPPORTED BY U.S. Dept. of Agriculture

4.0212, EFFECTS OF PESTICIDES AND THEIR DEGRADATION PRODUCTS ON PLANTS AND PLANT PATHOGENS

R.L. CALDWELL, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2014-4166-008)

OBJECTIVE: Determine: 1) effects of pesticides on soil plant pathogens, 2) degradation products of pesticides and rate of degradation by sunlight, chemical and biological degradation, 3) effects of pesticides on plants, both infected and non-infected, 4) synergistic effects of fungicides, insecticides and defoliants, with respect to objectives 1 and 3, and 5) effects of degradation products of objective 2 against common soil plant pathogens.

APPROACH: 1) Initially, pure culture techniques will be used for bioassay procedures, this will be followed by pesticide applications to autoclaved/nonautoclaved soil, both virgin desert and cultivated, and population trends noted; 2) decomposition will be determined by radioactive tracers and residue analysis, sterile/nonsterile soil and pH variation will be used to determine biological and chemical degradation, 3) pesticides will be applied to inoculated/noninoculated plants, visual effects will be noted, metabolic effects will be noted by extraction of plant chemical types, 4) as stated in approaches 1 and 3, 5) degradation products will be treated as in approach 1. Pesticide and pathogens used will be those of major concern in the southwest, such as: PCNB, zineb, nemagon, karmex, treflan, prometryne, aminotriazole, DEF, chlorinated hydrocarbons, and organophosphates, Rhizoctonia solani, Verticillium albo-atrum, Phymatotrichum omnivorum, Pythium sp., Phytophthora sp. and Thielaviopsis sp.

PROGRESS: This project was funded effective 1 July 69 and staffed 1 Aug 69. Initially, samples of native and cultivated soil were assayed for fungi and bacteria present; these were identified as to genus only. To date we have determined the appropriate levels and methods of application of Rhizoctonia solani to cotton plants (Deltapine). The application amounts of a herbicide (Treflan) have been determined and an experiment is in progress relating to the effect of Treflan, Rhizoctonia, PCNB alone and in combination, on cotton. All herbicides (4), and insecticides (2) to be used have been screened (filter paper bioassay) for fungitoxicity, no observable effects were noted up to 1,000 ppm. We are in progress of screening combinations of pesticides to determine any fungitoxicity.

SUPPORTED BY U.S. Dept. of Agriculture

4.0213, INSECT PESTS OF ARIZONA VEGETABLE CROPS

P.D. GERHARDT, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-0206-4161-142)

OBJECTIVE: Develop information on the biology and control of insect pests of commercially grown vegetable crops in Arizona. Particular reference to dosage rates, timing and application methods and how these affect the pesticide residues on these vegetable crops.

APPROACH: Control evaluation of candidate pesticides will be conducted, considering dosage rates, formulations, timing and method of application together with resulting pesticide residues at harvest time. Most important insect problems, namely the lepidopterous larvae occuring on vegetables, will be considered first. This will involve the use of replicated field plots on the University farms and in commercial fields where applicable. Where it is felt necessary the biology of these plots will be further investigated.

PROGRESS: Three formulations of Bacillus thuringiensis, two dusts and a wettable powder were compared with 2.5% BTB - 2% Parathion dust for the control of cabbage looper and beet armyworm larvae on fall head lettuce. Best control was with the wettable formulation applied as a spray three times. No difference was found between the two dust formulations and all were equally as effective as the BTB - Parathion dust formulation. Red La Soda variety of potato plants were treated with six different insecticides for the control of green peach aphids and potato psyllids. Thimet was applied as a granular formulation at planting time. The other five were applied twice during the growing season as sprays. Lannate 90% W.D. gave the best aphid and psyllid control and outyielded all other treatments. Another treatment was aluminum foil placed on top of the seed bed as the plants began emerging. Early in the season plants in these beds had practically no aphids or psyllids. Later on a few aphids and psyllids were present as the plants became larger and shaded the foil. Dust formulations of five pesticides were applied to the ears of sweet corn as a substitute for DDT in the control of corn ear worm. Lannate 2% dust was the most effective material. Desert flea beetle control on

seedling corn, normally controlled with DDT required three applications of other insecticides. Diazinon 14G and Lanadrin 15G were most effective. Golden Acre yellows resistant cabbage was treated four times with six different pesticides or combinations.

SUPPORTED BY Arizona State Government

4.0214. THE INFLUENCE OF CULTURAL PRACTICE COMBINATIONS ON THE YIELD AND QUALITY OF COTTON

R. FORD, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00413)

OBJECTIVE: Measure influence of combining currently recommended cultural practices upon the yield and quality of cotton produced. Find ways of increasing the efficiency of cotton production with emphasis on acceptable yields under a shortened land use time and on higher yields utilizing the full growing season. Develop better methods of utilizing winter legumes such as hairy vetch and crimson clover with emphasis on cotton planting practices. Determine what constitutes a 'stand' of cotton under different fertility levels and dates of planting. Measure the effects of varying cultural practice combinations on quality of lint produced.

APPROACH: Various cultural practices and combinations of cultural practices have been tested under this project for the past five years. Three fertilizer rates and three stand spacings have been tested together for four years. Three stand spacings and three dates of planting have been tested together for four years. These two tests were conducted at Marianna. The effect of skips on yields was also tested at the same location. Dates of planting ranging from April 15th to June 1st have been compared for two years. Single plant spacings of various widths have been subjected to several thinning dates for two years. These tests were grown at Keiser.

PROGRESS: Major emphasis in 1968 was given to the third and final year of an effort to develop ways of measuring insecticide phytotoxicity to plants. Early and late dates of planting with and without irrigation were coupled with high and low fertilizer rates and two varieties as agronomic variables imposed on six insecticides. These represented the hydrocarbons, the phosphates, and the carbamates. Measurements taken were plant growth rates, blooming rates, bloom shed percentages, boll maturation periods, yield and fiber properties. Irrigation or high fertilization, either or both, increased fiber length, decreased micronaire, decreased germination of resulting seed, and lengthened boll maturation periods. The hydrocarbons slightly increased the rate of plant growth, decreased shedding, and increased yields in two of the three years, including 1968. The phosphates tended to slow fruiting rate and lengthen boll maturation periods but did not reduce yields.

SUPPORTED BY U.S. Dept. of Agriculture

4.0215. BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

R.E. FRANS, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00550)

OBJECTIVE: Determine the effects of herbicides on anatomical and morphological responses, seed germination and growth, and selected metabolic systems.

APPROACH: Inhibitory responses of plants grown in nutrient solutions to which varying concentrations of the herbicides are added will be interpreted by mathematical growth expressions. Partial characterization of possible reactive sites or mechanisms will be determined by introducing compounds in mixture, competetively inhibiting or interfering with toxicity of the herbicide.

PROGRESS: Radioautographs showed that root uptake of C-methanearsonic acid (MAA- C) by johnsongrass from nutrient solution was rapid and translocation into all portions of the plant occurred within 4 hr after treatment. Basipetal and acropetal translocation of foliar and stem-applied MAA- C occurred in both johnsongrass and cotton, indicating that movement of the herbicide probably occurs in both phloem and xylem tissue. Methanol extracts of MAA- C may complex with either a sugar or organic acid or both. An MAA metabolite, with a positive reaction of ninhydrin, was present in the cotton fraction, suggesting that the metabolit may be a combination of the MAA molecule with histidine or one of its analogues. Spectrophotometric determination showed a build-up of amino acids in MAA treated johnsongrass but not in cotton. The increased levels of amino acids in johnsongrass suggest that the MAA metabolite may be blocking a protein synthesis pathway. The effect of 2,3,5-trichloro-4-pyridinol (pyrichlor), as well as carbonyl cyanide m-chlorophenyl hydrazone, 2,4-dichlorophenol, and oligomycin, on oxygen uptake and oxidative phosphorylation was investigated with mitochondria isolated from hypotocyls of etiolated soybeans. Pyrichlor inhibited both coupled and uncoupled reactions. This suggests that pyrichlor either acts on a nonphosphorylating intermediate close to the electron carrier chain or with a component of the electron carrier chain, or both.

SUPPORTED BY U.S. Dept. of Agriculture

4.0216. STORED GRAIN AND CEREAL PRODUCTS INSECT CONTROL BY METHODS LEAVING MINIMUM OF PESTICIDE RESIDUE

F.D. MINER, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00648)

OBJECTIVE: Investigate traps as a means of control of insects of stored grains and cereal products.

APPROACH: Develop methods of trapping larval and/or adult stages. Effectiveness of traps may be enhanced through various attractants, and value increased through toxicants or sterilants in combination with attractants. Evaluation of trapping as an adjunct to control will be undertaken under field conditions in conjunction with other control measures. Trapping devices and procedures will be evaluated as aids in locating sources of infestation.

PROGRESS: Cryptolestes turcicus was found to be attracted to sorghum grain infested with numerous species including its own, as determined by olfactometer tests using streams of air drawn through the grain. The insects were also attracted to pure cultures of their own species. They were not attracted to dis-infested grain or to pure cultures of other stored grain species. A stream of air was drawn through infested grain and then through a solid $CO(2)$ condenser. The condensate in small quantities was attractive to C. turcicus in an olfactometer and as a bait on a sticky-board trap. These results may contribute to eventual control of stored grain pests without insecticides.

SUPPORTED BY U.S. Dept. of Agriculture

4.0217. EFFECTS OF HERBICIDES ON QUALITY AND CHEMICAL COMPOSITION OF FRESH AND PROCESSED VEGETABLES

W.A. SISTRUNK, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00634)

OBJECTIVE: Determine the effect of herbicides on color, size, shape and appearance of raw vegetables; color, texture and flavor of the canned and frozen vegetables by both subjective and objective tests; chemical composition of the vegetables, and changes in quality during storage of canned vegetables, including tinplate corrosion.

APPROACH: Various herbicides will be applied at optimum and excessive rates to tomatoes, snapbeans and sweet potatoes grown in replicated plots. These vegetables will be harvested at optimum maturity; the raw product graded into sizes and/or color, and processed according to standard methods of washing, peeling, blanching, retorting or freezing, and stored for later analysis. Both canned and frozen samples will be analyzed for various constituents in order to define quality as to color, texture, flavor and acceptance by the consumer.

PROGRESS: TOMATOES: The effects of various methods, rates, and application of diphenamid on quality was not well defined. Hand-weeded plots and diphenamid at 2 lb/A pre-emergence produced slightly better color than the other treatments. SPINACH: The control plots produced spinach that was tougher in the canned products than the cycloate. The spinach treated with cycloate appeared to be slightly greener to a taste panel but the Hunter CDM did not detect a difference. CUCUMBERS: In brined cucumbers there was no effect of herbicides on the color,

firmness, or bloating of the brine stock. There was injury to the plants and a decrease in yield in both tomatoes and spinach where quality differences were indicated.

SUPPORTED BY U.S. Dept. of Agriculture

4.0218, WEED CONTROL IN HORTICULTURAL CROPS
R.E. TALBERT, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00605)

OBJECTIVE: Develop integrated systems of weed control in horticultural crops for the upper Midsouth region. Assess the selective properties of various herbicides and determine the factors influencing selectivity. Determine the effects of intensive herbicide usage in horticultural crops in relation to herbicide residues, weed ecology and product quality.

APPROACH: Replicated field studies comparing various systems of weed control will be established. Crop tolerance to herbicides and weed control edificacy will be measured under a variety of conditions in field and greenhouse studies. The residual activity of herbicide treatments will be monitored using chemical and biological assays. Effects of herbicide usage on ecological changes in vegetation and crop product quality will be observed.

PROGRESS: In some cases, mixtures of herbicides gave increased selective weed control over the single components including diphenamid plus methyl ester of amiben on direct-seeded tomatoes, DCPA plus linuron on Irish potatoes, alachlor plus linuron on snapbeans, DCPA plus chlorpropham and dinoseb plus diphenamid on southern peas, and sesone DCPA on strawberries. However, mixtures involving the methyl ester of amiben or dinoseb were not safely used in cucurbits. Promising new compounds were C-6989 on southern peas and strawberries, alachlor on Irish potatoes, transplanted tomatoes, snapbeans, southern peas, and strawberries, and C-6313 on Irish potatoes. Replanting cucumbers following a preemergence application of nitralin was hazardous for at least 1 month. Strawberries were injured by chloroxuron during hot, dry conditions and by C-6989 during the bloom stage. Up to 3X rates of nitrofen applied to greens caused considerable chlorosis, but there were no significant effects on the yield or processing quality of greens. Weed control was improved during the second year of herbicide application to orchards. Although terbacil has more postemergence activity on weeds, it is more hazardous to fruit trees than other herbicides. Incorporation of simazine reduced its activity. Herbicidal phytotoxicity to young trees was reduced by increasing the fertility level. Pear root stocks showed little tolerance to herbicides.

SUPPORTED BY U.S. Dept. of Agriculture

4.0219, INSECTICIDAL CONTROL OF VEGETABLE INSECTS
W.D. WYLIE, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00638)

OBJECTIVE: Provide recommedations for insecticidal control of vegetable insects; samples for residue analyses and/or taste tests; and conduct investigations of residue decay and initiate petitions for usage.

APPROACH: Usual methods of laboratory and field plot testing will be followed. Procedures for collecting and handling samples for residue analyses or taste tests are generally established. Details of procedures will vary from one situation to another.

PROGRESS: The use of adjuvants with Thuricide did not improve control of cabbage loopers on green crops. Blackstrap molasses had no effect while pinoline decreased effectiveness of Thuricide. Lannate caused damage to greens, especially turnips, even at dosages as low as 0.5 lbs. per acre. A regular dust was only slightly less phytotoxic than sprays but 'safened' dusts caused very little plant damage. Methyl parathion was much more phytotoxic than ethyl parathion. Plant damage was much more severe when sprays were applied to plants wet with dew. Phytoxicity was somewhat higher as emulsifiable concentrates increased in pounds active ingredient per gallon. TDE at 1-1/2 lbs. acre was only slightly less effective than 3 lbs. for bollworm control on tomatoes. Methyl parathion gave as good control as TDE but endosulfan, carbaryl, diazinon and dimethoate were less effective.

SUPPORTED BY U.S. Dept. of Agriculture

4.0220, DEVELOPMENT OF SAFE & EFFECTIVE MATERIALS FOR MANAGEMENT OF WESTERN FOREST INSECT POPULATIONS
D.C. SCHMIEGE, U.S. Dept. of Agriculture, Pac. Sw. For. & Rg. Expt. Sta., *Berkeley, California* (PSW2203)

OBJECTIVE: Develop safe, selective, nonpersistent, and effective materials and techniques to manage forest insect populations to protect the forest environment of the Western United States.

APPROACH: Screening and bioassay of candidate chemicals and formulations for evaluation, selection, and characterization of those most efficient for control of specific pest insects; chemistry and toxicology of selected materials, including study of modes of action and molecular manipulation to optimize control effects; and penetration, translocation, and metabolism of chemicals on and in forest trees to develop efficient foliar systemic treatments.

PROGRESS: Research continues to develop effective, specific, nonpersistent, and safe insect control treatments for serious forest insect pests. In 1969, a pilot test of Zectran completed a 5-year program of testing and evaluating a new treatment for the spruce budworm to replace DDT. A laboratory screening program evaluated an array of insecticides against the Douglas-fir tussock moth, the larch casebearer, the fall cankerworm, the California oakworm, and the orange tortrix. Alternatives to conventional insecticides were investigated. When administered to spruce budworm larvae in dosages far below those causing cholinesterase inhibition, Lannate produces a number of effects resembling those of juvenile hormone: delayed pupation, increased rate of weight gain, and increased incidence of pupal abnormalities. External and internal anatomy of spruce budworm larvae were investigated in detail to evaluate insecticide action. Particular emphasis was placed on impingement and penetration phenomena in and around the setae using radioactive Zectran. Laser holography was used to study the characteristics and behavior of insecticide aerosols. It allowed direct 3-dimensional stop-action study of spray particles as they impinged onto the western spruce budworm larvae and their silk webbing.

SUPPORTED BY U.S. Dept. of Agriculture

4.0221, BIOLOGICAL CONTROL OF HELIOTHIS ZEA ATTACKING COTTON
R. VANDENBOSCH, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B0-BIC-2292-H)

OBJECTIVE: Parasitic and predatory species affecting H. zea in California cotton fields, biology, ecology, phenology, distribution, nature of attack and total and relative efficacy of the natural enemies, cultural and ecological practices and selective chemical and microbial controls to augment biological control, mass release of entomophagous arthropods, introducing exotic natural enemies to supplement the native complex affecting H. zea.

APPROACH: Rearing of field collected material, exposure of lab reared H. zea and observation. The efficacy of the several natural enemies will be determined from cage and field studies and use of exclusion techniques. Bionomical studies will be made. Effects of chemical and microbial control agents on the beneficial species will be measured. Selective artificial controls will be sought and perfected. Mass release of entomophagous forms will be analyzed.

PROGRESS: An experiment in bollworm control demonstrated that intensive use of Methyl parathion and carbaryl caused a substantial reduction in cotton yield, apparently because of adverse effect on plant physiology. Reduced yield occurred even where bollworm infestations were severely reduced. The same experiment clearly demonstrated that cotton can withstand extremely high bollworm populations if predators occur in the fields. The predators destroy the bulk of the bollworms before they reach the late (damaging) instars. Cage studies of Hyposoter exiguae, a parasite of H. zea larvae, produced little useful information. Two factors adversely affected the experiments: (1) poor

survival of H. zea eggs and larvae obtained from a commercial insectary and (2) a lack of vigor in the insectary produced stock of H. exiguae used in the study. Interestingly, a field derived stock of the parasite, showed much greater vigor and fecundity and will be used in the 1970 studies.

SUPPORTED BY U.S. Dept. of Agriculture

4.0222, APPLICATION PRINCIPLES AND DESIGN REQUIREMENTS FOR WEED CONTROL EQUIPMENT

N.B. AKESSON, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D0-AER-1971-H)

OBJECTIVE: Improve or develop methods and associated equipment for weed control through study of mechanical, chemical, thermodynamic, and other principles.

APPROACH: Investigate mechanical cultivation; flame weeding; use of pre-emergence herbicides as affected by soil and incorporation and irrigation techniques; effects of chemical formulation, coverage, retention, and plant surface differences on foliage applied materials; evaluate spray-producing orifices to improve distribution and drop size control; methods of inhibiting germination of weed seeds in narrow band of soil immediately prior to planting; chemical and cover crop weed control for non-cultivation practices in orchard and vine crops; control undesirable plant species in such areas as range and forest lands; use mulches for general row crop weed control; and minimize toxic soil residues.

PROGRESS: A major effort was made this past season to establish correlations between propanil applications on rice and symptoms and damage to other susceptible crops grown in the area of the rice. Air sampling and test plant analysis indicates the pattern of air transport of the herbicide propanil under specific conditions. Significant reductions in small drop portions of spray produced by the Microfoil boom (AmChem Co.) and also a device developed here in the Department (called the L T N, low turbulence nozzle) point the way to reducing amounts of spray that would be susceptible to aerial transport. Mounted on the helicopter, these nozzles produced less drift than the usual ground rig with medium atomization nozzles. Limitation due to large median drops produced must be overcome, but there is evidence that this may be done.

SUPPORTED BY U.S. Dept. of Agriculture

4.0223, FUNDAMENTAL BIOCHEMICAL AND BIOPHYSICAL MECHANISMS INVOLVED IN HERBICIDAL ACTION

R.M. ASHTON, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D-ABO-2054-RR)

OBJECTIVE: California will study the comparative effects of treatments on proteolytic enzymes and protein synthesis and degradation.

PROGRESS: The herbicides 2,6-dichlorobenzonitril (dichlobenil), 7- oxabicyclo-(2.2.1) heptane-2,3-dicarboxylic acid (endothall), and 3,5- dibromo-4-hydroxybenzonitrile (bromoyxnil) were examined for their influence on the activity and synthesis of proteolytic enzyme(s) in the cotyledons of squash (Cucurbita maxima Duchesne) seedlings. None of these herbicides affected the activity per se of the isolated proteolytic enzyme(s). The presence of the herbicides in the culture solution during germination caused different effects on the development of the proteolytic activity in the cotyledons for each of the three herbicides. Dichlobenil reduced the development of the activity in both the excised cotyledons and the cotyledons of intact embryos. This inhibition was overcome in part by the addition of benzyladenine to the culture solution. The inhibition of hormone synthesis or export by the embryonic axis caused by dichlobenil could explain the observed results. Endothall inhibited the development of the proteolytic activity in the cotyledons of the intact embryo treatment but had little effect on the excised cotyledons. Benzyladenine did not reverse this inhibition. The effect of endothall resembled the inhibition caused by actinomycin D, possibly indicating that endothall interfered with ribonucleic acid metabolism. Bromoxynil inhibited the proteolytic enzyme(s) development in the cotyledons of intact embryos but not in the excised cotyledons. This inhibition was partly overcome by benzyladenine. These results suggest that bromoxynil not only interferes with the hormonal control mechanism but also proteinase synthesis.

SUPPORTED BY U.S. Dept. of Agriculture

4.0224, RESPONSE OF PLANTS AND PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES

D.E. BAYER, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D0-ABO-2566-RR)

OBJECTIVE: Determine effects of repetitive application or persistent pollutional levels of herbicides on the structure, chemical composition, and function of individual species of the plant community.

APPROACH: Study structural modification of plant organelles caused by herbicides and determine localization and distribution at the cellular and subcellular level. The effects of selected herbicides upon the mobilization of seed storage proteins during germination will be studied to determine the differences in mobilization of these food reserves. This information will be used to help evaluate contamination of our environment by herbicides and to predict shifts in species composition.

PROGRESS: Atmosphere and biological sampling during airplane application of propanil showed that particles of propanil drifted in excess of 20 miles. These particles were less than 50 microns in size but were still of sufficient volume to produce typical propanil symptoms on French prune trees. Electron microscopic examination appears to suggest the only cell organelle to be affected was the chloroplast. Physiological studies indicate the French prune tree is not capable of metabolizing propanil to nontoxic compounds rapid enough to prevent symptoms from forming with injury to the chloroplasts that come into contact with the herbicide.

SUPPORTED BY U.S. Dept. of Agriculture

4.0225, COMPARATIVE BIOCHEMISTRY OF HERBICIDES

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OBJECTIVE: Develop an understanding of the interactions between various herbicide molecules and the biochemical systems of plants, animals or micro-organisms.

APPROACH: The widespread use of agricultural chemicals, including herbicides, has broad implications with respect to both human health, and agricultural production. A thorough understanding of the biochemical properties of these compounds is therefore extremely important. The fundamental biochemical properties of phytotoxic compounds will be investigated. In vivo work with higher plants and in vitro work with enzyme systems derived from plant, animal and bacterial sources is anticipated; the experimental procedures, in general, will be those of enzyme chemistry and qualitative organic analysis.

PROGRESS: Aged potato tuber slices incubated with C labeled choline, enthanalamine, methionine, serine, and acetate showed that the incorporation of radioactivity into the lipid fraction increased with the length of time the slices had been aged. This incorporation was shown to be true lipid synthesis. An enhanced incorporation of labeled choline mainly was due to increased uptake while enhanced incorporation of labeled acetate resulted from the development of a fatty acid synthetase system during aging. In the case of enthanalamine, both its uptake and its relative incorporation into the lipid fraction increased. The major compound formed from choline was lecithin and from ethanalamine was phosphatedyl-ethanalamine and a small amount of lecithin. The labeled phospholipids were found exclusively in the microsomes up to 8-10 hours of aging while older slices showed some labeling in mitochondria suggesting that slicing induces immediate synthesis of microsomal (endoplasmic reticulum) membrane bound ATPases. Although complete separation has not yet been achieved, it appears that 3 membrane-bound ATPases are present. Histochemical and electromicroscope studies on the intracellular localization of ATPases show a very high concentration in the nucleoli of root cells and a definite activity at the plasmolemma of the oat root cells.

4. PESTICIDES

SUPPORTED BY U.S. Dept. of Agriculture

4.0226, MARKET QUALITY OF TABLE GRAPES AS INFLUENCED BY CHEMICALS APPLIED FOR WEED, PEST AND DISEASE CONTROL

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OBJECTIVE: Determine the effect of new chemicals on the appearance, texture and flavor of the fruit as well as the levels of residue remaining in the product.

APPROACH: Many new chemicals (some highly toxic) have been found effective as herbicides, pesticides, fungicides and growth regulators to improve the market quality of table grapes. The possibility of prolonging the storage life of table grapes by the use of modified atmosphere appears very promising, particularly in the light of the new fungicide dibromotetrachloroethane which is effective as it volatilizes from a solid state within the package. High carbon dioxide levels not only depress the rate of respiration of the fruit, but also depress the rate of growth of decay organisms. These factors together indicate a strong possibility that grapes can be enclosed in a relatively tight container thereby minimizing water loss from the fruit, yet decay can be controlled for several months.

PROGRESS: Sulfur dioxide is the only feasible material available as a fumigant to control decay of table grapes during handling, storage and transit. Though an excellent fugicide, it does cause chemical injury to the fruit that is accumulative with concentration and time of exposure. Needed is more exact information on the concentration-time exposure that offers the best compromise between adequate decay control and chemical injury within acceptable limits. Such information is necessary to develop a fumigation system whereby sulfur dioxide is generated from a source within the closed container to first, (1) surface sterilize the fruit immediately after packing and during precooling, then (2) contain infections in field-infected berries so that the decay does not spread during storage and/or transit. Critically controlled concentrations of sulfur dioxide in 'open' systems have shown that 16 ppm of sulfur dioxide for 24 hours in saturated air while the temperature is lowered from 25 to 5 C will effectively surface sterilize the fruit with minimal injury. To contain field infections during storage at 0 C about 8 ppm of sulfur dioxide is required. Higher concentrations are required at higher temperatures with correspondingly more injury.

SUPPORTED BY U.S. Dept. of Agriculture

4.0227, WEED CONTROL IN AGRONOMIC CROPS

R.F. NORRIS, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D0-ABO-1901-H)

OBJECTIVE: Develop satisfactory programs of weed control for crops other than cotton. Study influence of environmental factors on effectiveness of herbicides used in field crop situations; physiology and biochemistry of herbicidal action from a fundamental standpoint.

APPROACH: Evaluate most promising selective herbicide-agronomic crop combinations in the field, greenhouse and laboratory. Soil incorporation of herbicides will be emphasized. Fundamental studies include the influence of environmental factors (temperature, relative humidity, spray additives, etc.) upon foilar penetration and translocation, herbicide and surfactant interactions, distributional and metabolic fate of radio-labeled triazine herbicides, barban, dalapon, etc., and herbicide residues in plants and soils.

PROGRESS: Triallate (Avadex BW) gave excellent wild oat control in barley, resulting in yield increases in excess of 400 lb/A. Residue information is being obtained and a recommendation for this chemical should be possible in the 1970 season. Wheat showed less tolerance to this chemical than barley. Terbacil (Sinbar) has shown excellent control of general annual winter weeds and summer annual grasses in alfalfa. RH-315 continues to look promising in alfalfa and ladino clover fields infested with grass weeds. A program has been initiated to find better means of controlling dodder in alfalfa, with generally disappointing results. Herbicide testing in dry beans (lima, kidney and blackeye) is being increased, with special emphasis placed on controlling weed species in the Solanaceae. Logarithmic screening revealed several new chemicals that show considerable promise, with S- 6115 being the most outstanding. S-6115 has also given excellent week control in corn, at as low as 0.5 lb/A applied preplant incorporated. Extensive testing of herbicides for use in sugar beets has continued, with CP-52223 showing potential as a preplant incorporated herbicide. Phenmedipham (Bethanal) gave excellent weed control applied post- emergence during the winter and early spring, but less weed control and more crop injury occurred when applied during May and June.

SUPPORTED BY U.S. Dept. of Agriculture

4.0228, EXTENDING THE MARKET LIFE OF CALIFORNIA CITRUS FRUITS IN FOREIGN MARKETS

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OBJECTIVE: Relate market quality and chemical residues of U.S.- grown citrus fruits in overseas markets to condition at origin, pretransit, in-transit and destination handling, treatments, containers, and commodity temperature.

APPROACH: Determine decay, deterioration, chemical residues, and other market quality factors in test shipments of citrus fruits upon arrival at overseas ports, or arrival at terminal wholesale markets, and often actual or simulated handling at wholesale and retail markets. These evaluations will be related to product maturity and quality, and to pretransit and in-transit practices and environments. Plans include comparisons of break-bulk, palletized and containerized shipments, and decay-control treatments.

PROGRESS: Biphenyl residues in lemons are seldom over tolerance since lemons absorb one-third as much biphenyl as oranges when exposed to similar levels of biphenyl. Lemons injured by freezing or nitrogen storage absorbed excessive amounts of biphenyl indicating the involvement of a biological barrier. Biphenyl absorption by citrus occurred primarily in the rind tissue since separated orange peel absorbed four times more biphenyl than separated pulp segments.

SUPPORTED BY U.S. Dept. of Agriculture

4.0229, CHEMISTRY OF NEMATODES AND NEMATOCIDES

C.E. CASTRO, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2006)

OBJECTIVE: Trace chemical fate of nematocides in their path of migration from soils to extremities and edible portions of plants; quantitatively determine residues in each of these media.

APPROACH: In addition, it is intended to elucidate molecular processes occurring within nematodes and place host-parasite relationships of these animals on a chemical basis.

PROGRESS: Studies of the interactions of transition metal specie in organic and biological systems have revealed new insights into mechanisms of respiration, electron transport and biodehalogenation. These include: (1) The reaction of dimethylmethyl chromium carbenoids with olefins. (2) Peripheral attack in the reduction and oxidation of iron porphyrins. (3) Copper(I) substitutions. Scope and mechanism of cuprous acetylide substitutions. (4) Biodehalogenation. The pathway for transhalogenation and the stereochemistry of epoxide formation from halohydrins. (5) The oxidation of Iron(II) porphyrins by organic molecules. And describe respectively, (1) The reactions of a unique chromium carbenoid. (2) The importance of outer sphere electron transfer to hemes and hemoproteins and explanations for the reactivity of the globins and cytochromes. (3) The breadth and mechanism of Cu(I) acetylide substitutions. (4) The reversible enzymatic transhalogenation of epihalohydrins. (5) The kinds of organic molecules capable of oxidizing iron(II) porphyrins. Ubiquinone is suggested as a long range electron transfer agent.

SUPPORTED BY California State Government - Sacramento

4.0230, PHYSIOLOGICAL STUDIES ON WEEDS AND WEED CONTROL IN SOUTHERN CALIFORNIA

B.E. DAY, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-PLS-1475)

OBJECTIVE: Biological and physiological studies will be undertaken to secure information on the life cycles and conditions for growth, reproduction and survival of weeds in southern california fruit orchards. Phytotoxicity of herbicides to orchard trees and weeds will be studied and these data applied to the field development of selective weed control programs.

APPROACH: Increased effort will be devoted to studies of nutgrass control in the Coachella Valley.

PROGRESS: Fruit production and quality were not affected in orchards treated with terbacil and bromacil for five years. Herbicide treatments for 10 years with diuron and simazine did not result in soil residue build-up in the surface 5 feet. Relative sensitivity of four citrus rootstocks to herbicides is, in decreasing order, Troyer citrus orange, Sweet orange, Cleo mandarin, rough lemon. Herbicide toxicity in decreasing order is bromacil, terbacil,simazine, diuron. Granular diclobenil control nutsedge 15 to 18 weeks but does not control bermuda grass; while terbacil and bromacil control bermuda grass, but not purple nutsedge on sandy soil. DNBP in weed oil sprays reduces oil required and expense of contact sprays. Contact herbicides reduce nutsedge population but do not eradicate nutsedge, even with repeated applications. Simazine, the most widely used herbicide, does not control summer annual grass in orchards. Diuron controls annual grass if application is properly timed. Contact herbicides are being used but costs are high. New herbicides promise to solve the problem. These include R7465, nitralin, trifluralin, VCS 634 and others. Tree tolerance and performance trials are established in several orchards.

SUPPORTED BY California State Government - Sacramento

4.0231, CHEMICAL CONTROL OF POST-HARVESTING FRUIT AND VEGETABLE DECAYS OCCURRING IN PACKING HOUSES

J.W. ECKERT, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-1765)

OBJECTIVE: Develop a comprehensive research and evaluation program for chemical control of fruit and vegetable decay inciting microorganisms. Fungicide treatments will be developed to protect fruits and vegetables from decay and spoilage in packing houses, storage, transit, and during market period. Studies will be made of effect of applied chemical upon product quality.

APPROACH: With few exceptions most chemical materials can no longer be used readily as post-harvest treatments and comply with recent regulations of Food and Drug Administration. It is, therefore, essential that post-harvest fungicidal treatments for fruits and vegetables produced and shipped be examined in order to develop new and effective chemical treatments which comply with regulations and to provide information which will allow continued use of fungicides now successfully employed.

PROGRESS: A study of chemical structure vs antifungal activity in a series of lower primary aliphatic amines revealed that 3-methylpyrrolidine, sec-butylamine, pyrrolidine, 1-methylpropenylamine and cyclobutylamine were most active of 50 amines tested. (-) sec- butylamine was approximately 60 times more active than ( ) sec- butylamine. Sec-butylamine inhibited uptake of amino acids and protein synthesis by Penicillium digitatum. The postharvest fungicide o- phenylphenol is absorbed by both citrus fruits and pathogenic fungi. Excessive uptake by fruit causes high residues and injury. The quantity of o-phenylphenol absorbed by both oranges and spores of Penicillium digitatum was positively correlated with the concentration of undissociated o-phenylphenol in the treating solution. However, efficiency in decay control was correlated with factors favoring the selective absorption of the o-phenylphenate anion at potential infection sites on the surface of the fruit. Lower alkyl esters of o-phenylphenol were fungitoxic to both Penicillium digitatum and Diplodia natalensis but the methyl ether of o-phenylphenol was highly toxic only to the latter fungus. Substantially more free o-phenylphenol was isolated from the Diplodia culture indicating enzymatic cleavage of the ether.

SUPPORTED BY California State Government - Sacramento

4.0232, DEVELOPMENT OF SYSTEMIC FUNGICIDES FOR VERTICILLIUM WILT CONTROL

D.C. ERWIN, Univ. of California, School of Agriculture, *Riverside, California* 92502

The Research: Initiate a fundamental investigation to provide a basis for developing systemic fungicides capable of controlling verticillium wilt of cotton. Such research should: 1. Develop an understanding of the composition and characteristics of chemicals that are either directly toxic to verticillium wilt or which metabolically block its attack on, and the damage it does to the cotton plant; 2. Determine the structure specifications of such chemicals that will aid in their absorption, translocation and redistribution within the plant and 3. Investigate the possibility such chemicals may be most useful and effective if they are initially non-toxic to the plant and fungus, but by action of the plant or fungus, they produce reaction products that are fungicidal, or at least limiting, to growth of the pathogen.

SUPPORTED BY Cotton Incorporated - Raleigh, N.C.

4.0233, PEST CONTROL OF AVOCADO

W.H. EWART, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-1340)

OBJECTIVE: Study the biology and chemical control of the approximately 25 species of insect, mite, and snail pests of avocado trees.

APPROACH: Develop rearing techniques for maintaining laboratory cultures of as many pests of avocado as feasible. Screen new insecticides for phytotoxicity and effectiveness against the various pests. Sreeen new insecticides against the various pests with special emphasis on greenhouse thrips and avocado brown mite. Study insecticidal treatment with respect to methods of application, dosages, formulation and compatability with various spray additives, phytotoxicity, effect on beneficial insects and other side effects, and residues on and in fruit.

PROGRESS: Avocado Brown Mite: Data obtained on effectiveness of narrow-range oil and light medium oil and light medium oil sprays for mite control was forwarded to State Department of Agriculture and manufacturers and formulators of horticultural spray oils for use in obtaining registration of these treatments. Greenhouse Thrips: In field trials sprays containing (1) malathion tetradifon or (2) carbofuran were outstanding in preventing fruit scarring; (3) pyrethrium oil was less effective but is a useful treatment since it does not upset the biological balance in the orchards and is relatively nontoxic to mammals; (4) formetanate was relatively ineffective. Omnivorous looper: A spray containing naled (Dibrom(Reg)) was not effective. Galecron(Reg), a possible treatment for this pest, was not phytotoxic to Haas, Fuerte or Bacon varieties when applied at 8 oz. actual compound per 100 gals.

SUPPORTED BY California State Government - Sacramento

4.0234, RESPROUTING OF CHAPARRAL

J.R. GOODIN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-PLS-2184-H)

OBJECTIVE: Attempt to develop an understanding of the phenomenon of resprouting in chaparral species and the autecological, anatomical, physiological, and genetic factors which influence this phenomenon.

APPROACH: The research will be conducted in the field, greenhouse, and laboratory, studying phenology, rate of resprouting, anatomy, growth and development in vitro, carbohydrate levels, and genetic variability of the dominant chaparral species.

PROGRESS: Tandex continues to look more promising than picloram in many situations for the control of Quercus dumosa. Phytotoxicity to grasses has been a serious detriment to the use of this chemical, and studies are in progress for use of the grid application technique to avoid damage to surface vegetation. Final

analyses of the experimental watersheds treated with combinations of 2,4-D, 2,4,5-T, and picloram show that essentially all residues have disappeared from the water and soil. A careful study of initial succession of vegetation following these treatments suggests that low residue levels may be phytotoxic to a few species, but in general, the pattern of succession approximates that which occurs following wildfires. Such information will be of use to land planners concerned with long-term ecological effects of herbicides. Studies of the polar transport of auxin are continuing in sterile culture. The new oxygen combustion method for C-determinations will be employed to study quantitative and qualitative changes in growth regulators. A selective bioassay was devised to evaluate extremely low concentrations of picloram in soil and water. This assay is selective for picloram, and is not confounded with effects from phenoxy-type herbicides.

SUPPORTED BY U.S. Dept. of Agriculture

4.0235, CONTROL OF INSECTS AND RELATED PESTS OF FLORICULTURAL CROPS, NURSERY STOCK AND TURFGRASSES

R.N. JEFFERSON, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-1338-A)

OBJECTIVE: Develop more effective economical control measures for insect and related pests of greenhouse and field flower crops.

APPROACH: Laboratory and field studies of biology and habits of pests involved; laboratory and field studies with promising new materials and of equipment and methods of application.

PROGRESS: At 10 pounds of active ingredient per acre Dasanit, Akton, Landrin, Dyfonate, Furadan and Diazinon gave effective control of billbug larvae (Sphenophorus phoeniciensus) on Tifgreen bermuda grass. Lannate and Heptachlor were ineffective. Of 12 insecticides tested against the tobacco budworm (Heliothis virescens) on geraniums the most effective were Lannate, Azodrin, Monitor, C-9491 and C-2307. The materials were applied at 6 pounds of the active ingredient per acre in 300 gallons of water. In phytotoxicity tests on chrysanthemums and carnations the following materials (pounds active ingredient per 100 gallons of spray shown in parentheses) damaged both crops: Galecron (1/2 lb.), Fundal (1/2 lb.), Monitor (1 lb.) and Lannate (1 lb.). Compound 9491 (1 lb.) gave delayed injury to chrysanthemums.

SUPPORTED BY California State Government - Sacramento

4.0236, LIFE CYCLE, PHYSIOLOGY AND CONTROL OF PERENNIAL WEEDS AFFECTING SUBTROPICAL FRUIT CROPS

L.S. JORDAN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-PLS-1917)

OBJECTIVE: Study the life cycle and physiology of perennial weeds, and determine the best methods of controlling these weeds without adversely affecting subtropical fruit crops.

APPROACH: Initially the major effort will be devoted to studies of the physiology and control of nut grass and bermuda grass. Other important weeds will be studied under laboratory and field conditions when economic losses from the weeds are deemed sufficient to warrant such studies. In general, the investigations will be conducted as follows: Study the life cycle and physiology of the weed species and attempt to develop control methods based on physiological characteristics or growth habits of the plant. Investigate the effects of herbicides on the physiology of the weed species in an effort to improve the effectiveness of the herbicides.

PROGRESS: Evaluation of 140 herbicides in the field were made on 30 crops and 25 weed species. San 6706 and R 7465 are toxic to most annual crops but show promise in tree and vine crops. Kerb was selected for use in lettuce. Several potentially useful herbicides have been selected for further evaluation. Sorghum seed treatment with 1,8- naphtalic anhydride counteracts toxicity of EPTC, alachlor and diallate. The antidote did not counteract 10 other herbicides on several crops. Ten additional anhydrides and quinones were not antidotal to herbicides. Antidotes to herbicide will increase selectivity and weed control and reduce herbicide residues in the environment. Each antidote is specific to crops and herbicide groups. The antidotal action is not physical adsorption. Naphtalic anhydride is metabolically active and toxic to some plant species. It is translocated. Naphtalic anhydride is a powerful photosynthetic inhibitor being 1,000 times as effective as CMU on isolated, intact, spinach chloroplasts. 1,8-naphtalic anhydride may be the strongest inhibitor to photosynthesis yet discovered. Research with 1,8-naphtalic anhydride and potential antidotes will be emphasized. Ten plants have been developed which complete their life cycle in 30 days or less under controlled conditions. Their response to growth regulators and herbicides make them valuable for laboratory research with exogenous chemicals.

SUPPORTED BY California State Government - Sacramento

4.0237, DEVELOPMENT AND APPLICATION OF ANALYTICAL METHODS FOR THE DETERMINATION OF HERBICIDES AND PLANT GROWTH REGULATORS

L.S. JORDAN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-PLS-2007)

OBJECTIVE: Quantitative analytical methods will be developed for the determination of residues of herbicides and growth regulators in fruit, fruit products, the vegetative parts of fruit trees and in orchard soils. These methods will be employed in the practical determination of residue levels following field, and post harvest use of these chemicals in the production and processing of subtropical fruit.

APPROACH: Development of a procedure for the determination of 2,4- D in citrus fruits which has maximum sensitivity and a high confidence level. This will be used for the determination of residues in citrus where 2,4-D has been used as a herbicide. And also, study the amount of residue precent in lemons where 2,4-D has been used as a past harvest treatment.

PROGRESS: Fluorescence intensity as measured in a spectrophotofluorometer was used as the basis for the development of a method for the determination of 1-naphthalineacetic acid in citrus tissues. The cleanup for this sensitive detection method is accomplished by selective extraction, liquid-liquid partitioning and permanganate dilution. Inclusion of a silica gell cleanup column was necessary for peel samples. The method has a sensitivity of 0.1 ppm based on a 25 g sample. Preliminary analysis of field treated samples before the method was completed indicated that no naphthaleneacetic acid residues were present in the peel or pulp. It was determined that an ascorbate CuSO(4) system would degrade several herbicides to various degrees. An acid pH favored the reaction. Eptam, vernolate, and alachlor gave the most response and to a lesser degree, diallate, CDAA, and CDEC. Some of the breakdown products found were ethylene, ethane, propylene, and butene. Thirty different soils and eptam were tested in determining if such a degradation might occur in nature, but similar degradation did not occur.

SUPPORTED BY California State Government - Sacramento

4.0238, DETECTION AND DETERMINATION OF FUNGICIDES, BACTERICIDES, AND CHEMOTHERAPEUTIC AGENTS

M.J. KOLBEZEN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-1998)

OBJECTIVE: Development of analytical methods, if none exist, and application of these methods to residue analysis of every crop-fungicide combination important to southern California agriculture. Certain bactericides and possibly chemotherapeutic agents will be considered.

APPROACH: With some pesticides it is import also to study breakdown pathway since metabolites and decomposition products could be toxic. Whenever possible, field persistence and rate of decay of deposits of pesticides will be studied.

PROGRESS: Thiabendazole (TBZ) and benomyl are two promising decay control agents for citrus. TBZ is in commercial use, benomyl is in the experimental phase. A simple analytical procedure has been developed for analyzing wax formulations for TBZ, also a residue method for determining the magnitude of TBZ deposited on citrus fruit when applied by some commercially practical method. Similar types of analyses for benomyl are under study. Since many plants are sensitive to bromide ion in soils, some soils are being analyzed for bromide content resulting from

hydrolysis of methyl bromide (MeBr) when these soils are fumigated with MeBr. A correlation between bromide content and such factors as dosage, moisture, and pH is being sought. To date, correlations are vague. The analysis of soil atmospheres for MeBr concentrations is continuing in a long range project to determine the relation of soil characteristics to optimum diffusion to deeper regions for Armillaria mellea control.

SUPPORTED BY California State Government - Sacramento

4.0239, CONTROL OF NEMATODES IN NURSERIES AND ON PLANT MATERIALS

A.R. MAGGENTI, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2044)

OBJECTIVE: Identify species of nematodes and their distribution around plants in nursery culture. Evaluation of nursery plants as nematode host and carriers, and for resistance or susceptibility of nematode disease. Devise and evaluate methods for obtaining eradication, or near-eradication, of nematodes from nursery soils and nursery plants.

APPROACH: Soil and root samples will be collected from plants associated in and with nursery culture, and suspected plant parasitic nematodes identified. Greenhouse studies will be made with these nematodes to study pathogenicity and host range. After consideration of properties of available nematocides, a series of materials and dosages will be selected that are most likely to achieve eradication or a high degree of control of nematodes in nursery soils and plants. Treatments will be compared in replicated field trials, giving special consideration to sampling methods and detection probability. In laboratory and greenhouse evaluate hot water treatments and chemicals available from industry as eradicants of nematodes in or on nursery grown materials.

PROGRESS: Dipping trials with the following chemicals were conducted for the elimination of rootknot nematodes (Meloidogyne spp.) from plant roots: trimethoxy-2-bromopropane; dimethoxy-2-bromobutane; alpha-ethyl, beta-dibromopropionate; alpha-bromo, beta-ethyl propionate 1, 1-dibromo-2, 2-dietoxy-ethane; bromodine; V-C 13; 21149 (Union Carbide Co.); Bayer 68138; V-C 9-104; Stauffer N 3056; Shell SD 4965; Zinophos; Chemagro 5461; Niagra 15267; E. Lilly 300; Dupont 1410; and Lannate. None of these chemicals completely eliminated nematodes from the roots without injuring the plant. The most promising of these chemicals were V-C 13; Zinophos; Bayer 68138; and Dupont 1410.

SUPPORTED BY California State Government - Sacramento

4.0240, THE BIOCHEMISTRY AND MODE OF ACTION OF HERBICIDES

J.D. MANN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-PLS-2005-H)

OBJECTIVE: The objective of this project is to secure information on the mode of action of selective herbicides used or potentially useful in crop production. The machanism of resistance of some plant species to herbicides will also be studied.

APPROACH: Radioactive precursors of plant metabolites will be administered to plant tissues, in the presence of a wide variety of herbicides. Possible effects of these herbicides upon metabolism will be studied by tracer procedures.

PROGRESS: The nitrogen content of carrots and ryegrass was increased by pre and postemergence treatments with nitralin, trifluralin, and 4 symmetrical triazine herbicides. Several metabolites of terbacil and bromacil were isolated from Troyer and Koethen sweet orange seedlings by fluorescence TLC. Identification of the metabolites is in process. Simazine is converted to hydroxy simazine and dealkylated products in citrus seedlings. Dealkylation but not hydroxylation occurs in nutrient solutions surrounding citrus roots; simazine translocates readily in the apoplast and conversion occurs in roots, stems and leaves of citrus. An unidentified metabolite occurs in citrus fruit. Positive identification of simazine metabolites in citrus is underway. TLC systems were developed for separation of simazine and three metabolites. Simazine is more toxic to citrus trees growing in soil than trees growing in nutrient solution, whereas monuron is more toxic in nutrient solution. Several metabolites of monuron and photolytic degradation products have been isolated with TLC and are being identified.

SUPPORTED BY U.S. Dept. of Agriculture

4.0241, REACTIONS OF VEGETABLE CROPS TO APPLIED CHEMICALS, EXCLUSIVE OF NUTRIENTS

L. RAPPAPORT, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R-VCR-1175-D-R)

OBJECTIVE: Increased fruit setting; improved seed yield in breeding projects; control of flowering; control of vegetative growth; control of dormancy; effects of insecticidal, fungicidal, and phytocidal chemicals on yield, appearance, texture, taste, aroma, harvesting and storage practices, etc. of vegetable crops.

APPROACH: NOT-PROVIDED

PROGRESS: Cooperative screening trials were conducted involving 76 herbicide chemicals at 3 rates each on 8 vegetable crops in a spring trial and 80 chemicals at 3 rates each on 9 vegetable crops during the fall planting season. Studies on the effect of Dacthal on onion emergence were continued with emphasis on the effect of rate of herbicide and depth of planting over a period of time beyond the flag stage of the onion seedling. Ten chemicals were tested as preemergence herbicides or as post emergence treatments on asparagus seedlings from 2 to 10 weeks after emergence. Effective herbicides are necessary to make possible direct seeding for establishment of asparagus plantings. The chemical 2-chloroethanephosphonic acid (Ethrel) was tested on tomatoes to accelerate maturity. Ethrel at 250 and 1000 ppm increased both number and weight of early fruit harvested, although total yield was not greatly affected. Fruit maturity was advanced from 7 to 10 days by Ethrel treatment. Studies have also been initiated on the effect of this chemical on alteration of sex expression in pickling cucumbers and cantaloupe.

SUPPORTED BY California State Government - Sacramento

4.0242, CHEMICAL STRUCTURE RELATED TO SYSTEMIC ACTIVITY, METABOLISM, MODE OF ACTION, AND FATE OF CHEMICALS IN COTTON PLANT

H.T. REYNOLDS, Univ. of California, School of Agriculture, *Riverside, California* 92502

The Research: A detailed study of the metabolic behavior of systemic in cotton plants plus appropriate structural modifications is the key to the development of effective systemic insecticides. Research should include: 1. A detailed study of chemical structure related to systemic activity in the cotton plant. 2. Basic studies on the metabolism of systemics in the cotton plant as related to systemic activity aand toxicity to cotton insects. 3. Laboratory and field plot studied to evaluate promising candidate compounds for cotton insect control.

SUPPORTED BY Cotton Incorporated - Raleigh, N.C.

4.0243, COTTON PATHOLOGY FOR THE IRRIGATED WEST

R.H. GARBER, U.S. Dept. of Agriculture, Crops Research Division, *Shafter, California* 93263 (0200-02-08)

OBJECTIVE: Reduce the production hazard of verticillium wilt; improve seedling survival and vigor by more efficacious seed and soil treatment; influence of boll constituents on incidence and severity of rots.

APPROACH: Varietal reactions to different cultural practices, irrigation frequencies and duration, nutrient levels, plant populations, crop sequences, and duration, nutrient levels, plant populations, crop sequences, and precision tillage; cooperate in regional seed and soil fungicide studies. Tag several thousand flowers to identify bolls, harvest boll samples periodically for laboratory study of organisms on the surface, and of boll constituents; use boll washings for bioactivity trials, also carpel and locule constituents. Survey main production areas periodically for presence of bacterial blight.

PROGRESS: Field tests indicated significant increases in plant survival resulting from effective seed treatment with protectant and protectant-systemic fungicide seed treatments. Studies on multichemical application at planting time were continued.

Stands were improved by the use of fungicides. In the absence of a fungicide, phorate, either as granules or seed treatment, reduced stand. Phorate used as a seed treatment also reduced plant vigor. Several herbicides also reduced plant vigor. Data indicate that environment exerts a major influence on chemical interactions and any factors that delay emergence contribute to increased damage or to the deleterious effect of chemical treatment. Studies on crop rotations indicate the value of a barley crop between cotton crops in reducing loss due to verticillium wilt. When cotton crop residues were removed from fields, the level of verticillium wilt was significantly reduced. Results of five years of work indicate that temperatures can mask inoculum differences and become the determining factor in disease severity. Studies on virulence of Verticillium albo- atrum indicated repeated passage through cotton resulted in increased virulence. Cotton treated with the systemic fungicide benomyl exhibited less wilt symptoms, was taller, and yielded more cotton. Bioassay of leaves in September indicated presence of benomyl after two post- planting soil applications.

SUPPORTED BY U.S. Dept. of Agriculture

4.0244, BIOLOGY AND CONTROL OF WEEDS IN WESTERN IRRIGATED COTTON

J.H. MILLER, U.S. Dept. of Agriculture, Crops Research Division, *Shafter, California* 93263 (0710-01-06)

OBJECTIVE: Develop safe, practical, economical and effective weed control methods in irrigated cotton.

APPROACH: Conduct physiological, morphological, anatomical, ecological and agronomical research on factors affecting absorption, penetration and translocation of herbicides in plants; research on the performance, persistence, and movement of herbicides in soil as affected by water management, time and method of application, and soil characteristics; and research on combining chemical and nonchemical methods of control.

PROGRESS: Data from 2 years of field experimentation do not indicate that the insecticides phorate or disulfoton alleviate inhibition of lateral roots of cotton by the herbicides trifluralin or nitralin applied before planting. An alleviating action has been reported from research in Arizona. Continuing research indicates that spraying nitralin or trifluralin beneath the soil surface in horizontal bands or injecting them in the soil in parallel lines may be more efficient than incorporation in the soil with powered equipment with respect to weed control where applications are made as cotton is planted in moist soil. Sweep cultivators appeared equal to rolling cultivators for incorporation of herbicides applied at layby of cotton.

SUPPORTED BY U.S. Dept. of Agriculture

4.0245, SUGAR BEET DISEASES

J. ALTMAN, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00082)

OBJECTIVE: Study etiology of sugar beet Rhizoctonia and nematodes and determine effective control measures. Study modifications of disease and growth in beets due to herbicides and pesticides.

APPROACH: In vitro evaluation of sugar beet herbicides on Rhizoctonia and Heterodera schactii. Histological studies of the inoculated and uninoculated plants grown in Tillam-treated greenhouse soils.

PROGRESS: Predisposition tests were set up in the field and in temperature tanks to evaluate the effect of combinations of Rhizoctonia, Heterodera schachtii, and two herbicides on disease interaction. Field experiments confirmed previous observations in Colorado that Pyramin and Roneet can predispose plants to increased Rhizoctonia damage, in the absence of nematodes. Increased nematode reproduction was also observed in the absence of Rhizoctonia. Combinations of nematodes and Rhizoctonia resulted in more severe disease when beets were grown in herbicide treated soil than that resulting from such combinations grown without herbicides. (This research supported jointly by Projects 0215 and 0082).

SUPPORTED BY U.S. Dept. of Agriculture

4.0246, CONTROL OF WEEDS AND INSECTS IN SUGAR BEETS

A. DOTZENKO, Colorado State University, School of Agriculture, *Fort Collins, Colorado* 80521

The crop sequence in which sugarbeets followed beans had lower weed populations prior to thinning than did sugarbeets following either barley or corn. Lowest weed populations resulted in highest root yields. The rate and time of application of nitrogen fertilizer did not influence root yields and weed populations. The low-plus-residual nitrogen and high nitrogen treatments did reduce sucrose percent and purity which lowered sucrose production and tons of recoverable sugar per acre. The application of high nitrogen also reduced beet numbers prior to thinning and harvest. The application of preplant and post- emergence herbicides significantly lowered populations of all weed species. Kochia was controlled to a degree by the use of herbicides. However, significant populations of this barley left no residual damaging effects on the following beet crop. Herbicides did reduce beet stands prior to thinning, but because of weed competition in the no herbicide treatment the use of herbicides resulted in more beet numbers at harvest. The yield of all weed species prior to thinning and at harvest was lowered due to the use of herbicides. Herbicides significantly increased root yields, sucrose production and tons of recoverable sugar even though they caused reductions in sucrose and recoverable sugar percentages. Interaction of treatments revealed that most weed populations can best be controlled by a proper combination of crop sequence, nitrogen level and herbicides.

Varying kochia densities reduced light intensities as compared to the light received beneath a weed-free beet canopy. Significant reductions in the yield of roots and tops were recorded for each increase in density.

SUPPORTED BY Great Western Sugar Company

4.0247, FACTORS AFFECTING THE TOXICITY AND SELECTIVITY OF PRE-EMERGENCE SOIL HERBICIDES

J.L. FULTS, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00083)

OBJECTIVE: Investigate the role of soil factors as they relate to pre-emergence soil herbicides. Correlate the physical and chemical characteristics of pre-emergence herbicides with the phytotoxic action, selective action (as between crops and weeds), their movement and persistence in the soil. Interpret the interactions of the soil factors and herbicide characteristics as they affect specific weeds and crop plants.

APPROACH: Laboratory determination of major soil characteristics of a few typical Colorado soil types on which pre-emergence herbicides are being used. Greenhouse, laboratory and field tests with a limited number of herbicides to determine relative toxicities, selective action, movement and persistence. Correlation of A and B.

PROGRESS: Herbicides studied were picloram and dicamba used as soil incorporated materials. Plant pathogens studied were several soil inhabiting forms of Fusarium and Rhizoctonia solani. Host plants included both pathogen susceptible and resistant varieties of pinto beans, sugar beets, and tomatoes. Activities of the fungi were measured and studied. Data were statistically analyzed. Thirteen main experiments were conducted. Dicamba at 5 ppm strongly restricted the growth of both Rhizoctonia solani and Verticillium albo-atrum both important soil borne plant pathogens. Picloram greatly stimulated chlamydospore formation by Fusarium sp. Spores of Fusarium oxysporum f. lycopersci and F. solani f. phaseoli showed normal germination when low concentrations of picloram or picolinic acid or dicamba were present. Neither the absence of carbon or nitrogen sources nor the presence of both in different media influenced the germinability of Fusarium spores. Although picloram was applied at a concentration ten times lower than dicamba to a soil with a high potential for causing bean root rot due Fusarium solani f. phaseoli, it (the picloram) increased the number of propagules to a much higher

level than dicamba. Aspergillus niger and Penicillium sp. grow on the surfaces of picloram and picolinic acid solutions without any other source of nutrient.

SUPPORTED BY U.S. Dept. of Agriculture

4.0248, RESPONSE OF PLANTS AND PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES

J.L. FULTS, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00261)

OBJECTIVE: Determine effects of repetitive application or pollutional levels of herbicides on plant communities.

APPROACH: Determine effects of repeated applications of pre- emergence and post emergence herbicides on bluegrass quality and production. Study environmental factors affecting toxicity and selectivity of preemergence soil herbicides. Determine the influence of soil temperature moisture, microflora and organic matter on the disappearance of pyrazon, dicamba and picloram. Determine the direct and interacting effects of picloram and dicamba on the two soil plant pathogens -- Fusarium sp. and Rhizoctonia sp.

PROGRESS: Field plots of 5 varieties of Kentucky bluegrass and various subplots have been established. The long time effects of annual applications of 2,4-D, dacamine, betasan, dacthol, banvel-D, bandane and silvex on broad-leaf and annual grass weed populations, with and without nitrogen fertilization, will be studied. Measurements at timely intervals of turfgrass dry weight production, turf color, and density will be used as measures of response. Studies will also include residue samples and root studies to help explain long time effects.

SUPPORTED BY U.S. Dept. of Agriculture

4.0249, WEED CONTROL IN SUGARBEETS FOR THE INTER-MOUNTAIN WEST

E.E. SCHWEIZER, Colorado State University, U.S.D.A. Crops Research Div., *Fort Collins, Colorado* 80521 (0710-01-07)

OBJECTIVE: Develop principles, methods, and practices to control weeds in sugarbeets in the inter-mountain West.

APPROACH: Use laboratory, growth chambers, greenhouse, and field facilities to conduct experiments on the evaluation of new herbicides for weed control in sugarbeets when applied as preemergence, preplanting and postemergence treatments; on the penetration, absorption, and translocation of herbicides in sugarbeets and weeds; on the penetration, movement, persistence of sugarbeet varieties, genetic strains of sugarbeets, and associated weeds to herbicides under varying environmental conditions.

PROGRESS: For the first time, we produced normal yields of sugarbeets without the use of hand-labor for weed control by supplementing cultivation with effective herbicides. We applied a mixture of 3 lb/A of cycloate plus 1 lb/A of 3'-(N- isopropylcarbamoyloxy)propionanilide before planting, and then applied 2 lb/A of phenmedipham as a postemergence treatment. This weed control system minimized competition from weeds all season, and the yield of roots and sucrose per acre equalled that of hand-weeded plots. -- Nitralin and trifluralin, applied at 0.75 lb/A as a post-thinning treatment, effectively controlled Amaranthus retroflexus. Trifluralin produced more aberrant roots than did nitralin, but the number of aberrant roots was reduced significantly when soil surrounded the hypocotyledonary tissues at the time of application. Both herbicides induced twisting of sugarbeet roots at 0.05 lb/A in a simulated residue study. -- Dicamba, applied at 2 lb/A in August 1967, reduced the competitiveness of Convolvulus arvensis for 2 years, and residues in the soil dissipated to a level that did not significantly affect either the production of sorghum planted 13 months later, or of sugarbeets planted 25 months later.

SUPPORTED BY U.S. Dept. of Agriculture

4.0250, PRODUCTION AND QUALITY OF APPLES IN HIGH DENSITY PLANTINGS USING DWARFING ROOTSTOCKS

J.K. STACEY, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00157)

OBJECTIVE: Effect of different training procedures on 4 varieties of apples using 7 dwarfing rootstocks. Effect of herbicides on production and quality of same. Effect of Floraltone on lateral attachment and return bloom. Effect of Alar on color and size and the effectiveness as a stop-drop. Effect of GA 47 on fruit shape. Effect of different high density planting systems on productio and quality. Differential uptake of nutrient elements on variety/rootstock combinations. Effect of scoring and limb bending on production and return bloom. Effect of mechanical pruning procedures on tree development and production.

APPROACH: Soil treatments to be uniform. Blocks of trees to be randomized and replicated. Measurements to be taken to indicate vigor, precocity, order of blossoming in season, biennial bearing, uptake of elements, fruit color, size, yields, phytoxicity of chemicals and costs of establishing and maintaining all systems of training and spacing.

PROGRESS: 4 training systems x rootstocks x 2 varieties (3 replications) Second year training procedures completed. Measurements made of terminal growth, diameter of trunks, angle of limb attachment. Leaf analyses completed. All data ready for processing. 5 treatments x 2 rootstocks 1 interstem x 2 varieties (4 replications) Training procedures completed. Growth hormones applied Measurements were same as above. Data ready for processing. 1 training system x 5 rootstocks x 4 varieties (3 replications) All procedures and measurements, as above, completed. Data ready for processing. 2 treatments x 7 rootstocks x 2 varieties (3 replications) Above measurements made. Data ready for processing. Management Procedures - Job analysis records kept on all treatments. Herbicides applied and observations made for phytotoxicity. All trees treated with CuSO(4) and special irrigation method initiated to observe the effect on Phytophthora cactorum.

SUPPORTED BY Colorado State Government

4.0251, HERBICIDE SCREENING STUDIES ON SUGAR BEETS

E.F. SULLIVAN, Great Western Sugar Company, *Longmont, Colorado* 80501

The objectives of the research are (a) to evaluate weed control and crop selectivity response of candidate herbicides on sugar beets and (b, to define reliable and effective chemical weeding schemes employing the split-placement technique.

1. Potential of preplant-incorporated, preemerge, postemerge and layby placements and herbicides are evaluated. 2. Herbicide studies conducted under constant and logarithmic dosages in the field and greenhouse. 3. Assay of relative presence or absence of chemical residue in plant material and soil integral part of program.

4. Computer analysis of data including probit analysis.

SUPPORTED BY Great Western Sugar Company

4.0252, DYNAMICS OF FUNGICIDAL ACTION

J.G. HORSFALL, Conn. Agric. Expt. Station, *New Haven, Connecticut* 06504 (CONH00634)

OBJECTIVE: Discover the chemical and physical bases for fungicidal action, and use these discoveries for building newer and better fungicides.

APPROACH: Attempts are made to correlate fungicidal activity of new and old fungicides with their chemical structure. The clues thus disclosed lead to possible mechanisms of action, methods by which the fungicides disrupt the normal physiology of fungi. A study of the molecular structure or physical and chemical properties of the active compounds allows theories to be constructed concerning fungicidal mechanisms. These theories are then tested experimentally. The theories of fungicidal action are tested partly in terms of fungitoxicity data and principally by physiological and chemical techniques. In the testing of practicality of application of such principles field applications are made using apple scab, celery leaf blights, and Helminthosporial, Curvularial, and Rhizoctonial blight of turf grasses.

PROGRESS: 2 percent of chemicals tested on sporulation of Alternaria solani produce deformity of the conidium. The long narrow spore is broken and cells at the bend become globose and have little contact with each other. The active compounds include

thiones, thiols, and some non-sulfur chelators. The compounds may act by preventing synthesis of mucilage or breaking bonds that hold the cells of the conidium together. Four antisporulants including two thiol reagents effective in laboratory and greenhouse studies showed little effect on reducing early blight disease in the field. All of the compounds were toxic to tomato foliage in the field test. Injury to peach foliage by the combination spray of dodine and captan used for control of bacterial spot increases with the concentration of active ingredients and with temperature. The increased injury of the combination over either alone appears to be due to dodine, a surfactant, which increases the amount of captan entering leaves. Decomposition products of captan are phytotoxic when formed in the interior of the leaf. Present formulations of dodine and captan can injure peach foliage if concentrates are applied when the air temperature exceeds 27 C.

SUPPORTED BY U.S. Dept. of Agriculture

4.0253, CHEMICAL CONTROL OF WEEDS IN POTATOES

A. HAWKINS, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONS00354)

OBJECTIVE: Determine effects of chemicals for control of weeds, especially grasses which germinate before potatoes emerge or are a problem early in growth of potatoes. Determine effect of chemicals, and method of application for control of weeds which germinate late in the season. Determine effect of chemicals in suppressing and/or eradicating nutgrass in pototoes.

APPROACH: Objective 1, 2, 3. Compare three or more rates of chemicals in replicated plots in growers fields for control of either early germinating grassy weeds, weeds which germinate late in the season, or nutgrass. Observations will be made on weed control, and effect on potato plants. Yields and residues will be determined.

PROGRESS: In a comparison of rates of diphenamid, alone and with DNBP, and rates of EPTC 5G, applied late preemergence to Katahdin potatoes, excellent control of crabgrass was obtained with 3 lbs. diphenamid plus 2 1/4 lbs. DNBP per acre, and with EPTC at 4 lbs. active per acre. These treatments gave control of crabgrass superior to 3 lbs. of diphenamid alone per acre. DCPA at 7 1/2 lbs. active per acre gave acceptable control of crabgrass. DCPA and EPTC were applied for potatoes at the 4-inch stage following ridge-off and second weeding in a field infested with barnyard grass. DCPA gave poor control of barnyard grass at rates up to 9 lbs. active per acre, the highest rate used. EPTC gave good control of barnyard grass at 4 lbs. active per acre. Potatoes treated with EPTC at 8 and 12 lbs. per acre were slightly less vigorous early in the season as compared with those which received 4 lbs. EPTC per acre. Slightly lower yields were obtained to higher rates of EPTC, but the yield differences were not statistically significant. Where nutgrass is not a problem, a single application of diphenamid with DNBP for season-long weed control has several advantages over the present practice of applying EPTC. Incorporation and dry soil are required for proper EPTC application. Stunting and decreased yields have occurred with EPTC primarily with early applications at higher rates.

SUPPORTED BY Connecticut State Government

4.0254, BIOLOGY AND CONTROL OF INSECTS ON TOBACCO

J.B. KRING, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONH00376)

Progress:: Cyclodiene-resistant root maggots, Hylemya spp., are controlled by a preplant soil application of diazinon. This treatment has been used for several years and detectable field resistance has not yet been observed. Several other insecticides were tested this year as possible substitutes for diazinon, should resistance develop. There were applied to the row and then raked lightly into the soil. They were applied as granular formulations in dosage series to randomized replicated plots. The most effective compounds were diazinon, Dasanit (registered trademark), Dursban (registered trademark) and carbofuran. Next in effectiveness was Bux10 (registered trademark). There was an indication that disulfoton might be effective at rates in excess of 4 pounds of actual insecticide per acre. Carbofuran was phytotoxic to tobacco during the initial stages of growth. By bloom the plants had outgrown the early injury. Heavy mortality of earthworms occurred following treatment with 4 pounds of Bux10 and with 1, 2 and 4 pounds of carbofuran. It was reported last year that flies produced by these maggots are attracted to both white and yellow painted stakes. This year white stakes were used to attract flies to poisoned organic fertilizer. Dyfonate (registered trademark), GA493 and Lannate (registered trademark) combined with organic fetilizer killed flies attracted by the stakes to this mixture. Gardona (registered trademark) and VCS506 were not effective when used in this manner.

SUPPORTED BY Connecticut State Government

4.0255, ACTION OF SELECTIVE CHEMICALS ON MICRO-ORGANISMS AND HIGHER PLANTS

R.W. MILLER, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00074)

OBJECTIVE: Investigate the effects of chemicals on selected organisms.

APPROACH: The fungi Uromyces phaseoli typica. and Colletotrichum lindemuthianum, the bacterium Xanthomonas phaseoli, the nematode Meloidogyne incognita and the snapbean plant Phaseolus vulgaris will be used as tests models. Electrophoresis will be used to separate certain enzymes from each model for comparative studies before and after absorption of selectively active fungicides. Lipids, phosphorylated compounds, amino and organic acids, and carbohydrates will also be examined.

PROGRESS: A screening procedure has been devised to rapidly test effects of various agricultural chemicals on penetration and pathogenicity of various plant parasitic nematodes. This technique will facilitate evaluation of observed problems of crop reduction associated with the application of herbicides to sandy soils in Delaware. A literature review has revealed numerous similar observations throughout the United States. Two publications were submitted (see below) on the results of a field test. Work with Vitavax and Plantvax has been discontinued.

SUPPORTED BY U.S. Dept. of Agriculture

4.0256, CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES

E.M. RAHN, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00011-H)

OBJECTIVE: Evaluate herbicide combinations for control of nutgrass in corn, tomatoes, peppers, and lima beans. Evaluate herbicide combinations on soybeans, and cucurbits to widen spectrum of weed control, to increase margin of crop safety, and to reduce herbicide residues. Evaluate long term effects of terbacil on asparagus. Study mode-of-action and basis-of-selectivity of alachlor and possibly other new herbicides. Monitor excessive persistence of herbicide residues, contamination of surface and ground water by herbicides, and reduction of nodulation leguminous crops by herbicides.

APPROACH: Combinations of herbicides at varying rates will be used on several crops on soil heavily infested with nutgrass. Combinations of herbicides at varying rates will be used on several crops on soil infested with, or seeded to, such persistent weeds as jimsonweed, velvet-leaf, ragweed, and morninggiory. In mode-of-action studies, entrance of alachlor into root and shoot, as well as translocation and accumulation will be studied using gas chromatography and tritium labeled alachlor. Effect on respiration, protein synthesis using tritium labeled leucine, RNA synthesis using tritium labeled uradine will also be studied.

PROGRESS: Control of northern nutgrass in several vegetable crops was evaluated using two new herbicides, alachlor and butylate. On potatoes, alachlor, 4 lb/A, was as effective as the standard EPTC, 6 lb/A. On tomatoes and peppers, alachlor, 4 lb/A was effective on nutgrass but did injure the plants somewhat, but without yield reduction. Butylate caused crop injury. On sweet corn, alachlor, 2 lb/A, and butylate, 3 lb/A, both controlled nutgrass but butylate caused some yield reduction. On lima beans, alachlor, 2 lb/A, caused some early crop injury but did not reduce yields. In mode-of-action studies, alachlor, 1 ppm, did not inhibit

uptake of H-leucine by oat coleoptiles, but did cause 65% inhibition of incorporation of H-leucine into protein and 50% reduction of respiration. Terbacil, 3/4 lb/A, provided full season weed control on established asparagus without affecting yield.

SUPPORTED BY U.S. Dept. of Agriculture

4.0257, CHEMICAL CHANGES IN PESTICIDE RESIDUES DURING PROCESSING OF FRUITS AND VEGETABLES
R.P. FARROW, Natl. Canners Association, *Washington, District of Columbia* 20036 (W3-4-102(C))

OBJECTIVE: Identify degradation products of chlorinated hydrocarbon, organophosphate and carbamate pesticide compounds in fruits and vegetables after processing.

APPROACH: Subject fruit and vegetable buffered suspensions, juices, and processed products, containing pesticides, to the heat encountered during conventional canning. Evaluate product-pesticide combinations encountered commercially. Use radiotracer techniques as needed.

PROGRESS: Spinach and apricots with added pesticides were canned, given appropriate heat processes, and stored 1 year at ambient temperature and at 100 F. The carbamates, carbaryl, maneb, zineb, and ziram, were 87-100% destroyed during processing of spinach but only 12- 40% in apricots. The organophosphorus compounds, diazinon, guthion, and methyl parathion, had disappeared completely from spinach and apricots after a year at either temperature. Sixteen percent of the malathion remained in apricots after 1 year at ambient temperature. Trithion showed 29% survival in spinach and 16% in apricots under the same conditions. As a group, the organochlorine pesticides were most stable, particularly thiodan and TDE. Captan and methoxychlor had entirely disappeared from both products after 1 year at 100 F. Lindane and toxaphene were of intermediate stability. TDE is the principal transformation product of DDT in thermally processed spinach. Very little DDE was found. A third, unidentified transformation product, present in substantial amount, is chromatographically much more polar than DDT, TDE, or DDE.

SUPPORTED BY U.S. Dept. of Agriculture

4.0258, BIOLOGY AND CONTROL OF INSECT AND OTHER PESTS OF CUT FLOWERS
E.G. KELSHEIMER, Gulf Coast Agric. Expt. Sta., *Bradenton, Florida* 33505 (FLA-GC-01269)

OBJECTIVE: Study biology of pests that attack cut flowers and develop methods for their control. Control of wireworms attacking gladiolus corms. Control of mites, leafminers and other pests on field grown and potted chrysanthemums. Control of thrips and mites in carnation and roses.

APPROACH: New materials will be tested for insecticidal properties as well as phytotoxicity to plants and compatibilities among insecticides, fungicides, nutrients and miticides.

PROGRESS: Fall tests of materials for insect and mite control on Yellow Ice-berg field-grown chrysanthemums showed that better control of leafminers was achieved with combinations of Lannate LA (250/A) and Azodrin (3.2 EC). Lannate W.P. and Azodrin used at the same rate resulted in marginal chlorosis on the leaves. Mites, loopers and army worms were not serious problems.

SUPPORTED BY Florida State Government - Tallahassee

4.0259, NEMATODES - THEIR EFFECTS AND CONTROL ON VEGETABLE AND ORNAMENTAL CROPS
A.J. OVERMAN, Gulf Coast Agric. Expt. Sta., *Bradenton, Florida* 33505 (FLA-GC-00992)

OBJECTIVE: Effect of specific plant parasitic nematodes, alone or associated with soil microorganisms, on vegetable and ornamental crops. Effect of cultural practices and crop rotations on nematode population levels. Chemical methods of controlling economically important nematodes.

APPROACH: Host-parasite relationships of nematodes found associated with economic crops are being studied under controlled environments in growth rooms. Nematode species and population fluctuations in a summer cover crop x potato rotation are being evaluated on 2 soil types in the field. Effects of sub-soiling are being evaluated. Soil fumigants and non-volatile chemicals are being applied in infested fields and as plant dips for nematode control.

PROGRESS: Gladiolus: Root-knot nematodes in corms were controlled by 15 minute pre-plant corm dips containing Ziniphos 1 pt/100, but the treatment was phytotoxic. Ceresan L, 4 pt/100, not nematicidal, gave best flower production. Addition of Zinophos to Ceresan L dip controlled root knot, but cut flower production 50%. MBR 5667 .75 lbs/100 was nematicidal and improved yields. MoCap 1 pt/100 did not eliminate galling, but improved yields. Spinach: Dasanit 10 paa dwarfed seeded spinach. Vapam Dasanit, MoCap, Furadan, or Temik 100 paa increased emergence 100% over Vapam alone. Onions: Furadan or Temik 10paa bleached the foliage tips. Yields were increased over 100% by Dasanit, MoCap, Zinophos Thimet. Control of Trichodorus christiei with these materials lasted 27 weeks. Leatherleaf fern: MoCap 20 paa and Dasanit 10 paa controlled Pratylenchus penetrans in 3 established plantings for 9 months. P. penetrans recovered 6 months after application of Furadan or Temik 10 paa; Tirpate 10 paa applied as a drench gave 3 months control of the nema. Pre-plant rhizome-root dips (15 min.) with Bayer 68138 1/4 pt/100 or MoCap 1/4 pt/100 controlled P. penetrans harbored within the tissue; neither was phytotoxic. Ceresan L 4 pts/100 used as a fungicide killed the fern. On incubation, no nematodes were recovered from Pratylenchus-infected roots which had been dipped 15 minutes in Tirpate 1.3 pts/100 and Bayer 68138 1,000 ppm.

SUPPORTED BY Florida State Government - Tallahassee

4.0260, BIONOMICS OF THE PLANT NEMATODE TRICHODORUS CHRISTIEI
A.J. OVERMAN, Gulf Coast Agric. Expt. Sta., *Bradenton, Florida* 33505 (FLA-GC-01193)

OBJECTIVE: Not Provided

APPROACH: Not Provided

PROGRESS: Granular incorporation at planting of Ambush (10 lb/A), MoCap (30/A), Dasanit (10 lb/A) gave excellent initial control of Trichodorus christiei and prevented the rapid recovery expected of the species following nematicide applications. No T. christiei were recovered for three months after Ambush and MoCap treatments; after four months there was 4 percent recovery of T. christiei (5 nematodes/150 ml soil) in these plots. Population levels of T. christiei, at the end of three months, was 20 per cent of normal following Dasanit applications, 60 percent at the end of four months. Thimet (10 lbs/A) and Zinophos (16 lb/A) were 50 percent effective in controlling this nematode at the end of three months, populations returned to normal in the fourth month. Ambush and MoCap at rates applied were phytotoxic, the other materials did not improve chrysanthemum yield. Where planting was delayed for a month following treatment, only MoCap was phytotoxic in natural soil. In previously steamed soil, Ambush, Zinophos Thimet (4.5 lb/A) and Dasanit, as well as MoCap, were phytotoxic.

SUPPORTED BY Florida State Government - Tallahassee

4.0261, BIOLOGY AND CONTROL OF INSECTS AND RELATED PESTS ON ORNAMENTAL PLANTS
S.L. POE, Gulf Coast Agric. Expt. Sta., *Bradenton, Florida* 33505 (FLA-GC-01353)

OBJECTIVE: Determine seasonal history, biology, ecology, and prevalence of insects and related pests infesting ornamental plants. Develop an efficient and effective program for control.

APPROACH: Investigate the biology and ecology of the important insects and mites destructive to ornamental plants and nursery products. Insecticides and miticides will be evaluated for effectiveness and phytotoxicity.

PROGRESS: Dyfonate 10 g at 25 grams per 5 gallon container reduced the population of the oleander scale, Phenocaspis corkerelli (Cooley) on Bird-of-Paradise, Strelitizia reginae. All new foilage has remained free from the scale for six months.

4. PESTICIDES

SUPPORTED BY Florida State Government - Tallahassee

4.0262, CHEMICAL CONTROL OF MITES AFFECTING CITRUS

R.C. BULLOCK, Indian River Field Laboratory, *Fort Pierce, Florida* (FLA-RL-01457)

OBJECTIVE: Establish better control of citrus rust mite, citrus red mite, and Texas citrus mite.

APPROACH: Potential acaricides will be compared with standard acaricides in grove trials. Dosage, phytotoxicity and compatibility with other compounds will be determined.

PROGRESS:

SUPPORTED BY Florida State Government - Tallahassee

4.0263, CONTROL OF WEEDS IN WARM SEASON TURFGRASSES WITH HERBICIDES

G.C. HORN, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-HT-01282)

OBJECTIVE: Evaluate herbicides and develop more effective methods of controlling weeds in turfgrasses.

APPROACH: New temporary soil fumigants will be evaluated to determine their effectiveness for control of weeds that cannot be selectively controlled in turf. Preemergence weed control will include evaluation of new herbicides that have preemergence activity. Postemergence weed control will include evaluation of new herbicides that have activity on established weeds. Non-selective herbicides will be evaluated at different rates and frequencies of application for control of weeds that cannot be selectively controlled in turf. Evaluations will be made visually estimating the degree of control. Turf tolerance will be determined by using rates 2 and 4 times that usually necessary for satisfactory weed control and evaluated by visually estimating the degree of discoloration and thinning.

PROGRESS: Tifdwarf bermudagrass has become very popular for putting green use in Florida during the past 5 years. Weeds have become a major problem in some of these greens. Complaints of damage to Tifdwarf from herbicides, recommended for other bermudas, used for weed control prompted this study. A 5 year old Tifdwarf green, in excellent condition, was used to determine phytotoxic effects of 20 herbicides at recommended rates and twice recommended rates. Herbicides and rates used in 0ai/A, in parentheses, were atrazine (1, 1/2), simazine (1, 1/2), Prometryne (1, 1/2), DSMA (6,4,2), MSMA (6,4,2,1), 2, 4-D-amine (2,1, 1/2), 2,4-D-butyric (2,1, 1/2), Silvex (2,1, 1/2), ASAK (36,18, 9), Herban (6,3,1-1/2), Banvel-D (1, 1/2, 1/4), Treflan (8,4,2), Betasan (36, 18), Dacthal (48,24), TOK (8,4,2), Tenoran (12,6), Sindone (16,8), Sindone B (16,8), DSMA 2,4-D-amine (4, 1/2 and 2, 1/2 resp.) and MSMA 2,4-D-anime (4, 1/2). Each material was applied without oil and with 2 gpa of sunspray 11EL oil. Results - Simazine, atrazine and prometryne were very toxic, at both rates used, for two months but plots did recover. These materials should not be used on Tifdwarf bermudagrass. DSMA and MSMA at higher rates produced phytotoxic effects that lasted about 7 days and then looked better than the checks.

SUPPORTED BY Florida State Government - Tallahassee

4.0264, FUMIGANTS AND DIPS FOR CONTROL OF INSECTS

L.C. KUITERT, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-EY-01315)

OBJECTIVE: Evaluate improved methods of insect control on ornamental plants and subtropical fruits by use of fumigants and insecticidal dips.

APPROACH: Various fumigants and insecticides will be used at different concentrations to determine their effectiveness in controlling insect pests. Studies to determine phytotoxic effect of these materials on living plants and injury to subtropical fruits when controlling insect pests.

PROGRESS: In cooperation with the Division of Plant Industry insecticidal treatments including 2 drenches, 9 dips and 4 granular formulations were applied to calamondins infested with coffee root mealybugs, Geococcus coffeae. The infestation was located at Ustler's Nursery, Apopka. The infested plants to be treated were growing in 2" pots. Plants were placed in plastic trays (12 plants/treatment) and the tray placed in the dip treatment so the soil surface was below the surface of the insecticide treatment for 5 minutes, removed and allowed to drain before plunging in steam sterilized media. The treatments and the Active Ingredients (ounces) per 100 gallons included, Bayer 68138 (6), Geigy 13005 (14.7), DiSyston (16), Azodrin (12.8), Zinophos (8), Zinophos (16), phorate (16), DuPOnt 1410 X 90W 8 and Dasanit (16). Azodrin, Zinophos, lannate and phorate gave excellent control after 4 weeks. The drench treatments consisted of zinophos and Dasanit used at the rate of 8 oz per 15 gallons and applied to 80 sq. ft. of bed with plants in 2 and 4 inch pots plunged in media. Treatments were applied with a hose-on applicator and then watered in. These plots have received five applications at 2 week intervals. The mealybug populations have been greatly reduced with only an occasional live specimen being found. The test is still in progress. This method is much simpler than the dip method and could be accepted by the nursery man. The granular treatments consisting of lannate, carbofuran, Dasanit and phorate were not effective.

SUPPORTED BY Florida State Government - Tallahassee

4.0265, CHEMICAL WEED CONTROL FOR COMMERCIAL VEGETABLE PRODUCTION

S.J. LOCASCIO, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-VC-00591)

OBJECTIVE: Determine effectiveness of certain chemical preparations for control of weeds in vegetable production on sandy soil.

APPROACH: Testing of materials to which crops have wider tolerance ranges than the present recommended chemicals; herbicides which can be used postemergence on crops where only preemergence weed control is now recommended or vice versa; chemicals which are better suited to crops such as eggplant, lettuce, cucumber, squash, and okra where there are presently no weed control recommendations. Herbicides which are more specific for certain hard to kill weeds like Bermudagrass, torpedograss and nutgrass; better formulations of our present materials, especially those which will reduce solubility or retain materials against leaching; chemicals which act as nematocides and soil fungicides but also have herbicidal properties; chemicals which are less volatile and less dependent on soil moisture for effective weed control.

PROGRESS: Twenty-four herbicide treatments were evaluated on Charleston Gray watermelons in the spring of 1969. Treatments that provided the best weed control throughout the season were 1 pound per acre nitralin surface applied and water into the soil with over-head irrigation at the rate of 1 inch per acre, 1 pound per acre terbacil surface applied and preplant incorporated. Maximum fruit yields were obtained from plots treated with .75 and 1.5 pounds per acre paraquat applied delayed preemergence (before emergence of the watermelon seedlings), preemergence applications of 1 pound per acre nitralin surface applied or watered in. One pound per acre terbacil surface applied or preplant incorporated. Lower rates of terbacil from .125 pound to .5 pound per acre surface applied or preplant incorporated did not provide adequate weed control.

SUPPORTED BY Florida State Government - Tallahassee

4.0266, REDUCTION OR ELIMINATION OF PESTICIDE RESIDUES ON FOOD AND FEED PRODUCTS

N.P. THOMPSON, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-FS-01242)

OBJECTIVE: Study food and feed products with respect to: location and persistence of pesticide residues in market products, effects of pesticide residues on quality characteristics, development of commercial marketing and processing techniques for detection, removal and/or neutralization of pesticide residue effects.

APPROACH: Florida will contribute under objective 1a and 1c by studying persistence and methods of reducing excessive residues of DDT, endrin, toxaphene and parathion on leafy crops such as cabbage and celery at a marketable stage of development.

PROGRESS: Celery ribs painted with an ethanol solution of Parathion-S were frozen after intervals of 3 hrs. 1, 2, 3 and 5 days. Frozen rib pieces were cross-sectioned at 16 u. Sections were mounted on glass microscope slides, freeze dried, coated with Kodak NTB - 2 liquid photographic emulsion and placed in a freezer for 30 days. The emulsion was developed and coverslips were mounted over sections. Comparison, by oil emersion phase contrast microscopy, of the emulsion layer and the section showed silver grains above epidermal areas as well as above outer cortical cells indicating that parathion applied in this way does not all remain on the cuticle. No specific accumulation, such as in vascular tissue, has been observed. The internal appearance of radioactivity could explain the difficulty of parathion removal with surface washing procedures.

SUPPORTED BY U.S. Dept. of Agriculture

4.0267, CENTRALIZED PESTICIDE RESIDUE INVESTIGATIONS OF SOUTHERN AGRICULTURAL EXPERIMENT STATIONS

C.H. VANMIDDELEM, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-FS-01202)

OBJECTIVE: Develop pesticide residue research center with emphasis on chemical and instrumental methodology. After analytical load has been determined, metabolic fate studies initiated with various plants.

APPROACH: Coordinated regional residue problems are undertaken with the prior approval of the technical committee. The centralized laboratory furnishes to the other residue laboratories in the region a standardized sampling, extraction and cleanup procedure to follow. The central laboratory helps to evaluate lab to lab variation in analytical procedures by analyzing one sample field replication from each state experiment. Referee samples are prepared at the central laboratory for distribution to and analysis by all the participating state laboratories. These referee studies aid in the elucidation of laboratory variation in sample cleanup and between various types of gas chromatographic detectors.

PROGRESS: Develop sensitive and reliable analytical procedures for analyses of pesticide residues and obtain information on possible uptake of chlorinated hydrocarbon pesticides by crops growing in contaminated soils. Exchange collaborative samples, determine effect of peanut oil in samples on accuracy of electron capture gas chromatographic analyses for dieldrin residues. Advantages and disadvantages of various commercially available GLC detectors investigated by collaborative exchange of common samples. Oil content in sample can have a significant effect in depressing dieldrin values compared to samples containing no oil. Data indicates that sodium thermionic detector is superior to flame photometric detector in terms of sensitivity and noise. Thermionic detector was inferior to photometric detector in selectivity, accuracy, precision, drift and dynamic range. Thermionic detector required more attention and was more erratic than photometric detector. Peanuts grown on some soils containing as low as 0.1 ppm dieldrin can become contaminated with residues that exceed the FDA action level. All cooperators experienced analytical difficulties with oil in samples.

SUPPORTED BY U.S. Dept. of Agriculture

4.0268, PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES AND ENVIRONMENTS

C.H. VANMIDDELEM, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-FS-01469)

OBJECTIVE: New or improved extraction, cleanup and analytical techniques; preplanned cooperative regional experiments; fate of pesticides and toxic metabolites in plants, animals and soils; disappearance rates of pesticides from commodities and environments.

APPROACH: The central laboratory will initiate basic studies on sample extraction, cleanup and analytical techniques for pesticides in cooperation with other interested state laboratories in the region. Cooperative field experiments between the central laboratory and other laboratories will be designed to solve pesticide residue problems of regional interest. This laboratory will investigate the movement, accumulation and metabolic fate of several pesticides in higher plants. The central laboratory will continue to conduct studies on the disappearance rates of various pesticides on commercial crops.

PROGRESS: An alkali flame detector with a KBr pellet was evaluated as to its response to several carbamate pesticides and compared to an AFID with a Rb(2)SO(4) pellet. The flame photometric detector was evaluated on various citrus fruit previously treated in the field with a promising phosphorodithioate called Torak. This detector was observed to have distinct advantages over the thermionic detector, particularly on uncleaned citrus extracts. The effects of dieldrin and DDT on the photosynthetic rate of Chlorella pyrenoidosa were measured. Initiated work with human tissue cultures with the ultimate goal of observing changes in cellular biochemistry as influenced by subtoxic levels of pesticides. The uptake of 2,4-D-C from liquid nutrient solution into corn, peanuts and soybeans was investigated by autoradiography, TLC and liquid scintillation. In corn roots, radioactivity appeared at Rf .35 in addition to .80 which corresponds 2,4-D-C using 8:1:1 isopropanol:ammonia:water as the eluting solvent on aluminum oxide plates.

SUPPORTED BY U.S. Dept. of Agriculture

4.0269, ECOLOGICAL RECORDS ON ELGIN AFB RESERVATION

D.B. WARD, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-BT-01410)

OBJECTIVE: Measure the effects on the surrounding vegetation of an Air Force program of testing biological weapons, using active herbicidal and bacterial agents.

APPROACH: A series of transects have been established at varying distances from the test area. Frequency of occurrence of species of vascular plants is measured with replication permitting quantitative measurement of significance of any observed fluctuations in number of individuals intercepted by transects, thus determining if spray driftage from test area has significantly affected population sizes of vascular plants in surrounding area.

PROGRESS: A pre-existing Air Force program on the Eglin AFB Reservation, Florida, of testing spray equipment designed to apply military chemical and biological agents by aerial means, has given rise to the possibility that the testing program is affecting the biota outside the test area. A program of sampling the vegetation by means of nested transects, and subsequent analysis, gave little indication that the effects of spray driftage were of effect in reducing the frequency of any plant species. A supporting program was begun of documenting the present flora of the Reservation, as a base for understanding effects of future Air Force activities.

SUPPORTED BY Florida State Government - Tallahassee

4.0270, CHEMICAL WEED CONTROL FOR COMMERCIAL VEGETABLE PRODUCTION

J.R. SHUMAKER, Florida Agric. Expt. Station, *Hastings, Florida* (FLA-PR-00591)

OBJECTIVE: Determine effectiveness of certain chemical preparations for control of weeds in vegetable production on sandy soil.

APPROACH: Testing of materials to which crops have wide tolerance ranges than the present recommended chemicals; herbicides which can be used postemergence on crops where only preemergence weed control is now recommended or vice versa; chemicals which are better suited to crops such as eggplant, lettuce, cucumber, squash, and okra where there are presently no weed control recommendations. Herbicides which are more specific for certain hard to kill weeds like Bermudagrass, torpedograss and nutgrass; better formulations of our present materials, especially those which will reduce solubility or retain materials against leaching; chemicals which act as nematocides and soil fungicides but also have herbicidal properties; chemicals which are less volatile and less dependent on soil moisture for effective weed control.

PROGRESS: CABBAGE - Winter weed control trials consisting of preplant, soil incorporated trifluralin and postplant CDAA CDEC, CDEC, DCPA, nitrofen and propachlor were conducted with direct seeded and transplanted cabbage. Chickweed, Stellaria media, and seedling dock, Rumex hastatulus, were the most numerous weeds. DCPA at 10.5 A/A (lbs.) was superior to other herbicides tested. Good weed control was observed following the use of trifluralin at 1.0 A/A (lbs.) and CDAA

CDEC, both at 3.0 A/A (lbs.). Propachlor at 3.9 A/A (lbs.) were slightly less effective. All herbicide treated plots produced significant increases in yields over the uncultivated control in the direct seeded cabbage. POTATOES - Preemergence application of 17 herbicide treatments gave variable weed control. Metaburon at 3.0 and 2.0 A/A (lbs.), linuron at 2.0 and 1.0 A/A (lbs.), Maloran at 2.0 and 1.0 A/A (lbs.) and Lasso at 4.0 A/A (lbs.) gave good control of weeds and were superior to other herbicides tested. DCPA at 10.5 A/A (lbs.), Lasso at 2.0 A/A (lbs.), DNBP at 3.0 A/A (lbs.), EPTC at 6.0 and 4.0 A/A (lbs.) and nitrofen at 4.0 A/A (lbs.) were rated slightly less effective. Trifluralin incorporated into the soil after planting reduced yields. Smartweed, Polygonum pensylvanicum, interfered the most with harvest operations.

SUPPORTED BY Florida State Government - Tallahassee

4.0271, BIOLOGY AND CONTROL OF INSECTS AND RELATED PESTS ON ORNAMENTAL PLANTS
R.M. HARANOWSKI, Sub Tropical Agric. Expt. Sta., *Homestead, Florida* 33030 (FLA-SB-01353)

OBJECTIVE: Determine seasonal history, biology, ecology, and prevalence of insects and related pests infesting ornamental plants. Develop an efficient and effective program for control.

APPROACH: Investigate the biology and ecology of the important insects and mites destructive to ornamental plants and nursery products. Insecticides and miticides will be evaluated for effectiveness and phytotoxicity.

PROGRESS: Six varieties of chrysanthemums were used to obtain data on phytotoxicity and efficacy of three formamidine acaracides which were applied at 4 and 8 oz of the formulations per 100 gal at 7 and 14 day intervals. Foliage of 'White' and 'Yellow Iceberg,' 'Bluechip,' 'Shasta' and 'Beauregard,' but not 'Pinocchio,' showed interveinal yellowing and marginal chlorosis in plots treated with EP-333 and EP- 334. Injury from EP-332 was not noted until flowers were cut when yellowing was observed on older leaves of 'Yellow' and 'White Iceberg.' EP-332 did not control the two spotted spider mite. EP-333 and EP-334 did provide a measure of control but higher dosages would probably be needed for good consistent control. Morocide, Morestan and Kelthane were applied to roses with and without M-45 and Daconil to determine if these compounds had any effect on the acaracides. Neither fungicide affected control by the miticides. Three weekly applications of TH367- I, TH427-I, GA490, GA494, GS19849, Morocide, Carzol, CP49674 and Chloropropylate were applied to roses infested with a very high population of two-spotted spider mites that had shown a high degree of resistance to most compounds. Only Morocide, GA490, GA494, GS19849 and TH397-I reduced the number of mites to less than 10 per leaf compared to 50 on check plots. In other tests, dicofol, Galecron, Dessin and Morestan were effective mite controls.

SUPPORTED BY Florida State Government - Tallahassee

4.0272, CHEMICAL WEED CONTROL FOR COMMERCIAL VEGETABLE PRODUCTION
R.W. HARKNESS, Sub Tropical Agric. Expt. Sta., *Homestead, Florida* 33030 (FLA-SB-00591)

OBJECTIVE: Determine effectiveness of certain chemical preparations for control of weeds in vegetable production on sandy soil.

APPROACH: Testing of materials to which crops have wider tolerance ranges than the present recommended chemicals; herbicides which can be used postemergence on crops where only preemergence weed control is now recommended or vice versa; chemicals which are better suited to crops such as eggplant, lettuce, cucumber, squash, and okra where there are presently no weed control recommendations. Herbicides which are more specific for certain hard to kill weeds like Bermudagrass, torpedograss and nutgrass; better formulations of our present materials, especially those which will reduce solubility or retain materials against leaching; chemicals which act as nematocides and soil fungicides but also have herbicidal properties; chemicals which are less volatile and less dependent on soil moisture for effective weed control.

PROGRESS: Previous work has shown diphenamid is an effective pre- emergence herbicide for direct-seeded tomatoes, but three experiments, each of which had several inches of rain soon after application, showed it to be nearly ineffective. Under these conditions, planavin, Niagara 20439, amiben ester (65-81B) and Lasso gave good control of most weeds. Lasso caused such severe stunting that it would be unsatisfactory for tomatoes. Planavin and the amiben ester gave excellent control of purslane while the others were less effective. Amiben was nearly ineffective with wild lettuce (Lactuca sp.) and planavin was only partially effective. Bermuda grass and a few other weeds seemed to resist all herbicides. Prickly poppy is particularly resistant to all herbicides used on tomatoes. High rates of planavin (2 lb/A) and amiben ester (4 lb/A) caused a slight reduction of tomato germination in some experiments, but not in others. Niagara 20439 should be tested further.

SUPPORTED BY Florida State Government - Tallahassee

4.0273, PRELIMINARY EXPLORATORY RESEARCH AT THE SOUTH FLORIDA FIELD LABORATORY
P.H. EVERETT, South Florida Field Laboratory, *Immokalee, Florida* 33934 (FLA-SF-00001)

OBJECTIVE: Conduct preliminary investigations on vegetable crops.

APPROACH: Exploratory research experiments will be conducted on tomatoes, watermelon and vegetable crops with respect to nutrition, pest control, variety trials and disease control.

PROGRESS: Effect of lime on Fusarium wilt of watermelons.--Four lime and/or calcium materials at 4 rates were compared factorially for their effectiveness in reducing damage caused by Fusarium wilt. The amount of wilt decreased and the yield increased as the rate increased from no lime to 6 tons/acre. Calcic limestone was the most effective and gypsum the least, with dolomite and a 1:1 mixture of calcic and domolite being intermediate. Effect of Pinoline 1919 on tomato yields.--'Pinoline' is derived from terpene polymers and is a tradename of Miller Chemical and Fertilizer Co. Pinolene at 6 concentrations: 0, 0.5, 1.0, 2.0, 3.0 and 5.0% (in water) were applied at both 7 and 14 day intervals to tomatoes. The 7 day plots received 6 applications and the 14 plots received 3 applications. Phytotoxic symptoms were evident on the foliage of plants sprayed with the 5.0% concentration at both the 7 and 14 day intervals. However, this damage to the foliage was not reflected in the yield since there was no significant difference in yield due either to concentration or application interval.

SUPPORTED BY Florida State Government - Tallahassee

4.0274, CHEMICAL CONTROL OF SCALES AND OTHER INSECTS INFESTING CITRUS
R.F. BROOKS, Citrus Agricultural Expt. Sta., *Lake Alfred, Florida* 33850 (FLA-CS-00835)

OBJECTIVE: Determine most effective and economical scalicides, and determine insecticides necessary to control other insects of major importance.

APPROACH: Where insecticides are tested in the field, treatments are replicated three to four times. Factors considered include dosage, phytotoxicity, timing of application in relation to effect on trees and fruit quality and compatibility with other materials.

PROGRESS: Various insecticides were evaluated for control of scale insects, whiteflies, and aphids. Glover and Purple Scale Control.-- Promising materials were Lannate, Furadan, Lannate-oil, Velsicol VCS- 506, Monitor, and ethion-oil. Chaff Scale Control.--Effective materials were Furadan, Lannate, Velsicol VCS-506, Monitor, Union Carbide 34096, ethion-oil, and oil emulsion. Yellow Scale Control.--Effective materials were Lannate, Furadan, Velsicol VCS-506, Monitor, ethion-oil, and emulsion. Citrus Snow Scale Control.--Promising materials were ethion, carbophenothion, parathion, malathion, Lannate, Velsicol VCS-506, Monitor, Supracide, Monitor-oil, Hercules 14503, Thompson-Hayward 346-I, and dioxathion. Citrus Whitefly Control.--Effective materials were Union Carbide 34096, Furadan, and Monitor. Aphid Control.-- Promising materials were oxydemeton-methyl, Bidrin, Thompson-Hayward 346- I, and Temik.

SUPPORTED BY Florida State Government - Tallahassee

4.0275, CONTROL OF POSTHARVEST CHEMICAL RESIDUES IN OR ON CITRUS FRUITS
F.W. HAYWARD, Citrus Agricultural Expt. Sta., *Lake Alfred, Florida* 33850 (FLA-CS-01146)

OBJECTIVE: Determine effect of treatment conditions on chemical residues from citrus packinghouse processes and develop methods of process control that will insure maximum effectiveness of treatment within legal chemical residue standards.

APPROACH: Effect of treatment conditions on residues will be studied first. Some of these variables will be time of exposure to treatment, temperature, concentration of active agent, pH of solution, ventilation of fruit container, and species or variety of citrus fruit. Chemical residue determinations will be primary consideration, but measurements of effectiveness of treatment will be made. Following determination of effect of treatment conditions on residue, sets of conditions will be chosen, and checked for effectiveness and level of residue.

PROGRESS: Simulated, in-transit fumigation of citrus fruits with 2-aminobutane was studied to determine the effects of treatment conditions on residues of this fungicide. Experiments were made with 'Hamlin' and 'Valencia' oranges, 'Dancy' tangerines and 'Temple'. Residues increased with time, temperature, and dosage of 2-aminobutane. Heavy loads of fruit in the fumigation cabinet delayed the buildup of residues. Residues can be kept within the legal tolerance of 20 ppm by proper selection of treatment conditions. At higher temperatures, dosage and length of fumigation period offer the best method of controlling residues. At lower temperatures there is little tendency to exceed the legal tolerance but dosage of 2-aminobutane should be controlled.

SUPPORTED BY Florida State Government - Tallahassee

4.0276, CHEMICAL CONTROL OF MITES ATTACKING CITRUS
R.B. JOHNSON, Citrus Agricultural Expt. Sta., *Lake Alfred, Florida* 33850 (FLA-CS-01457)

OBJECTIVE: Establish better control of citrus rust mite, citrus red mite, and Texas citrus mite.

APPROACH: Potential acaricides will be compared with standard acaricides in grove trials. Dosage, chytotoxicity and compatibility with other compounds will be determined.

PROGRESS:

SUPPORTED BY Florida State Government - Tallahassee

4.0277, WEED CONTROL IN CITRICULTURE
R.L. PHILLPS, Citrus Agricultural Expt. Sta., *Lake Alfred, Florida* 33850 (FLA-CS-00945)

OBJECTIVE: Devise effective, safe, and practical methods of using herbicides for controlling weeds in and adjacent to citrus plantings and sites. Study the effects of herbicides on citrus trees.

APPROACH: Control of weeds in groves and nurseries -- Field trials will be established to evaluate the effectiveness of diuron, simazine, and EPTC on control of annual weeds in groves nurseries. Repeated low rates of dalapon will be studied for perennial grass control in groves. Control of aquatic and ditchbank weeds in coastal groves -- Several commercially available soil steritant and growth-regulator type herbicides will be evaluated for control of submersed and emergent aquatics and ditchbank vines, brush and perennial grasses in coastal grove ditches. Residual effects of annual or semi-annual applications of herbicides on tree growth and yield will be studied. A continuous program of screening new herbicides will be conducted.

PROGRESS: Dichlobenil has continued to give excellent control of a wide number of weeds. After 2 applications the first year, only 1 application per year has been required for satisfactory control. Results with diuron were also favorable but control did not last as long. Control with terbacil was not satisfactory in some cases because tolerant weeds were present. The addition of paraquat increased the effectiveness of diuron and terbacil where larger weeds were present when applied. Treflan gave excellent control of annual grasses but tolerant weeds were not affected in many plots. Several new herbicides were tested. GS-14254 and VCS-438 showed promise for use in citrus groves because of their long-lasting effects on weed growth and their low toxicity to citrus trees. Vine control studies were made using growth regulators, preemergence herbicides and contact herbicides. In general, 2,4,5-TP was the most effective phenoxy herbicide tested. The addition of surfactants and non-phytotoxic oils increased its effectiveness. Casoron was the most effective preemergence herbicide tested, followed by the triazines. Contact herbicides resulted in good control with frequent applications.

SUPPORTED BY Florida State Government - Tallahassee

4.0278, PETROLEUM OILS AS CITRUS TREE SPRAYS IN FLORIDA
W.A. SIMANTON, Citrus Agricultural Expt. Sta., *Lake Alfred, Florida* 33850 (FLA-CS-01252)

OBJECTIVE: Relate physical and chemical properties of petroleum oil to effectiveness in control of insects, mites and disease, and to phytotoxic effects. Determine if oils of specific properties can be used advantageously on Florida citrus. Improve methods for determining oil deposits obtained with field applications.

APPROACH: Twenty-five specially prepared oils of known properties and 30 commercial spray oils will be evaluated by laboratory tests. Dosage-mortality data will be obtained against citrus red mite eggs and Florida red scale. Certain of the oils will be evaluated for phytotoxic effects as indicated by transpiration rate of sprayed seedlings. Certain oils will be applied to field plots to study effect on tree and fruit.

PROGRESS: The 21 samples of citrus spray oils picked up by State Department of Agriculture inspectors in 1968 were subjected to laboratory tests to determine conformance to specifications developed under this project. Of 2 sample oils apparently intended as type FC 412-66, both failed to meet specifications. Of 19 samples oils apparently intended as type FC 435-66, 10 met specifications and 9 did not comply. The most common fault was a departure in distillation characteristics. Three of the 21 samples failed because of low unsulfonated residue and 1 also failed because of low gravity. The test results were relayed to the State Chemist. On June 13 the Pesticide Technical Committee for the State Department of Agriculture held a hearing on a proposal to include the spray oil specifications from this project in official regulations. Assistance was given the State Chemist in equipping his laboratory for spray oil testing and in providing reference standards. Many inquiries about the field use of spray oil were handled: however, fewer problems concerning spray oils were encountered than in prior years.

SUPPORTED BY Florida State Government - Tallahassee

4.0279, PRELIMINARY RESEARCH ON CUCURBITS AND FRUIT CROPS
J.M. CRALL, Watermelon & Grape Inves. Lab., *Leesburg, Florida* 32748 (FLA-WG-00001)

OBJECTIVE: Investigate new problems in the production of cucurbits and fruit crops in Florida.

APPROACH: Preliminary studies will be made on bacterial diseases of watermelon; these will include identification of the causal organisms, conditions favoring development of the diseases they cause, establishment of host range, and methods of control. Preliminary studies on grapes will include trials on varieties, nutrition, herbicides, hormones, rootstocks, and trellising. Peach varieties will be tested.

PROGRESS: The value of a protein-base foam and Hotkaps for cold protection of watermelon seedlings was investigated. Although minimum temperatures under both foam and Hotkaps were 3 to 16 F higher than minimum ambient temperatures, there were no differences in either early or total yields for planting dates or cold protection treatments. Ethrel caused the development of hermaphrodite flowers at an earlier than usual stage of growth and decreased the ratio of male to hermaphrodite flowers in cucumber, pumpkin, squash, and cantaloupe, but not in watermelon. Soil applications of Emjeo corrected Mg deficiency symptoms in grape leaves, and increased Mg content of petioles and soluble solids content of berries, but decreased plant vigor and fruit yields. Pruning weights were higher from vines on Munson trellis than from those on either 4-Wire Horizontal (4WH), or

Geneva Double Curtain (GDC) trellises, but fruit yields were highest on 4WH, intermediate on GDC, and lowest on Munson trellises. Weed control without phytotoxicity was best in mature vineyard with Karmex, Casoron, and Simazine at 6 lb. (active ingredient per acre); in young vineyard with Simazine, Casoron, and Planavin at 4 lb.; and in a cutting nursery with a Ramrod-Atrazine mixture at 5 lb.

SUPPORTED BY Florida State Government - Tallahassee

4.0280, CHEMICAL CONTROL OF SOIL FUNGI, NEMATODES, AND WEEDS AFFECTING WATERMELONS
N.C. SCHENCK, Watermelon & Grape Inves. Lab., *Leesburg, Florida* 32748 (FLA-WG-01151)

OBJECTIVE: Effect of soil fumigants on soil fungi, nematodes, weeds, and crop response.

APPROACH: Fumigants will be applied to land intensively cropped in watermelons. Both Fusarium wilt resistant and susceptible varieties will be planted in treated areas. Populations of Fusarium sp., Rhizoctonia sp., Pythium sp., other soil fungi, plant parasitic nematodes, and weeds will be estimated. Stand counts, vigor ratings, and yield will be used to evaluate crop response.

PROGRESS: Vorlex adequately controlled Fusarium wilt in soil moderately infested with Fusarium oxysporum f. niveum but it was phytotoxic to watermelons (35 gallons per acre broadcast). Thirty-two days after treatment, seedling stands of both Charleston Gray (wilt resistant) and Florida Giant (wilt susceptible) varieties were lowest in Vorlex-treated areas. Differences among chemical treatments in final stands of Charleston Gray were not statistically significant, but final stand of Florida Giant was significantly highest in Vorlex-treated soil. Vorlex-treated soil consistently had the lowest soil fungus populations and yielded no Fusarium colonies throughout the season. Total fungus populations were usually highest in Busan-treated soil, resulting from an apparent stimulation of certain species of Penicillium. A total of 24 different genera and species of fungi were isolated from Busan-treated soil while only 12 different fungus species were obtained from Vorlex-treated soil. Charleston Gray variety had the highest yields and differences among chemical treatments were not significant. Florida Giant yields were exceedingly low in Busan-treated (92.3 CWT/acre) and untreated soils (73.2 CWT/acre) but were also below average in Vorlex- treated soil (160.3 CWT/acre).

SUPPORTED BY Florida State Government - Tallahassee

4.0281, CHEMICAL CONTROL AND PHYSICAL AUTECOLOGY OF INSECTS ATTACKING CIGAR-WRAPPER TOBACCO
W.B. TAPPAN, North Fla. Agric. Expt. Sta., *Quincy, Florida* 32351 (FLA-NF-01214)

OBJECTIVE: Evaluate chemicals for control of insects attacking cigar-wrapper tobacco; measure some effects of air and soil temperature and/or humidity upon insect pests of cigar-wrapper tobacco and insecticides used for control.

APPROACH: Screening of new materials. Determine efficiency of insecticides on control of insects and their effects on yield, quality, and other characteristics. Instrumentation of experiments to determine effects of temperature and/or humidity on individual insect pests and insecticides.

PROGRESS: New insecticides found effective for control of the following insects were: Green Peach Aphid-Azodrin, Furadan, and Lannate; Budworm-Azodrin, Furadan, GS-13005, Lannate, and Thuricide 90 TS spray; Cabbage Looper-Azodrin, Furadan, GS-13005, and Lannate; Flea Beetle- Azodrin, Furadan, GS-13005, Lannate, and Parathion Thuricide 90 TS spray; Cutworms-Dylox bait; and Flase Chinch Bug-TH-427-I and Thuricide 90 TS spray. Phytotoxicity with Azodrin and Fundal eliminates these materials for use on wrapper tobacco. Crop evaluation of Furadan phytoxicity indicates this material can be used without commercial objection. Symptoms of veinbranding virus infection appeared in plants 8 to 12 days after exposure to infected aphids. Yields, leaf quality, and crop value were improved by Lannate and Thuricide 90 TS spray. Neither Lannate nor TH-427-I caused any objectionable off-flavor in cigars manufactured from treated cigars. Uptake of Endrin and DDT from cigar-wrapper tobacco soils by turnips was minimal.

SUPPORTED BY Florida State Government - Tallahassee

4.0282, CHEMICAL CONTROL OF NEMATODE ROOT ROT COMPLEX OF SHADE-GROWN TOBACCO
W.B. TAPPAN, North Fla. Agric. Expt. Sta., *Quincy, Florida* 32351 (FLA-NF-01074)

OBJECTIVE: Not Provided

APPROACH: Not Provided

PROGRESS: Vorlex at 7 and 20 gallons per acre effectively reduced weed growth and the number of transplants lost to fungus rots. All treatments except Dasanit and Lannate at low rates reduced the number of plants with physiological wilt symptoms. Bayer 68138, Dasanit, Furaden, and Vorlex effectively reduced nematode numbers in the roots. Florida 17 apparently is more sensitive to nematode attack than Florida 15 since treatment responses were more pronounced. Plant growth, yield, and crop value were increased by all treatments. Coarse root indices were reduced by all treatments except the low rate of Bayer 68138 indicating some slight root injury from the compound. Phytotoxicity from Furadan was light indicating the material may be commercially acceptable for use on some varieties. None of the treatments had any effect on weather fleck. Dasanit, Furadan, and Temik increased soil nitrogen conversion in the field and growth chamber studies.

SUPPORTED BY Florida State Government - Tallahassee

4.0283, ABSCISSION OF TREE FRUITS
UNKNOWN, North Fla. Agric. Expt. Sta., *Quincy, Florida* 32351 (FLA-NF-01301)

OBJECTIVE: Effect of new chemicals on induction or prevention of abscission of both young and old fruit; anatomical and biochemical changes occurring during development of both naturally and chemically- induced fruit abscission; physiological effect and phytotoxicity of selected chemicals on trees under field conditions.

APPROACH: Chemicals will be screened to promote and prevent abscission of tree fruits. Screening trials will involve both whole trees and detached fruits, and an attempt will be made to determine the anatomical and biochemical changes induced in the tissue by the active compounds during abscission. Isolation and characterization of the compounds produced as a result of metabolism of the abscission influencing compound will be attempted to determine the identity of the actual compound influencing abscission.

PROGRESS: Development of a chemical means of thinning peach fruit is imperative if the industry is to continue. Replicated single-tree plots of Armgold and Maygold peaches were sprayed with several chemicals as full bloom and post-bloom sprays. Full bloom sprays of Ethrel at 100 ppm on Armgold and 300 ppm on Maygold gave adequate thinning but not as good as the 500 ppm rate. Fruit size was greatly increased where the thinning was the best. Post-bloom application of 400 ppm of 3-CPA when seed length was 9-10 mm resulted in the most efficient thinning of any 3-CPA treatments.

SUPPORTED BY Florida State Government - Tallahassee

4.0284, CHEMICAL WEED CONTROL FOR COMMERCIAL VEGETABLE PRODUCTION
W.T. SCUDDER, Central Fla. Agric. Expt. Sta., *Sanford, Florida* 32771 (FLA-CF-00591)

OBJECTIVE: Determine effectiveness of certain chemical preparation for control of weeds in vegetable production on sandy soil.

APPROACH: Testing of materials to which crops have wider tolerance ranges than the present recommended chemicals; herbicides which can be used postemergence on crops where only preemergence weed control is now recommended or vice versa; chemicals which are better suited to crops such as eggplant, lettuce, cucumber, squash, and okra where there are presently no weed control recommendations. Herbicides which are more

specific for certain hard to kill weeds like Bermudagrass, torpedograss and nutgrass; better formulations of our present materials, especially those which will reduce solubility or retain materials against leaching; chemicals which act as nematocides and soil fungicides but also have herbicidal properties; chemicals which are less volatile and less dependent on soils moisture for effective weed control.

PROGRESS: Excellent weed control in direct-seeded cabbage was obtained with both nitrofen and propachlor at 4 lbs. and with CDEC and diphenamid at 6 lbs., applied as over-the-top sprays when the cabbage seedlings with 1 in. tall. Trifluralin at 1 lb., nitralin at 2 lbs., and DCPA at 10 1/2 lbs. gave excellent control of grasses, but poor broadleaf weed control. Only 2 treatments produced crop injury. These were CDAA at 6 lbs. and BAS-2902 at 4 lbs. In a crop residue study with nitralin, radishes, turnips, and carrots were planted following pre-plant incorporated treatments at 0, 2 1/2, 5, and 10 lbs. per acre. All 3 crops accumulated some nitralin in the edible roots at all treatment levels, increasing with both rate of application and exposure time. The check samples from all crops contained less than 0.01 ppm detectable nitralin. In radishes sampled at 46 days after treatment, there was 0.04 ppm residue at the 5 lb. rate and 0.08 at the 10 lb. rate. Turnips at 74 days failed to survive in soil treated with 10 lbs. of nitralin. Carrots at 118 days contained 0.08 ppm from 5 lbs. and 0.24 ppm residue from the 10 lb. treatment.

SUPPORTED BY Florida State Government - Tallahassee

4.0285, THE EFFECT OF HERBICIDES ON GROWTH, YIELD, AND LONGEVITY OF PEACH TREES

J.W. DANIELL, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO-01-0054)

OBJECTIVE: Develop weed control practices and evaluate effects of herbicides on peach production and longevity of trees. Study effects of sodded middles with chemical weed control in rows on the amount of soil compaction from mechanical equipment.

APPROACH: Herbicides will be applied to young and mature trees for seasonal weed control and to study their effects on yield, growth, and longevity of trees. Certain cultural practices will be studied which may be affected by non-harrowing of soil. Studies will be initiated to control problem weeds as they build up from continuous use of a herbicide. Weeds will be controlled with chemicals in rows. About eight feet will be left in the middles in sod which will be mowed for soil compaction studies. Greenhouse and laboratory studies will be used to supplement and implement field tests.

PROGRESS: Experiments were designed to study the cumulative effects of herbicides applied successively for several years on weed control, and on growth and longevity of peach trees. In both 1- and 2- year old orchards, treatments which provided very effective weed control and produced growth of trees equal to or better than the harrow or tree hoe checks were: paraquat 1/2 and 1 lb ai/A; terbacil 2 and 2.5 lb ai/A; incorporated dichlobenil 4 and 6 lb ai/A; simazine 4 and 5 lb ai/A; CP- 44939 3 lb ai/A; diphenamid dinoseb 6 4.5 lb ai/A, and chloropropham dinoseb PPG-124 4 4 1 lb ai/A. Treatments which gave fair weed control, but required an additional treatment with paraquat during the summer to give full season control, were: granular dichlobenil 5 lb ai/A; nitralin 2 and 4 lb ai/A, and W.P. dichlobenil 4 and 6 lb ai/A (not incorporated). There was a significant increase in growth of trees in the simazine, dichlobenil, and nitralin plots when compared to trees in the tree hoe check plots at Ft. Valley, Ga. (2 year). There was no significant differences in growth of trees between treatments at Experiment, Ga. There was no direct phytotoxicity to any trees from the use of the herbicides in these experiments. At the present time, there is no difference between treatments in longevity of trees.

SUPPORTED BY Georgia State Government

4.0286, WEED CONTROL IN NURSERY STOCK

T.A. FRETZ, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO-01-0056)

OBJECTIVE: Screen and evaluate herbicide-mulch combinations for use on canned and field grown nursery stock. Study the reported increases in persistence of herbicides when incorporated on organic mulches.

APPROACH: Herbicides at several rates will be screened in regard to their effectiveness when used in herbicide-mulch combinations. Screening will be done in pots and evaluation will be determined by the percent kill of selected weed species. Promising combinations will be used on container grown nursery stock.

PROGRESS:

SUPPORTED BY Georgia State Government

4.0287, DEVELOPMENT OF WEED CONTROL PRACTICES ADAPTABLE TO THE PRODUCTION OF GRAIN AND FORAGE CROPS

W.S. HARDCASTLE, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO01028)

OBJECTIVE: Develop weed control practices for corn. Develop weed control practices for other grain and silage crops. Define and attempt to eliminate or minimize toxicological problems incident to the above uses.

APPROACH: The major exploratory phases of the field portion of this study will be located in the Piedmont, with other field testing in the Coastal Plain, Limestone Valley, or Mountain areas, as appropiate. Applications of experimental herbicides, as they become available, will be made to subject crops with research plot sprayers or with commercial equipment adapted to assure precise metering of materials. At least in the exploratory phases, supplemental irrigation will be used as required. Fertilizer and pesticide applications, other than herbicides, will follow standard recommended practices for the crop involved. Laboratory, greenhouse, and environmental chamber effort will be used to supplement and extend field investigations, especially in the areas of residual toxicities.

PROGRESS: Of 92 trials of chemicals, combinations, methods or time of application to heavy stands of sicklepod, common ragweed, common morninggiory, redroot pigweed, cocklebur, prickly sida, and large crabgrass at 2 locations; in preemergence applications to corn, new compounds BAY 86791 at 1/4 to 1 lb/A resulted in poor general broadleaf and good grass control, at high rates sicklepod control was good, but crop damage was excessive; S-6115 at 3 lb/A gave excellent grass and broadleaf control including sida; ACD 15 M was excellent for pigweed and sida control at 1 and 2 lb/A. BAS 2903 at 3-4 lb/A resulted in poor broadleaf and good grass control; SD 15418 at 1-3 lb/A resulted in excellent general weed control at higher rates; VCS 438 at 2-3 lb/A gave poor general broadleaf control at 2 lb/A but good control at 3 lb/A and excellent grass and sida control at both rates, alachlor 2-4 lb/A gave excellent general weed control at high rates; C 6989 3-4 lb/A and C6313 2-4 lb/A resulted in fair broadleaf and good grass control at high rates. 1 1 lb/A equaled weed control from field rates of each compound alone.

SUPPORTED BY U.S. Dept. of Agriculture

4.0288, THE EFFECTS OF A CROP-HERBICIDE ROTATION SYSTEM ON CERTAIN SOIL CHARACTERISTICS

L.S. JONES, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO01051-H)

OBJECTIVE: Study effects of applications of several herbicides to corn, cotton, soybeans and peanuts grown in a 4-year rotation on release and oxidation of sulfur, nitrification, soil organic matter and aggregate relationships. Determine the residual phytotoxicity of herbicides and/or their degradation products.

APPROACH: Field studies on a Tifton loamy sand will be the responsibility of ARS personnel. This personnel will determine if toxic residues occur using bioassay methods. At the Georgia Station, organic matter and aggregate relationships will be determined on soil samples from 0-6' and 7-12' horizons of all plots. Incubation studies for nitrification and for the release and oxidation of sulfur from an amino acid will be conducted.

PROGRESS: Soil samples were collected from the 0-6' and 7-12' horizons of all plots prior to fertilization and application of pesticides and again at harvest time. The initial samples have been analyzed for organic matter, nitrogen, exchangeable calcium, magnesium, and potassium. In addition, a study designed to evalu-

ate the potential microbiological activity of the soils has been conducted. This study indicated that applied ammoniacals oxidized to nitrates at rates in agreement with those found for similar soils. All soil samples have been prepared for analyses for aggregate distribution and stability. Methods suitable for sulfofication and nitrification studies have been selected and these will begin immediately.

SUPPORTED BY U.S. Dept. of Agriculture

4.0289, BIOLOGY AND CONTROL OF INSECT PESTS OF ORNAMENTAL PLANTS

H.H. TIPPINS, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO00154)

OBJECTIVE: Determine important species of insects infesting ornamental plants. Study biology and habits. Develop effective and safe control measures.

APPROACH: The life cycle, habits, and seasonal occurrence of the principal pests will be determined by laboratory rearing and field observations. Practical control measures will be developed. The importance of the biological control will be studied. The phytotoxicity or adverse effects of insecticides on ornamental plants will be determined. Pests to be investigated will include scale insects, lacebugs, and leaf crumplers. Emphasis placed new systemic insecticides.

PROGRESS: In studies on the morphology of scale insects, 20 species of Diaspidini were found to be sexually dimorphic in the second instar. The males possess variously modified ducts which are unlike those of the female in any stage. Morphologically the second instar males show phylogenetic affinities which are often completely obscure in the adult female. A new pest, Maskell scale, was found to seriously affect juniper nursery stock. This scale was controlled with parathion spray and granular dimethoate and Temik in field tests. A new pest, Eusophera sp. -- a lepidopterous borer, was found infesting the roots and lower trunk of magnolia seedlings. Dieldrin sprays were apparently effective in controllig borers in the trunk. In greenhouse tests, several systemic insecticides were highly effective in the control of the azalea leafminer, Di-Syston , Meta-systox and dimethoate applied in irrigation water gave complete control of the leaf miner and prevented reinfestation for nine months. Dimethoate was phytotoxic to one azalea variety. Ninety to 100% control of tea scale was obtained in greenhouse and field tests with systemic insecticides applied to the soil and with oil emulsion sprays. Subfreezing temperatures the day oil sprays were applied to camellia had no adverse effect on the plants.

SUPPORTED BY U.S. Dept. of Agriculture

4.0290, ETIOLOGY OF MERCURIAL PHYTOTOXICITY (FAT LEG) OF SEED PEANUTS

D.K. BELL, Georgia Coastal Pl. Expt. Sta., *Tifton, Georgia* 31794 (GEO-02-0159)

OBJECTIVE: Determine at what stage after treatment phytotoxicity occurs and the effects of temperature and planting depth on the expression of toxicity in three peanut cultivars.

APPROACH: Starr, Florigiant, and Early Runner seed will be treated with various rates of ethylmercury chloride or methylmercury dicyandiamide in dry form or solution. Seed will be incubated at various temperatures and germinated at time intervals during the incubation to note fat leg (toxicity symptom). Seed will be planted at various depths in soil and artificial media to determine effects of planting depth.

PROGRESS: Objectives: Determine the relative susceptibility of seed of Spanish, Runner, and Virginia peanut types to organomercurial toxicity, where in the period from seed treatment through germination the toxic response occurs, and the effect of planting depth on degrees of the toxic response. Cv. Early Runner was most susceptible to excessive organomercury treatment, cv. Starr (Spanish) was least susceptible, and cv. Florigiant (Virginia) was median. Peanut seed exposed to an excessive amount of organomercury for 36 hr sustained much greater damage from toxicity than did seed exposed for 12 hr. Increasing planting depth from 2 to 5 inches greatly increased the toxic response in seed from both exposure periods. Peanut seed treatment techniques should be refined according to commercial seed types to prevent both under and excessive applications of organomercury fungicides. The treating machine may require considerable improvement, and operators should be better trained.

SUPPORTED BY Georgia State Government

4.0291, WEED CONTROL IN PLANT INDUSTRY

N.C. GLAZE, Georgia Coastal Pl. Expt. Sta., *Tifton, Georgia* 31794 (GEO-02-0117)

OBJECTIVE: Develop adequate economical means of controlling weeds in crops grown for transplants which do not deleteriously affect the crops in question and that minimize the danger of herbicide residue accumulation. Initial work will be devoted to tomatoes because of the large industry volume.

APPROACH: Herbicides will be evaluated as their physicochemical and biological responses indicate. Various times of application will be investigated and also the influence of herbicide formulation.

PROGRESS: Herbicide evaluations were conducted on direct-seeded tomatoes and peppers. Pebulate has been found to be highly injurious when applied and incorporated shortly before tomato seeding. When applied 4 inches deep with covered sweeps, this injury has not been noticed. Combinations of two herbicides are also being evaluated in order to control a broader weed spectra and reduce the degree of crop injury obtained.

SUPPORTED BY Georgia State Government

4.0292, WEED CONTROL INVESTIGATIONS IN SEEDED AND TRANSPLANTED VEGETABLE CROPS

N.C. GLAZE, Georgia Coastal Pl. Expt. Sta., *Tifton, Georgia* 31794 (GEO-02-0120)

OBJECTIVE: Develop adequate, economical, and safe means of controlling weeds in vegetable crops which leave a minimum of herbicide residues in soils and on the harvested plant products. Work is in progress on sweetpotatoes, transplanted tomatoes, and some salad crops. New areas of investigation will lie within the cucurbit and legume groups.

APPROACH: Various herbicides will be evaluated according to their known selectivity and physico-chemical properties. Methods of application, timing, etc. will be considered to provide maximum protection with minimum quantities of herbicides.

PROGRESS: Herbicide evaluations were conducted on lima beans, cucumbers, watermelons, turnip and mustard greens. Nitrofen has given excellent weed control without injuring turnip or mustard greens. Nitralin was added as a recommended practice on cucumbers and watermelons. Other new compounds and combinations of herbicides were evaluated for weed control and crop tolerance on the previously named crops.

SUPPORTED BY Georgia State Government

4.0293, WEED CONTROL IN AGRONOMIC CROPS OF THE SOUTHEASTERN COASTAL PLAIN

E.W. HAUSER, Georgia Coastal Pl. Expt. Sta., *Tifton, Georgia* 31794 (0710-01-08)

OBJECTIVE: Develop economically suitable weed control practices and systems of weed control (including acceptable crop tolerance) for peanuts and crops grown in rotation, with emphasis on control of nutsedge. Determine the impact of changes in weed ecology in the Southeastern Coastal Plain. Determine persistence of herbicides in soil following various schemes of herbicide treatment. Develop improved techniques for application of herbicides. Also, determine losses caused by weeds.

APPROACH: Conduct intensive greenhouse and field experimentation envolving candidate herbicides, systems of herbicides, and herbicides plus mechanical weed control. Evaluate crop responses to weed control practices including yield and quality. Characterize persistence of herbicides in soil by use of bioassays.

PROGRESS: Continuing research with several systems of weed control in cotton, corn, peanuts, and soybeans grown continuously, and in several three-crop rotations, indicates that combining herbicides with cultivation is more efficient than using either herbicides or cultivation alone. In the absence of cultiva-

tion, more use of herbicides appears necessary for good weed control and this can lead to crop injury. Cultivation alone frequently failed to provide satisfactory weed control. -- Injection of butylate in soil at planting of corn combined with directed postemergence sprays of ametryne or linuron appears particularly effective for control of several troublesome species of weeds, including Panicum texanum, Digitaria spp., Cassia obtusifolia, Amaranthus spp., and Richardia scabra. -- A banded application of herbicides to half of the width of rows of cotton combined with cultivation controlled weeds as well as broadcast application of herbicides without cultivation, and in some instances as well as broadcast application with cultivation. Banding, as opposed to broadcasting, can be used to reduce the total amount of herbicide required, and it may prove more efficient when combined with cultivation.

SUPPORTED BY U.S. Dept. of Agriculture

4.0294, EVALUATION OF CHEMICAL COMPOUNDS AS NEMATOCIDES

A.W. JOHNSON, Georgia Coastal Pl. Expt. Sta., *Tifton, Georgia* 31794 (GEO-02-0125)

OBJECTIVE: Test chemical compounds for nematocidal activity, phytotoxicity, and specificity to various species of nematodes and develop soil fumigation on a practical crop production basis. Improve efficiency of soil fumigation through development of new application techniques. Feasibility of controlling wide range of crop pests through single pesticide applications.

APPROACH: Control of various nematode species will be measured by population change, root damage, and yield response of test crop following treatment with nematocides. Yield, plant vigor and color will be used to determine phytotoxicity. New equipment and modifications of existing equipment will be tested to determine methods of gaining maximum benefits from soil fumigation. The feasibility of controlling several crop pests with single application procedures will be studied by application of single, broad spectrum biocides or mixtures of specific biocides.

PROGRESS: Several new experimental nematocides show promise of controlling root-knot, sting, root-lesion, stubby-root and stunt nematodes on cotton, tobacco, sweet corn, lima bean, tomato, sweet potato and millet-sudangrass hybrids. Mixtures of specific pesticides applied in a single application, continue to show promise in controlling plant-parasitic nematodes, weeds and soil fungi in cotton and tomato transplants. Evaluation of pesticides and methods of application has made possible the achievement of 100 percent control of root-knot nematodes and good control of grasses and weeds in tomato transplants, which is necessary in transplant production. Complete control of root-knot nematodes on tomato transplants was also achieved this year by applying several nematocides separately through an over-head sprinkler irrigation system. This is the first account of nematicide application in this manner in transplant production.

SUPPORTED BY Georgia State Government

4.0295, CULTURE AND PHYSIOLOGY OF FLUE-CURED TOBACCO

J.D. MILES, U.S. Dept. of Agriculture, *Tifton, Georgia* (0500-04-02)

OBJECTIVE: Efficient cropping systems for flue-cured tobacco to improve yield and usability.

APPROACH: Examine interactions among cultural practices, such as varieties, sucker control methods, and leaf populations to improve production systems and methods. Aid production improvement program with biochemical and physiological studies of plant growth and development with emphasis on the function, mechanism and metabolism of growth regulators.

PROGRESS: A field experiment with flue-cured tobacco showed that 1-decanol (5%) was effective in controlling both terminal and axillary buds. Ethrel (2-chloroethylphosphonic acid) applied to these chemically topped plants at 150 mg ae per plant caused all leaves to yellow in four days. Leaves remaining on the stalk (65-70%) were harvested at once and cured in 3 days. Chemical composition of the cured leaf changed only slightly. A field experiment to study the interactions of N rates, sucker control chemicals and leaf ripeness at harvest showed that higher N increased yield but reduced price index. Sucker control chemicals increased yield and price. Tobacco harvested underripe had the highest filling value and lowest sugar content. The effectiveness of Ethrel in causing yellowing of flue-cured tobacco depends on whether the plants are topped or not-topped prior to treatment. Ethrel treatment did not produce a detrimental effect on the chemical quality of the leaf. Depending upon concentration, Ethrel either stimulates or retards tobacco seed germination and early seedling development. Further studies on the growth inhibiting substance present in young tobacco leaves indicate that it is an acyclic, weakly acidic substance. Preliminary GLC-mass spectrometry studies indicate a mass of 288 and infrared spectra show it to be a polyhydroxy compound with a ketone group present.

SUPPORTED BY U.S. Dept. of Agriculture

4.0296, ANTIMICROBIAL ACTION OF BIPHENYL AND DERIVATIVES ON CITRUS SPOILAGE ORGANISMS

F. SENSER, Ludwig Maximilians Universitat, *Munich, Germany* (HC-- (E10-AMS-3))

OBJECTIVE: Determine the mode-of-action of biphenyl and related compounds in order to obtain information useful for developing less toxic substitutes that would not affect the odor or flavor of the fruit.

APPROACH: Determine effect of biphenyl on germination and development of various citrus spoilage fungi. This will involve such studies as permeability of spores and mycelium to biphenyl and accumulation of the chemical in certain parts of the cells. Determine carbohydrate metabolism of the molds as influenced by biphenyl. Conduct studies on combination of biphenyl with other substances to reduce biphenyl concentrations needed. Study manner in which the organisms develop resistance.

PROGRESS: Biphenyl was found to be slightly inhibitory to hexokinase, glycerol-1-phosphate dehydrogenase, and Beta-hydroxyacyl- CoA-dehydrogenase. It is strongly inhibitory to phosphotransacetylase and glutamate dehydrogenase. Sodium orthophenylphenate (SOPP) has only a slight inhibitory effect on hexokinase and guanase. SOPP blocks phosphotransacetylase and glutamate dehydrogenase. The measurements indicating strong or blocking activities are assumed to be effective under the biological conditions of the use of the fungicides. Naturally occurring orange and lemon oils were found to inhibit the metabolism of Trichoderma lignorum. When small quantities of SOPP (10 mol/l) were combined with 0.4% lemon oil, respiration was completely blocked. The inhibiting of the oils increase strikingly with the addition of SOPP.

SUPPORTED BY U.S. Dept. of Agriculture

4.0297, PESTICIDE RESIDUE CLEARANCE PROGRAM

A. BEVENUE, Univ. of Hawaii, Agricultural Experiment Sta., *Honolulu, Hawaii* 96822 (HAW00613)

OBJECTIVE: Obtain pesticide residue data, spraying of crops with pesticides will be carried out. Samples will be taken and prepared in a form suitable for analysis.

APPROACH: Chemical analysis will be carried out. Analytical procedures for the determination of pesticides will be modified to make it applicable for the particular plant sample being tested.

PROGRESS: Residue studies on the miticide Morestan (6-methyl-2,3- quinoxaline dithiol cyclic carbonate) on papayas and papaya purees were completed, and the compiled residue and field data were submitted to Chemagro Corp., Kansas City, Mo., on March 14, 1968 to support petition to FDA for a residue tolerance. Residue studies on the same miticide are in progress on the macadamia nut. Thus far, no residue has been found in the edible portion. Residue studies on Diuron bracket3- (3,4-dichlorophenyl)-1, 1-dimethylurea closing bracket on papayas were completed; data sent to Dupont Co. to support registration petition. Residue studies are in progress on captan bracketN-(trichloromethylthio)-4-cyclohexene-1, 2-dicarboximide bracket on the taro root and on pentachlorophenol on the pineapple. Thus far, no captan residues are detectable in the taro root. Penthachlorophenol residues in the pineapple (fruit, bran, and crowns) range from 0.001 ppm in the fruit to 0.07 ppm in the bran. Supplementary research activities have produced useful related data described in the publications listed below.

4. PESTICIDES

SUPPORTED BY Hawaii State Government

4.0298, PESTICIDE RESIDUES IN PLANTS ANIMALS AND SOILS

J.W. HYLIN, Univ. of Hawaii, Agricultural Experiment Sta., *Honolulu, Hawaii* 96822 (HAW00609)

OBJECTIVE: Fate of pesticide residues on or in plants, animals, or soils; metabolism, growth and climatic variables may be investigated. Prevention, removal, or destruction of pesticide residues in or on treated plant parts, animals, or animal products development of new and/or improved methods for single and multiple pesticide residues.

APPROACH: Correlate residual levels of alkyl dithiocarbamate fungicides on plants with their phytotoxic effects. Identification of residual chemical responsible for these effects. Analyse for dithiocarbamate group and for metal ion to determine differential loss or metabolism of the sulfur and metal portions of the pesticide, rates of release of metals from the two types of compounds. Fungicide isotopically labelled with S or C . Fate of labelled compounds will be determined by isolation, identification, and quantitation of residual applied fungicide, metabolites and degradation products. Identified compounds will be studied for phytotoxicity.

PROGRESS: The total fate of dimethyldithiocarbamate fungicide residues on papaya has been determined. The principal products are conjugates of the fungicide residues with glucose and alanine. However, significant amounts are converted to volatile materials as carbon disulfide and carbon dioxide. In addition, a certain portion is metabolized to inorganic sulfate. There is no indication that hydrogen sulfide is formed. A perfusion apparatus has been developed to permit isolation of microorganisms from soil for the study of the microbial degradation of pesticide residues. Preliminary soil perfusion experiments indicate that the metabolic breakdown of DDT, diuron, dacthal and several other organochloride pesticides can be studied with this apparatus. Studies with certain soils indicate that the o,p'- isomer of DDT is preferentially degraded.

SUPPORTED BY U.S. Dept. of Agriculture

4.0299, PESTICIDE RESIDUE METABOLITES

J.W. HYLIN, Univ. of Hawaii, Agricultural Experiment Sta., *Honolulu, Hawaii* 96822 (HAW00611 F)

OBJECTIVE: Determine metabolic products formed when pesticides are applied to selected plants and soils. Biochemistry and toxicology of metabolites and their biological significance as residues.

APPROACH: The migration of the pesticide residue into and throughout the plant will be studied by radioisotopic and radioautographic techniques. Metabolites, if present, will be isolated from extracted plant material using procedures such as thin layer chromatography, column chromatography, electrophoresis, etc. Identity of isolated metabolite produced by various species will be estimated. Transformations of the pesticides by soil microorganisms will be studied. The toxicology of novel metabolites will be determined.

PROGRESS: The effects of organothiophosphate and organophosphate insecticides on purified enzymes other than acetylcholinesterose has been studied. Pepsin, trypsin, and chymotrypsin are not appreciably affected. Preliminary results indicate that alkaline phosphatase is 50% inhibited by 1-10 x 10 molar concentrations of a wide variety of phosphate insecticides. The metabolic fate of ring labelled diazinon has been studied on papaya plants. The principle metabolite is the pyrimidinol. This is further degraded into metabolites incorporated into the plants normal structure since radioactivity bound in proteins is found both above and below the point of application.

SUPPORTED BY U.S. Dept. of Agriculture

4.0300, THE RELATIONSHIP OF INSECTS TO THE LEAFROLL VIRUS DISEASE OF POTATO

G.W. BISHOP, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00323)

OBJECTIVE: Conduct a survey to determine what insects inhabit potato fields and the relative abundance of those insects. Determine what insects are capable of transmitting the potato leafroll virus. Study the ecologies and life histories of the insects determined to be vectors. Determine the natural infectivity of the vectors and the vector-virus relationships.

APPROACH: Field observations will be made in the potato seed growing areas to determine what insects are capable of transmitting the leafroll virus. The life history, distribution, seasonal occurrence and overwintering habits of these insects will be determined. The effect of grower practices on vector and leafroll abundance will be studied. Vector-virus relationships will be studied by controlled inoculations of potato plants.

PROGRESS: Several systemic insecticides applied at planting time were evaluated for potato insect control in replicated field plots at Aberdeen, Idaho. Temik at three pounds actual toxicant per acre was significantly more effective than Temik at two pounds or disulfoton at three pounds. However, Temik at two pounds was more effective than disulfoton at three pounds. Liquid disulfoton had a shorter residual period and was initially less effective than the granular formulation. Several food sprays containing yeasts and sugars were applied to unreplicated potato plots for preliminary evaluation of the attractiveness of these materials to predators of the green peach aphid. No differences in predator numbers between treated and untreated areas was observed. One formulation was extremely phytotoxic. There was evidence that the applications should have been made about two weeks earlier. Laboratory colonies of the green peach aphid were established from collections made at various localities in Idaho. Preliminary results indicate that there are marked differences in the host preferences among the colonies. Counts to compare differences in insecticide susceptibility are in progress.

SUPPORTED BY Idaho State Government

4.0301, POTENTIAL EFFECTS OF HERBICIDES ON PLANT METABOLITES AND RESIDUES IN CROPS AND SOIL

L.C. ERICKSON, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00546)

OBJECTIVE: Determine the accumulative effects of annual applications of certain herbicides on several crop and weed species and on the resulting herbicide residues in Palouse soil under prevailing environmental conditions; the infleunce of herbicide and environment on certain sugar protein or nitrogen fractions in several crops and on the status of herbicide residues in the crops at certain growth stages.

APPROACH: Five herbicides will be applied as weed control applications in the major crops. Three herbicide rates will be applied. Data will be obtained to determine their influence on: sugar and protein fractions in the crops, residues in both crops and soils, qualitative and quantitative weed populations, and continuing crop yields.

PROGRESS: 4 rates of picloram, igran, linuron, dicamba and silvex were applied pre plant in May. No herbicide affected the rapidity of emergence of peas, wheat, barley, flax or buckwheat. Linuron improved flax stands. Silvex, linuron, and igran increased pea yield. Picloram was not phytotoxic to buckwheat but delayed buckwheat maturity. It appeared that picloram caused protein depletion: linuron 14.7, silvex 14.5, igran 14.5, dicamba 14.0 and picloram 13.3. Protein in barley and wheat decreased as herbicide rates were reduced. These differences may be due to physiological effects from the herbicides. These differences could be the result of decreasing quantities of nitrogen available to the crop plants as weed populations increased. Variation in % sugar content were linuron 4.7, dicamba 4.5, picloram 4.3, igran 4.3 and silvex 3.9. Dicamba appears to be translocated into the seed of crops harvested from the dicamba treated plots, as seed germination rates were depressed and eventually diseases invaded. Delayed and reduced germination will reduce the seeds growth potential under field conditions. In September, surface soil samples (0-6') were taken from each plot, dried and stored until February. Peas were then used in bioassay to detect the presence of prevailing herbicides. All herbicides were detected and found to be residual. After 2 additional months, only picloram was detected in this bioassay.

SUPPORTED BY U.S. Dept. of Agriculture

4.0302, DEVELOPMENT OF SYSTEMIC PESTICIDES WITH LOW PHYTO- AND MAMMALIAN-TOXICITY PROPERTIES:
A.W. HELTON, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00551)

OBJECTIVE: Evaluate new structures in vitro against a Cytospora fungus, and other organisms as appropriate. Evaluate candidate compounds for host toxicology-compatibility via root-absorption, stem absorption, and foliar absorption. Evaluate candidate compounds for pest-control efficiency in the laboratory, in a greenhouse, and in field plots. Study metabolism of tested structures in host plants.

APPROACH: In vitro assays will evaluate compounds for contact- toxicity to assay fungus and provide reference curves for estimation of concentration detected in treated host tissues by bioassay. Host toxicology studies will provide information on the upper limits at which candidate compounds can be used and the rate of translocation in host tissues. Pest control studies will be conducted with Cytospora and Coryneum canker fungi, with mildews, and with other pests as appropriate so that effective structure can be located.

PROGRESS: Sixteen compounds were investigated repeatedly in laboratory assay against a Cytospora fungus. Most promising of these were Aureofungin, TBZ, and G-20072, where growth of the fungus was inhibited completely as concentrations as low as 1.5 ppm in the culture medium. Other materials were promising also, i.e. at 1.5 ppm RH-893 inhibited growth 80%; Streptimidone, 70%; Busan 72, 60%; TCMTOB, 55%; Antimycin-A, 53%. None of these materials could be tested in plot trees because of the extreme damage done by the 1968-69 winter period, and consequently no report can be presented which deals with performance in vivo. Laboratory and greenhouse investigations into the physiology of Cytospora canker development in peach trees are not sufficiently complete for reporting at this time.

SUPPORTED BY U.S. Dept. of Agriculture

4.0303, ILLINOIS CONSUMERS' REACTION TO USE OF PEST CONTROL ON AGRICULTURAL PRODUCTS
M. DUNSING, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-60-0365)

OBJECTIVE: Obtain insight concerning the Illinois consumers' knowledge, attitudes, acceptance and demand for agricultural products subjected to varying degrees and alternative methods of pest control.

APPROACH: Phase 1--The following tests and scales will be developed concerning the use of pesticides on agricultural products: consumer knowledge test; attitude scale to determine attitudes and intensity; consumer acceptance test; consumer demand test. A pilot study of households in the Champaign-Urbana area will be undertaken to test these measures. Phase 2--The above measures will be test these measures. Phase 2--The above measures will be used with a representative sample of households in Illinois. Phase 3--A study will be made of consumer acceptance of agricultural products known to be pesticide treated or non-treated.

PROGRESS: For the 704 usable records, the significance of the relationships (chi-square) between the 26 independent variables and the knowledge and attitude statements was determined as was the significance of the relationships between the knowledge and the attitude statements. A linear regression model was used to test the following: the respondent's attitudes concerning the use of pesticides in food production are an explicit function of the occupation, education, and family income of husbands and wives, their knowledge about pesticides, the extent of use of pest control chemicals around the house and yard, the extent to which they think substances should be added to food to decrease spoilage, the extent to which they would buy fruits and vegetables if labelled 'pest control chemicals used in growing' as well as whether they would be willing to pay more for fruits and vegetables to eliminate the use of pest control chemicals and how much more. On the other hand, the respondent's attitudes are not an explicit function of the other factors obtained such as number in the family, owning or renting, health problems, etc. The findings to date indicate that a need exists for educational programs in this area. The type of information needed in these educational programs will be indicated as a result of this project. Papers are currently being written and will be submitted for publication.

SUPPORTED BY U.S. Dept. of Agriculture

4.0304, PHYSIOLOGY AND CONTROL OF WEEDS IN SOYBEANS
L.M. WAX, Univ. of Illinois, U.S.D.A. Crops Research Div., *Urbana, Illinois* 61801 (0710-01-09)

OBJECTIVE: Develop new and improved means of weed control in soybeans and investigate differential aspects of the physiology, biochemistry, and ecology of crops and weed.

APPROACH: Conduct research program including evaluation of new herbicides and methods of application. Determine the extent and nature of losses resulting from weed infestations. Conduct life cycle studies on specific problem weeds. Correlate physiological differences in weeds and soybeans with selectivity of herbicides.

PROGRESS: Greater proportions of amiben absorbed through roots appear to be translocated to shoots in susceptible plants than in tolerant plants. Tolerant species appear to fix more of the absorbed amiben in roots as nontransportable N-glucosyl amiben, and we believe that this action can account for most of the differences between tolerant and susceptible species in the amounts translocated to the shoots. -- Soybean-weed competition studies indicated that 4 to 5 weeks of weed control is required after planting until soybeans can compete effectively with common annual weeds in the row. Thereafter, weeds emerge but are unable to compete with soybeans, presumably because of the heavy shading by the soybeans. -- Buried seed of several species of weeds germinated almost equally well from 1/2 to 2-inch depths, but few emerged from 4 inches. Ambrosia trifida, however, emerged readily from seed at depths of 1/2 to 4 inches. Ambrosia artemisiifolia, A. trifida, and Polygonum pensylvanicum emerged early in the season, but very little thereafter. Abutilon theophrasti emerged early and continued for some time thereafter in the season. Ipomoea spp., Datura stramonium, and Setaria glauca emerged throughout the season. -- In studies on harvesting soybeans, 40,000 pigweed plants/A reduced soybean yields about 25% by competing, and caused an additional loss by increasing harvesting losses. The increased harvesting losses were mainly in threshing rather than in gathering.

SUPPORTED BY U.S. Dept. of Agriculture

4.0305, STORED GRAIN INSECT PESTS AND THEIR CONTROL IN UTTAR PRADESH, INDIA
B.P. KHARE, Uttar Pradesh Agric. Univ., *Nainital, Uttar Pradesh, India* (SP68(A7-MO-15(K)))

OBJECTIVE: Determine losses caused to grains by insects and develop insecticide control measures including effect of residues on the grains.

APPROACH: First, kind and amount of damage and kinds of insects will be determined from samples taken in 5 climatic zones of Uttar Pradesh. Second, the effect of moisture, heating and C0(2) on biology of the insects will be studied. Old methods of storage to be studied as base to develop new methods that will reduce losses specially in farmers' homes. Third, insecticides will be evaluated for biological effectiveness and for potential adverse effects of their residues on grains in laboratory tests and under actual storage conditions.

PROGRESS: A survey of different zones of Uttar Pradesh was conducted as earlier reported. Samples of wheat, maize, and paddy were analyzed for quantitative and qualitative losses. The past year's work was devoted to assessing: (1) weight loss of grain, (2) loss of germination, (3) estimation of avoidable losses by EDB fumigation, (4) effect of insect feeding on protein content, (5) effect of type of storage structure and zones on nonreducing sugars of grain and free fatty acid values. A study of insect population in different zones in relation to type of structure being used by the farmers for storage of different grains was also conducted. The loss in weight found due to insect feeding in paddy and maize

varied from 0.16 to 5.87 percent and 0.91 to 10.86 percent, respectively. A decrease in the protein content was evident in the germ and endosperm-eaten kernels of maize, but there was an increase in the protein of infested paddy kernels.

SUPPORTED BY U.S. Dept. of Agriculture

4.0306, INTERACTION EFFECTS OF HERBICIDE COMBINATIONS ON GROWTH AND RESIDUES IN PLANTS

L.L. DANIELSON, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (0710-03-10(CA))

OBJECTIVE: Determine phytotoxicity and interaction effects on crop plants, including residue levels, of herbicide mixtures and combinations.

APPROACH: A systematic study will be undertaken to determine the interaction effects of specific herbicides chosen on the basis of present knowledge of the mode of action of each individual material. An attempt will then be made to determine if other herbicides having a similar mode of action will give the same kind of interaction. For example, dinitrophenols are highly synergistic in combination with the photosynthetic inhibitor, simetone. Initially, the research will be conducted in the greenhouse, growth rooms, and laboratories, but the results will be checked out under field conditions. Penetration, translocation, degradation, and residues of herbicides and combinations in plants will be studied.

PROGRESS: In studies to determine plant structural parts receptive to herbicides preparatory to investigations of the effects of herbicide combinations, EPTC, chlorpropham, propham, and CDEC did not affect pea shoot growth but the shoot zone adjacent to the crown root node of corn was highly sensitive. Growth of corn was reduced and crown roots severely inhibited. Shoots of corn and peas were sensitive to diuron. In corn the shoot adjacent to the crown root node and the tissue of the first internode were the most susceptible. The uppermost shoots of peas below the soil surface were most sensitive. Trifluralin did not affect growth of corn and peas when placed in the shoot zone after emergence although the crown roots of corn were severely inhibited. Naptalam, dalapon, and 2,4-D did not affect growth of corn under similar conditions and of these herbicides, only 2,4-D reduced growth of peas. Wheat, barley, and oat plants were severely injured when treated with EPTC at the coleoptilar internode. Sorghum plants were severely injured regardless of the shoot zone exposed. Thus sorghum is considered most susceptible to EPTC, and wheat, barley, and oats equally tolerant of this herbicide. The results suggest that growth responses to EPTC are dependent on the stage of plant development at time of treatment. In studies of herbicide combinations, an antagonistic response of EPTC and 2,4-D was observed when the herbicides were applied to sorghum plants.

SUPPORTED BY U.S. Dept. of Agriculture

4.0307, INSECT PESTS OF CUCURBIT CROPS

G.E. GOULD, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (INDO1059)

OBJECTIVE: Not Provided.

APPROACH: Not Provided.

PROGRESS: The principal insect pest of cucurbits, the striped cucumber beetle (Diabrotica vittata (F.), was controlled by applications of dieldrin repeated 5 to 7 times up to blossoming. Several carbamate insecticides were found to be effective. The two best were carbaryl and Furadan (reg.trademark). Carbaryl caused some phytotoxicity to cucumbers resulting in stunting and delayed maturity, especially under high relative humidity and temperature. Plots treated with Furadan(reg.trademark) were superior to all others and had little or no beetle feeding and bacterial wilt. These plots had larger plants and higher yields. Best control with all materials was obtained by repeating applications at 3 to 7 days, depending upon rainfall and plant growth. Bacterial wilt, which is carried only by the cucumber beetles, could be controlled only by the presence of a good insecticide on the foliage when beetles migrated into the plots. Granular materials applied around the base of the plants or preplanted in the soil did not give protection against beetle attack. Carbaryl is now the recommendation against beetles on cucurbits in Indiana, while Furadan(reg.trademark) could be added if FDA clears a tolerance for these crops.

SUPPORTED BY Indiana State Government

4.0308, TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS

F. CARLIN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01624)

OBJECTIVE: Study the effects of pesticides on acceptability and/or nutritive value of agricultural commodities. Develop procedures for the removal, reduction or de-toxification of pesticide residues and conversion products in agricultural commodities. Develop or improve methods for determining pesticide residues in agricultural commodities in marketing channels.

APPROACH: Determine effects of 2, 4-D on acceptability of grapes, tomatoes, strawberries, and snap beans. The influence of preparation and processing techniques on stability of pesticides in fruits and vegetables. The effects of X-ray and beta radiation, freezing, storage, dehydration and possible chemical antagonists on malathion in eggs and broiler tissue. Develop new chemical or non chemical detection methods.

PROGRESS: Pigment extraction and column chromatographic procedures indicated that beta-carotene, lycopene or total pigments in tomato juice were not affected by sublethal doses of 2,4-D on tomato plants grown in greenhouses. Juice made from treated and control Heinz tomatoes were similar in color measured by a Hunter Color Difference Meter and flavor evaluated by a trained taste panel. Further studies of malathion application to the chicken indicated that in vivo degradation was more complete than previously demonstrated in in vitro conditions with partially purified liver carboxyesterase. Only trace amounts of ingested pesticide remained intact in the feces. The addition of volite 2,4-D in a concentration of 1 ppb to the atmosphere surrounding grape and tomato plants adversely affected the fresh market quality of the fruit harvested from these plants under certain environmental conditions. Thus, it would seem that no direct relationship between the level of 2,4-D in the atmosphere and the degree of adverse effect on fruit quality can be determined without regard to the specific environmental conditions previous to and during exposure. Evidently malathion degradation in the hen's body is controlled at least in part by the carboxyesterase enzyme system. Mono-acid and di-acid forms of malathion are the major metabolites even though other forms were isolated.

SUPPORTED BY U.S. Dept. of Agriculture

4.0309, HERBICIDES - THEIR ADAPTATION TO HORTICULTURE CROPS, AND STUDIES OF CONTAMINATION

E.L. DENISEN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01519)

OBJECTIVE: Determine herbicide adaptation for the specific horticultural crop areas: vegetables, turf, ornamentals and fruits; and develop herbicide and cultivation programs on a seasonal plan based on edaphic, ecological, and physiological factors. Consider economic factors in terms of labor requirement, herbicidal efficiency, and crop performance. Expose horticultural plants to minimum contaminating concentrations of chemicals of the 2,4D type as could occur from vicinity sprays or 'leaky' storage and obtain representative data on effects of these herbicides on performance of selected plant materials in regard to production, ornamental value, and ability fo propagate sexually and asexually.

APPROACH: In adptations of herbicides for vegetables, turf, ornamentals, and fruits, herbicide programs will be developed on a seasonal basis considering the ecological factors of soils, rainfall and temperature and the physiological factors of species and variety response, cuticular condition, carbohydrate levels and differentiation. Economic factors of cost and yield influence will be studied. In herbicide contamination studies a minimum concentration of 2,4D needed to produce visual symptoms will be established. A main trial of concentric rows of several species with a source of contaminant in the center will provide information on physiological, morphological and yield effects.

PROGRESS: At sustained sublethal 2,4-D exposures (1 ppb), zinnia seed misshapen and poor vitality. Premature germination of ripening seeds in the seed heads was not found in 1969. Pin oak and sugar maple trees were markedly stunted, ceased yearly growth sooner and exhibited premature senescence symptoms including tattered and lost foliage, but did not show appreciable growth deformations. Cabbage did not show typical malformation but split and stunted heads were clearly associated with the higher exposures. Maturity of tomato, pepper and bean exposed from before set was markedly delayed. Although photographical documentation was stressed, color infrared (closeup or airplane view) did not aid interpretation of results.

SUPPORTED BY U.S. Dept. of Agriculture

4.0310, FUNGICIDAL & FUNGISTATIC PROPERTIES OF ANTI-OXIDANTS AND RELATED COMPOUNDS

A.H. EPSTEIN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01723)

OBJECTIVE: Determine fungistatic and fungicidal activity of selected compounds supplied by U.O.P. and test active compounds for possible protective and/or systemic activity in plant disease control. Volatile compounds of low mamalian toxicity will be tested for efficacy in controlling storage molds.

APPROACH: Compounds of low mamalian toxicity with suspected fungistatic or fungicidal activity will be bioassayed in an inhibition plate type of test against Ceratocystis ulmi (Dutch elm disease) and Botrytis sp. (Nursery storage mold). Systemic activity of active compounds will be determined by application on elm seedlings growing in the greenhouse. BA and BHA, both volatile, low toxicity compounds, will be tested for efficacy in controlling mold development on high moisture corn in small-scale storage. Results will be used in considering establishment of field scale tests.

PROGRESS: The following compounds supplied by the Universal Oil Corporation are being tested: (1) Benzo furoxane (2) B.H.Q. (Butylated Hydro Quinone). Tests to date indicate that both compounds are active against Ceratocystis ulmi giving good inhibition zones in agar previously seeded with spores of the fungus. Both compounds are moderately soluble in water. Further tests to determine phytotoxicity, methods of application and activity against other plant pathogenic fungi will be investigated. It is expected that this phase of the project will be continued. B.H.Q. has Food & Drug Administration clearance as a food additive and in this project was tested for possible use as a control for storage molds in high moisture corn. Although preliminary tests indicated that surface mold development was delayed in large scale tests using CO(2) evolution as a measure of fungal activity total degradation of treated corn was not significantly different from the untreated control. This phase of the project will not be pursued further.

SUPPORTED BY Iowa State Government - Des Moines

4.0311, MONITORING AND ASSAY OF PHYTOTOXIC AIRBORNE PESTICIDES AND VOLATILE POLLUTANTS

C.H. SHERWOOD, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01802)

OBJECTIVE: Evaluating (uncontrolled) air pollution cases involving appreciable concern to the public or damage to crops. Detecting pollution incidence in representative Iowa rural and urban areas and improving use of instruments and biological tests. Relate damage potential to plant characteristics, pollutants, pollution patterns and environment. Provide concerned gardeners and commercial growers means for limiting damage from air pollution.

APPROACH: Obtain notification of pollution and other cooperation by extension personnel and state horticultural organizations. Monitor and assay representative rural and urban sites for pollution as related to environmental conditions, identifying advantages and disadvantages of instrumentation and biological tests and relating to sources and risks. Through controlled exposure patterns and pre- and post-exposure conditions improve diagnosis and prognosis procedures relating to 2,4-D, NH(3), O(3), SO(2) and other pollutants, pollutant combinations and patterns. Test use of indicator plants and observation training for concerned gardeners. Test advantages of incorporating warning or marking agents in high risk home-use packaged pesticides and formulations of profesional applicators. Develop use of protective or antagonistic materials such as organic irons, sequestrins and oxidation catalysts against known or expected pollutants.

PROGRESS: New treatment facilities and bottled gas injections produced more predictable effects (O(3), NO(2), SO(2), HCl, Fl, NH(3), H(2)S, 2,4-D singly and in combinations). Bluegrass, oat, tomato, bean and zinnia and 10 and 20 minute exposure sets typically used. Additive effects less than 1 1, no synergism, only O(3) and 2,4-D markedly less (10 X) together. However, morphactin and ethrel plus 2,4-D markedly increased effect and may be a synergism. Air sampling was conducted at two locations near Ames. One station had samplers at 1 m and 15.2 m above ground, the other only at 1 m. The number of days with pollutants was about the same as 1968, but with lower concentrations. More pollutants were found at the farm station than the urban station at the 15.2 m height. Most common compounds detected were 2,4-D and DDE. In rain samples the most common compounds were dieldrin, kelthane and endrin.

SUPPORTED BY U.S. Dept. of Agriculture

4.0312, FATE AND SIGNIFICANCE OF LABELLED PESTICIDES RESIDUES IN RICE

C. TOMIZAWA, Natl. Inst. of Agric. Sciences, *Tokyo, Japan*

Rice is a staple food crop consumed by the greater part of Asian people, and the majority of Asian countries executed various programes for the increase in rice production in order to prevent the starvation of the people caused by rapid increase of population. In this connection, although the important and growing role of chemicals for protecting rice is confirmed, public sensitivity to the problems of food and environmental contamination of all kinds has increased recently. It is essential that the evaluation of toxicity of pesticide residues be made with total residues including not only pesticide itself but also its decomposition products which might be toxic to mammals. Such comprehensive survey of pesticide residues is sometimes difficult to perform by means of a single analytical equipment. For this purpose, isotope tracer techniques may provide a powerful and unique tool. As a programme of first year of work, organo-phosphorus compounds, fungicides for rice blast disease, is taken up, and fate and nature of C14, P32 and (or) S35-labelled compounds in rice are examined.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

4.0313, SUGAR BEET VARIETAL AND HERBICIDE INVESTIGATIONS

E.E. BANBURY, Colby Branch Agric. Expt. Sta., *Colby, Kansas* 67701 (KAN-05-892)

OBJECTIVE: Evaluate comparative yield performance, sucrose percentage and disease tolerance of sugar beet varieties, evaluate sugar beet selectivity and weed control performance of selected herbicides, determine yield, sucrose percentage and chemical residue in sugar beets treated with herbicides, evaluate time and amount of herbicide applications to sugar beets.

APPROACH: The sugar beet variety trial will be composed of 8 hybrids and one open-pollinated variety for comparison. These to include types for resistance to leaf spot and/or curly top disease. In the herbicide trials, weed seed will be sown prior to or during experiment establishment to insure the presence and more uniform dispersion of weeds. Herbicide applications are to be made pre-plant and pre-emerge at variable rates. Weed and beet seedling counts will be taken in evaluation of weed control and crop injury. In addition, visual estimates of weed control effectiveness and crop retardation will be included.

PROGRESS: Objectives. (1) To evaluate comparative yield performance, sucrose percentage and disease tolerance of sugar beet varieties, (2) to evaluate sugar beet selectivity and weed control performance of selected herbicides, (3) to determine yield, sucrose percentage and chemical residue in sugar beets treated with herbicides, (4) to evaluate time and amount of herbicide applications to sugar beets, (5) to study the economics of cultural practices in the production of sugar beets following grain sorghum. Progress: A variety test near Goodland in 1968 included

12 varieties. Test results are not yet available. Five herbicide tests were conducted with a total of 85 treatments. Included were variable such as herbicides or experimental chemicals, combinations of herbicides, rate, and time of application (preplant and preemerge). Notes on differences in degree of weed control, selectivity of the chemicals, optimum rate of application, and amount of crop retardation were obtained. Preliminary work involving cultural practices in the production of sugar beets following grain sorghum was started in 1968. Beets will be planted in the spring of 1969 to complete the sequence.

SUPPORTED BY Kansas State Government - Topeka

4.0314, WEED CONTROL INVESTIGATIONS
W.M. PHILLIPS, Fort Hays Br. Agri. Expt. Sta., *Hays, Kansas* 67601 (KAN00304)

OBJECTIVE: Research objectives are to discover more efficient chemical, cultural, mechanical, biological, nd combination methods of controlling annual and perennial weeds in sorghum, winter wheat, summer fallow, and other crops grown in rotation.

APPROACH: The following research is proposed: Application of pre- emergence and post-emergence herbicides on sorghum to determine their effect on the crop and their capabilities for weed control in the crop. Study differential varietal responses of sorghum and winter wheat to herbicides. Determine the penetration, movement, and persistence of herbicides in soil, and study the effects of herbicidal treatments on subsequent crops. Examine the effectiveness of herbicides in combination with minimum tillage practices for controlling weeds throughout summer fallow-wheat-sorghum and summer fallow-wheat rotations, and study the effect of these treatments on conservation of moisture. Determine the role of surfactants, repeat treatments, and other techniques in reducing the total amount of herbicide needed to control weeds.

PROGRESS: Work continued on the herbicide-minimum tillage concept of weed control in a wheat-sorghum-summer fallow rotation. In 1969, plots which received an application of atrazine after the 1968 wheat harvest and were tilled twice prior to seeding sorghum became infested with weedy grass. In spite of this competition, these miminum tillage plots yielded substantially more grain than the plots which were tilled conventionally. The concept of herbicide-zero tillage for fallow prior to sorghum production has been largely abandoned, except for academic interest, at least until more satisfactory herbicides are developed. New herbicides and combinations of herbicides applied pre...rgence showed considerable promise for controlling weeds in sorghum without causing undue crop injury. Combinations which involved an effective broadleaf weed herbicide and an effective grassy weed herbicide gave impressive broad spectrum weed control. Observations were continued on plots previously treated for field bindweed (Convolvulus arvensis L.) control. Picloram and 2,3,6-TBA are effective bindweed control herbicides, but both chemicals persist in the soil for extended periods.

SUPPORTED BY Kansas State Government - Topeka

4.0315, RELATION OF CHEMICALS AND CULTURE TO RESPONSE OF FRUIT PLANTS
R.W. CAMPBELL, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00265)

OBJECTIVE: Determine the influence of various chemical compounds used as insecticides fungicides, herbicides, growth regulators, or fertilizers on the photosynthetic activity, blossom bud formation, fruit production or vegetative characteristics of fruit plants.

APPROACH: These studies are designed to measure detailed responses of some horticultural corps to chemical pesticides, fertilizers and growth regulators. The effects of chemicals on plants under varying environmental conditions have been studied. Work has been conducted in the field, greenhouse and laboratory. Laboratory techniques employed in plant tissue analyses include colorimetry, spectrophotometry and chromatography. Growth tests involving bio-assay plants have been utilized. The use of radioactive tracers is planned for future work.

PROGRESS: Jonathan apple trees were randomly sprayed with aqueous solutions of TIBA and B-9 in May 1968. No significant differences between treatments and controls was noted in terms of terminal growth, twig diameter, and number of flowers in April 1969. A study to determine the effect of succinic acid, 2,2-dimethylhydrazide (Alar) on zinc translocation in 2 year old greenhouse grown pecan trees was carried out. Two months after planting a foliar applications of Alar were made followed by a soil treatment of Zn 65. Results showed the uptake of Zn 75 was too low to produce significant results. A tissue analysis with atomic absorption of tomato plants sprayed with Zn sulphate and Alar failed to show a positive correlation between Alar and Zinc translocation. A study was initiated to determine the changes in nitrogenous compounds, enzyme activity and other physiological phenomena in two garden pea varieties under conditions of water stress as influenced by B-9. Seed of Alaska (drought susceptible) and Burgess (drought resistant) varieties were germinated in vermiculite and transplanted to a culture solution. After establishment B-9 was added to the solution as were different concentrations of carbowax to produce low, medium and high water stress conditions. Plants were harvested one week after carbowax treatment and assays for protein, nitrate, amino acid, nitrate reductase, and glutamine synthetase were conducted immediately after harvest. Relative turgidity, transpiration rate and dry weight of plants also was determined.

SUPPORTED BY U.S. Dept. of Agriculture

4.0316, WEED CONTROL IN HORTICULTURAL CROPS
J.K. GREIG, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00621)

OBJECTIVE: Study mode of action of herbicides on weed species at various stages of development. Determine effects of chemical herbicides on horticultural plants. Develop effective methods of controlling weed species in horticultural crops.

APPROACH: Study effect of time and rate of application of chemical herbicides to problem weed species in horticultural plantings. Obtain basic information concerning effects of chemical herbicides on growth and development and quality of horticultural plants. Evaluate various methods of weed control in horticultural crops.

PROGRESS: Post-emergent applications of RP2929 (4-dimethylamino- thiocyanobenzene) and RP17623

SUPPORTED BY U.S. Dept. of Agriculture

4.0317, INVESTIGATIONS OF CEREAL AND FORAGE CROP DISEASES AND THEIR CONTROL
E.D. HANSING, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00076)

OBJECTIVE: Investigate the causal organism, physiological race, disease, environmental factors affecting the organism and disease, and control through cultural practice, disease resistance, and fungicides (including the effect of the fungicide on the plant) on wheat, oats, barley, sorghum, and other cereal and forage crops.

APPROACH: Physiological races of fungi which occur naturally in Kansas will be used: Tilletia foetida, Ustilago tritici, U. avenae, U. kolleri, U. nuda, U. hordei, U. nigra, Sphacelotheca sorghi, Erysiphe graminis tritici, Puccinia graminis tritici, and P. rubigovera tritici (the last 2, control with fungicides only). Standard and experimental fungicides will be used. Experiments will be conducted in the field, greenhouse, and laboratory.

PROGRESS: Experiments were continued (cooperation with plant breeding) to develop wheat cultivars resistant to bunt and loose smut, barley resistant to brown loose smut, and oats resistant to loose smut and covered smut. Extensive experiments were conducted to determine the effect of the systemic fungicides Benlate (benomyl) and Plantvax (oxycarboxin) on control of rusts of wheat. Single applications of Benlate and Plantvax partially controlled leaf rust and increased yields, test weights, and 1000 kernel weights of the cultivars Bison, Parker, and Shawnee. They also partially controlled both leaf rust and stem rust in the cultivar Yorkstar (white winter wheat) and increased its yield, test weight, and 1000 kernel weight. Vitavax effectively controlled loose smut of wheat and brown loose smut of barley. Twenty- one farmers' samples of 4 loose-smut susceptible cultivars of Kansas wheat (non-treated, 0.2 - 14.5% infected spikes)

were treated with Vitavax at 4 oz/cwt of seed. Complete control of loose smut was obtained in treated seed of 19 samples while 0.1 and 0.2% occurred in 2 samples. Experiments are being conducted to determine the effect of the fungicide Plantvax (oxycarboxin) on the metabolism of wheat plants grown in nutrient solutions.

SUPPORTED BY Kansas State Government - Topeka

4.0318, FATE OF MALATHION RESIDUES ON GRAIN SORGHUMS

A.H. KADOUM, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (SP34(A9706))

OBJECTIVE: Determine degradation and metabolism of malathion on stored living and autoclaved grain sorghum.

APPROACH: Sorghum varieties having different seed coat textures will be used in metabolic study of malathion. Identity of malathion and metabolic products to be made by paper, thin layer and gas liquid chromatography. Radioisotope tracer techniques will detect metabolites. Degradation and metabolism of malathion residues on living and autoclaved sorghum and on glass to be studied. Drosophila melanogaster to be used in toxicity evaluation of degradation products.

PROGRESS: Separation and determination of malathion and some of its metabolites from stored grains by thin-layer chromatography has been completed. Studies on the effects of some organophosphorous compounds and their metabolites on sorghum grain, esterase, and certain insects attacking sorghum grain have been accomplished. Comparison studies on the fate of malathion in corn, wheat, and sorghum are currently in progress. The effect of different sources of light on malathion and its metabolic products are being investigated.

SUPPORTED BY U.S. Dept. of Agriculture

4.0319, FATE OF MALATHION RESIDUES GRAIN SORGHUMS

A.M. KADOUM, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN-05-912)

OBJECTIVE: Determine initial and aged malathion residue levels to study disappearance rates and behavior patterns; Study malathion metabolism on sorghums and determine the metabolic products.

APPROACH: Compare degradation of malathion residues on living and autoclaved sorghums and determine effects of temperature, light, and humidity on malathion degradation; and compare malathion metabolism on live sorghums, autoclaved sorghums, and glass surfaces and investigate the enzymes that are active in malathion degradation.

PROGRESS: Extraction and cleanup methods were studied to determine malathion and its hydrolytic products using gas-liquid chromatography. Use of acidified acetone extraction is satisfactory for routinely analyzing samples containing malathion, malathion half-ester, and malathion dicarboxylic acid in the presence of waxes and pigments of the grain sorghum, corn, and wheat. The acids are quantitatively converted to their methyl esters by reaction with BF(3)-methanol. Malathion was applied to grain sorghum from 6 hybrids at one pint of 57% emulsifiable concentrate per 1000 bushels. Little hybrid effect on malathion degradation was found during 12 months' storage at 80 F and 60% relative humidity. Grain moisture content and storage temperature significantly affected residue retention but foreign material had no effect on the rate of malathion disappearance.

SUPPORTED BY Kansas State Government - Topeka

4.0320, ATOMIC AND NUCLEAR RESEARCH WITH ACCELERATORS

R.B. LEACHMAN, Kansas State University, School of Arts, *Manhattan, Kansas* 66502 (AT(11-1)-1766)

In nuclear physics, emphasis will be on heavy-ion scattering, many- nucleon transfer in heavy-ion reactions, properties of highly deformed nuclei as studies by fission isomers, nuclear lifetime measurements by the Doppler shift attenuation method, and coulomb excitation with heavy ions. In addition, research of current interest with proton-induced reactions will be undertaken by studies of analog states and proton- induced gamma rays. In atomic physics, measurements will be made of charge-changing cross sections for slow heavy ions, production of ions with negative charge for tandem Van de Graaff ion sources, and ionic charge changing processes for fast heavy ions. Stopping of heavy ions in solids will concentrate on channeling properties in thin, single crystals. The use of heavy-ion scattering from food-stuffs will continue in development as a method of detecting trace amounts of pesticides.

Results: Detailed comparison has been made of the prompt and isomer fission of Am242. Lifetimes of excited states of K39 have been measured by the Doppler shift method. Charge changing cross sections for fluorine ions have been measured. Trace amounts of pesticides in foodstuff have been observed by oxygen ion scattering.

SUPPORTED BY U.S. Atomic Energy Commission

4.0321, CYTOGENETIC EFFECTS OF ATRAZINE ON GRAIN SORGHUM

G.H. LIANG, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN-05-897)

OBJECTIVE: Plant abnormalities induced by herbicides have often been reported. These abnormalities sometimes are transmittable from generation to generation. Transmittable changes in plants induced by herbicides may be caused by a genetic alteration. A better understanding of the cytogenetic response of plants of herbicides, and of their changes in chemical composition would provide useful information not only to effective and safe weed control but also to the comprehension of basic genetic mechanism. Determine changes in chemical composition and cytogenetics following application of atrazine.

APPROACH: My previous work has demonstrated that abnormal chromosome behavior in sorghum plants occurred as a result of atrazine application. The mechanism of inducing such irregularities should be further explored. Abnormal chromosomal behavior may be related to the alteration of certain metabolic pathways and to the misfunction of genes.

PROGRESS: Grain sorghum (Sorghum bicolor (L.) Moench) was sprayed with 2-chloro-4-ethylamino-s-triazine (atrazine), propylene glycol butyl ether ester of 2,4-dichlorophenoxyacetic acid (2,4-D), alkanolamine salts of 2,4-D, and nonphytotoxic petroleum oil (crop oil) or their combinations when plant heights were 2 to 4, 4 to 6, and 6 to 8 inches for grass weeds, broadleaf weeds, and sorghum, respectively. Microscopic examinations of pollen mother cells from all herbicide- treated sorghum revealed chromosomal aberrations, mostly aneuploidy and polyploidy, and aberration frequencies increased when herbicides were combined. Increases in chromosome numbers were observed in various meiotic stages. The mechanisms for increasing chromosome number probably differs from that of colchicine. The cells containing multiples of a nonbasic number of chromosomes, fragments and bridges, and micronuclei could cease to function or be less competitive than normal pollen since morphological abnormalities or differences in seed setting and germination percentages were not found from plants derived from previously atrazine-treated plants.

SUPPORTED BY Kansas State Government - Topeka

4.0322, INVESTIGATIONS WITH ORNAMENTAL PLANTS

C.E. LONG, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00213)

OBJECTIVE: Investigate the adaptability of woody ornamental plants to Kansas. Also to supply information on propagation material from proven adaptable plants to nurseries and the trade for further trial. It is proposed that the 35 years of growth records on ornamental trees and the 20 years of records on ornamental shrubs can be published in bulletin form.

APPROACH: This project is divided into three phases: Growth records of campus trees. Growth records of deciduous and broadleaf evergreens in the shrub collections. Plant propagation studies.

4. PESTICIDES

PROGRESS: Repeat applications of Dichlobenil at rates up to 200 ai/acre for three years have resulted in no observable phytotoxicity to selected ornamentals. Rooting studies of ornamentals treated with herbicides continue to show no adverse or benficial effects. A study of electrical resistance in selected rose cultivars was completed. This study involved the use of a series of resistance readings obtained from over wintering rose canes, varieties Matterhorn, Bewitched and Summer Sunshine (Hybrid teas), Queenie Saratoga and Europeana (Floribundas), and Camelot, and Scarlet Knight (Grandifloras), in an attempt to correlate resistance to low temperature injury susceptibility. Resistance readings were obtained with a Boyoucous Model C Bridge. Other observations included: dates of leaf color change, leaf fall, bud development and new leaf appearance. In general it was concluded that there is a positive correlation between electrical resistance and cold hardiness. Results showed that Hybrid Tea varieties were most hardy, followed by Grandifloras, with Floribundas being least hardy. These results correlated with resistance readings obtained. Multiflora cultivars are highly variable in terms of cold hardiness. Evaluation of herbicides for weed control in selected ornamentals was continued this year.

SUPPORTED BY Kansas State Government - Topeka

4.0323, NUT AND TREE FRUIT INVESTIGATIONS

N.W. MILES, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00025)

OBJECTIVE: Field testing of varieties of fruits and nuts to determine adaptability to Kansas, including yielding ability, fruit and nut quality and collection of phenological data. The effect of various chemical growth regulators on fruit set, fruit size, and preharvest drop will be studied.

APPROACH: Comparisons are being made of various apple rootstocks including the evaluation of clonal apple rootstocks for the production of dwarf or semi-dwarf trees. Cultural and fertilization practices for trees fruits to determine the best soil management practices for apples and peaches.

PROGRESS: Excessive atmospheric contaminations of 2 4-D herbicide from a nearby military fort caused excessive and visible damage to fruit crops. Pears were damaged most severely and the cultivar Bartlett was most tolerant of the species. Apples, black raspberries, and pecans showed severe distortion but recovered in later growth. Peaches and other stone fruits, and strawberries were relatively tolerant. Grape buds were at balloon stage at time of contamination and, although damage was serious, vines were not killed. Damaging late spring freezes reduced apple production by 50 per cent and peaches by more than 95 per cent. Golden Delicious, Winesap, Jonathan and Red Delicious apple cultivars ranked highest to lowest in production. Alar at 1500 ppm proved an effective stop-drop spray on Jonathan and Winesap but not Yellow Delicious. It was shown that a John Bean Model C-275 speed sprayer could be converted to 3X and 6X concentration spraying without significant change in spray distribution pattern in 25 year old apple trees. Fall applications of Alar at 5000 ppm, Pensalt TD 692, and TD 6241 did not change the low temperature tolerance of Jonathan or Red Delicious apples or peach in fall or winter. Observations will be made in spring 1969 to determine effects on blossom date and tissue low temperature resistance. Preliminary data on stub-pruning vs. standard pruning indicates that more prunings (total) were removed in stub- pruning and early yield might be reduced slightly (1 yr. croping data). This was generally true for both G. Del. and R. Del., spur type or standard type, and seedling or dwarfing rootstock.

SUPPORTED BY Kansas State Government - Topeka

4.0324, FIELD EVALUATION OF HERBICIDES

O.G. RUSS, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN-05-898)

OBJECTIVE: Provide uniform data on crop production and performance when chemical weed control is included as a farming practice. Provide uniform data on the performance of herbicides when they are included as a method of weed control in crop production.

APPROACH: Apply label approved herbicides to study weed control and crop injury in corn, sorghum, soybeans, wheat, and alfalfa. Studies to be conducted at Manhattan, North-Central Field, Cornbelt Field, Newton Field, East-Central Field, and Southeast Kansas.

PROGRESS: Field evaluations were made of label registered and some experimental herbicides for control of annual weeds in alfalfa, wheat, soybeans, corn and grain sorghum. Several herbicides or rate of application will be removed from the evaluation testing and new entries will be added. Alachlor applications to grain sorghum resulted in severe sorghum injury at several locations. Alachlor or combinations containing alachlor will be removed from the 1970 tests. Three methods of applying herbicides, preplant, preemergent, and early post emergent, were included in the evaluation tests. Studies of herbicide persistence in the soil and their influence on subsequent crops were continued. First year data indicate no injury to soybeans and winter wheat grown on plots treated with herbicides on grain sorghum in 1968. On a limited basis, sorghum lines are being screened for resistance to herbicides that will control wild cane. Also, soybean lines are being screened for resistance to atrazine.

SUPPORTED BY Kansas State Government - Topeka

4.0325, SORGHUM AND CORN PHOTOTOXICITY PROBLEM AT WICHITA KANSAS

W.H. SILL, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN-05-839)

OBJECTIVE: Not Provided.

APPROACH: Not Provided.

PROGRESS: This project supported by the Vulcan Chemical Company was reactivated with the return of a graduate student, Miss Aurora Salazar, from the Philippines, to resume her graduate work at KSU. She is continuing her study of the effects of an isomer of Benzene Hexachloride on the growth and morphology of the sorghum plant, particularly the roots. The present studies are in the preliminary stage.

SUPPORTED BY Kansas State Government - Topeka

4.0326, SOUTHEAST KANSAS EXPERIMENTAL FIELD

J. WINZER, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN-SEK)

OBJECTIVE: Improve horticultural production in Southeast Kansas by determining those crops and practices which will best suit the ecological and economical situation. Research in pecan production will be of major concern. The best possible propagation, cultural and management methods will be sought for both the existing native pecans and the planted pecan groves. The best adapted pecan varieties are selected native nuts will be determined. Some walnut investigations will also be carried out, as will studies of adaptation and management of tree fruits, small fruits, vegetables, ornamentals and forest species.

APPROACH: The work planned will include thinning, fertilization, intercropping, pest controls, pruning and managment practices for existing native pecans. Propagation techniques will be studied as they apply to topworking native trees and grafting nursery trees. Rootstock investigations will apply to both nut and fruit trees. Research into appropriate varieties or species as well as cultural studies will be carried out to a lesser extent with tree fruits, small fruits, vegetables, ornamentals, and forest trees.

PROGRESS: Herbicide evaluation trials were initiated in 1968. Preemergent chemicals were combined with paraquat and dalapon and applied post-emergent to non-bearing Peruque trees. Observations included toxicity to pecan trees and weed control. Post-emergent applications to native trees included 5 pre-emergent herbicides combined with dalapon or paraquat. Single and split applications of paraquat alone were also evaluated for weed control. Total weed growth was reduced most by paraquat treatments applied 4/25 and 6/26. No injury was observed from any herbicide treatment. In all treatments weed residues were present which would interfere with mechanical pecan harvesting equipment. Pecan samples were collected for residue analysis. Subsurface drainage was found to be beneficial to newly set nursery trees; trees growing in drained soil made about twice as much growth as those in undrained soil. A replicated planting of northern hardy pecan cultivars made in 1964 is making excellent growth; a few trees produced nuts this year. A positive response

to thinning and the application of either 500 or 1000 pounds of ammonium nitrate per acre continues to be noted.

SUPPORTED BY Kansas State Government - Topeka

4.0327, WEED CONTROL IN AGRONOMIC CROPS
J.F. FREEMAN, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00164)

OBJECTIVE: Attempt to discover new weed control principles. Develop chemical, cultural, biological and ecological and combination methods to control weeds in agronomic crops. Determine effects of environmental and edaphic factors on response of these crops and associated weeds to weed control treatments.

APPROACH: Field Plot evaluation studies of promising herbicides will be conducted on corn, soybeans, tobacco and sorghum to determine tolerance of the crop and response of various weeds to preplanting, preemergence, postemergence or post transplanting treatments. Methods of placement of the herbicide with relation to the soil surface in preplanting or preemergence applications, time of treatment in relation to planting or transplanting of the crop, and directional spraying in late post emergence applications will be investigated for purposes of altering the effects of the herbicide on crops, weeds, and soils. Bioassay techniques will be used in greenhouse and laboratory studies of persistence and movement in the soil of selected long-residual herbicides in relating soil characteristics to phytotoxicity in various crops that might follow the treated crop under field practices.

PROGRESS: 82 herbicides applied at various rates and in different combinations on corn, soybeans, tobacco and alfalfa. Since fall panicum (Panicum dichotomiflorum) has become an extremely serious pest in corn and soybeans, one of the major emphasis was to concentrate on obtaining satisfactory herbicide treatment to control this weed. Four herbicides, simazine, atrazine, primazine (atrazine prometryne) and alachlor were applied to minimum tillage corn as pre-emergent treatments. Simazine at 4 lb/A gave significantly greater control of fall panicum, than the other treatments. Atrazine 1 3/5 lb/A simazine 4/5 lb/A, atrazine 4 lb/A, simazine 3 lb/A, primaze 2 lb/A and alachlor 2 lb/A gave slightly less fall panicum control. Although the control of fall panicum was slightly less with these herbicides than with simazine, there was no significant reduction in yield.

SUPPORTED BY U.S. Dept. of Agriculture

4.0328, WEED CONTROL IN HORTICULTURAL CROPS
L. STOLTZ, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00563)

OBJECTIVE: Develop effective and practical methods of weed control in horticultural crops in Kentucky. Evaluate the physiological effect of herbicides on horticultural plants and on weeds.

APPROACH: Studies will be made in the field and in the greenhouse and laboratory, on fruits, vegetables, and ornamentals, and on turf for controlling lawn weeds. Standard techniques and equipment will be used, including replicated, randomized, complete block design. Study of effects of environmental conditions on the phytotoxicity of various herbicides will be included.

PROGRESS: A degree of fall weed control was accomplished in tall bearded Iris with Enide, Treflan, Simazine and Sesone but recommended rates for field application did not provide satisfactory weed control. Relative tolerance of Iris to several herbicides at higher rates was determined. Simazine at 100 ppm did not stop growth but produced tip burn of the leaves within four weeks. Plants remained alive but ceased growing after treatment with Enide and Treflan at 100 ppm. Other herbicides that were tested killed the plants, some herbicides at rates as low as 10 ppm. Simazine, Treflan and Enide are being applied at rates ranging from 4 to 20 pounds per acre on Iris grown in soil to determine their tolerance to these herbicides over a longer period of time. Hydrogen bonding of 2,2-dichloropropionic acid (dalapon) to N-methylacetamide as a protein was studied using infrared spectra. Changes in spectra indicated that the dalapon carboxyl-OH, hydrogen bonds significantly to the model amide carbonyl group. According to this indication, the dalapon molecule must not be ionized to be active. Expected predominance for ionized dalapon molecules at the pH of plant sap explains the high rates of application of this herbicide needed for producing damage in plant tissue.

SUPPORTED BY U.S. Dept. of Agriculture

4.0329, CONTROLLING THE RESPONSES OF CROP AND WEED PLANTS TO HERBICIDES
J.G. GOSSELINK, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01205)

OBJECTIVE: Increase efficiency and lower herbicide residue by timing applications to coincide with peaks of sensitivity of the plant. Increase specificity of herbicide action by differential response to time of application. Increase rate of detoxification of herbicides by timing application to optimum time in the diurnal metabolic cycle. Control plant growth by modification of the normal production of growth regulators.

APPROACH: Cotton, soybean and weed seedlings will be treated with herbicides at different times in a 24-hour cycle. Response will be measured and correlated with normal rhythmic metabolic changes and leaf movements. Samples of treated and untreated plants taken over 24-hour periods will be analyzed for auxins to correlate growth with rhythmic auxin production, and to study the influence of herbicides on this rhythmic production.

PROGRESS: A diurnal rhythm of susceptibility of cotton and soybean seedlings to a number of different herbicides was clearly shown (Gosselink & Standifer, 1967b). Seedlings are more susceptible to equivalent applications of herbicides in early daylight hours than at other times. Response is not considered endogenous, since it was not observed under constant light and temperature conditions. Existence of a metabolically mediated circadian rhythm of absorption of inorganic P was established in Euglena. Passive absorption of P also showed a tendency to vary in a circadian manner, but differences were not statistically significant. This means, if translation of higher plants is valid, that while metabolism undoubtedly varies diurnally and could thus influence herbicide sensitivity, there is no strong evidence that diurnal changes in physical structure of the membrane allows changes in passive movement into and out of cells. Results of this project indicate the practical application of the work is questionable. Project is terminated in favor of more urgent problems.

SUPPORTED BY U.S. Dept. of Agriculture

4.0330, THE EFFECT OF CHEMICALS USED IN AGRICULTURE ON THE SOIL MICROFLORA
A.D. LARSON, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB00837)

OBJECTIVE: Determine the effect of herbicides, pesticides, defoliants, etc., upon the microorganisms present in the soils of Louisiana.

APPROACH: Studies are being made with the mixed microflora of the soil and with pure cultures of Nitrobacter to observe the possible toxicity of the older herbicides dalapon and the newer fenac upon the processes of nitrification, i.e., the oxidation of ammonia to nitrites and the subsequent oxidation of nitrites to nitrates. The study is utilizing soil perfusion units wherein the perfusate bearing the substrate and the toxic agent are passed over the organisms in a column of soil. The degree of toxicity is evaluated by the quantitative determination of nitrite; by the appearance of it in the oxidation of ammonia and by its disappearance in its oxidation to nitrate.

PROGRESS: The research during the past year has been concerned with the effect of two systemic fungicides, benomyl (1-(butylcarbamoyl)- 2-benzimidozole carbamic acid, methyl ester) and Vitavax (2,3-dihydro-5- carboxanilido-6-methyl-1,4-oxathiin) on microorganisms. Benomyl was quite specific in that it inhibited the growth of fungi and yeast, but not bacteria. It inhibited oxygen uptake by eucaryotic but not procaryotic cells. Benomyl was shown to inhibit oxidation by yeast mitochondria but not the action of enzymes of glycolysis. Yeast grown in the presence of benomyl possessed abnormal mitochondria. It seems that benomyl is an inhibitor of mitochondrial activity and formation and therefore is most active on eucaryotic cells. Vitavax has growth inhibitory effects on fungi and some bacteria. Studies with

mitochondria prepared from Neurospora crassa showed that Vitavax is a potent inhibitor of mitochondrial oxidative activity. The observed results may explain the mode of action of Vitavax on microbial cells. However, Vitavax was shown to be a potent inhibitor of oxidative activity of rat mitochondria and mammals are considered to be quite insensitive to the fungicide. From our studies during the past year we have obtained evidence that two systemic fungicides have a marked inhibitory effect on mitochondrial oxidative activity. This inhibitory effect may be the primary mode of action of systemic fungicides.

SUPPORTED BY U.S. Dept. of Agriculture

4.0331, FUNDAMENTAL STUDIES ON WEED CONTROL
W.C. NORMAND, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB00971)

OBJECTIVE: Study mechanism of action of herbicides in plants. Evaluate effects of herbicides on plants under varying environmental conditions. Evaluate effects of weed competition on plant growth and development.

APPROACH: Studies will be made on the physiology of cotton and weed plants after herbicidal treatment. Temperature-moisture interactions will be studied under controlled conditions in the greenhouse and laboratory, as well as under semi-controlled conditions in the field. Greenhouse and laboratory studies will be made on effects of weed competition.

PROGRESS: Studies of Sido species in Louisiana have been continued. Though various ecotypes were found, only two species, S. rhombifolia and S. spinosa have been identified. There was evidence that the latter species was more resistant to postemergence applications of diuron, fluometuron, or prometryne which may have been due to less stem absorption than in the other species. No morphological evidence was found to explain this difference. Several methods for breaking dormancy of Sida seed have failed, but one compound which releases ethylene did improve the germination of apparently dormant seed. Tests were conducted to determine whether combinations of pesticides applied as seed treatments or preemergence sprays might interact to affect the response of cotton plants. Eight herbicide combinations were evaluated in all combinations with a systemic fungicide and a systemic insecticide. No responses could be ascribed to interaction of these pesticides, though previous observations of stand improvement in herbicide treated plots when a fungicide is used were supported. Seed and seedlings from these plots will be evaluated to seek possible effects on the progeny. A study of mitotic anomalies of excised cotton roots grown in cultures containing nitralin revealed that tissue cultured at 15 C was more subject to such anomalies than was tissue grown at 20 C. A slight increase in the evidence of atypical mitotic figures was also noted in the controls at the lower temperature.

SUPPORTED BY Louisiana State Government

4.0332, INSECTS & MITES ASSOCIATED WITH GRASSES & PLANTS, THEIR IMPORTANCE & MEANS OF CONTROL OF PESTIFEROUS SPECIES
A.D. OLIVER, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB00744)

OBJECTIVE: Determine the economic injury caused by mites & insects & methods for controlling them. Evaluate the role of beneficial species associated with pest species on ornamentals. Study methods of possible cultural practices which increase or reduce pest problems as related to nursery operations. Determine the phytotoxic effects of promising & recommended insecticides & acaricides on growth, grafting & rooting success of plants treated for pest control. Identify beneficial or harmful effects of insects on Christmas tree production.

APPROACH: Basic biological studies of insects & mites will be conducted by maintaining cultures in the laboratory. Effects of photoperiod & temperature gradients on reproduction & susceptibility to chemicals will be determined by holding the cultures in bioclimatic cabinets under different treatment regimes. Field control work will be done at outfield nurseries. Chemical control experiments will be conducted using randomized block designs. Biological control agents will be studied as pest populations increase & decrease. Identifications will be made by using departmental collections, taxonomic keys & national museums. Cultural control will be studied in cooperation with nurserymen. Because of the variation in methods of plant propagation much can be learned which will be helpful in formulation of pest control recommendations. Efforts will be directed toward determining factors which contribute to development of injurious pest populations.

PROGRESS: Chrysanthemums infested with the two-spotted spider mite, a looper, P. includens, bollworms, fall armyworms, southern armyworms, aphids and flower thrips can be protected with proper applications of Lannate at 1 tbsp/5 gal. water and Azodrin, Acarol or Supracide at 1 tbsp/gal of water. Phytotoxicity was not apparent at these rates of application to foliage or flowers. DiSyston 10% G. applied at 1 lb active/1000 sq. ft. of container azaleas gave complete protection from azalea leaf miner, privet mite, southern red mite and a two-spotted mite, Eotetranynchus clitus for 4 months. Field applications at 6 lbs/acre gave control of the southern red mite on azaleas and Japanese holly. Cygon at 1 qt of 2E/50 gal. water gave good control of tulip tree scale on magnolia.

SUPPORTED BY Louisiana State Government

4.0333, STATE WIDE WILDLIFE INVESTIGATIONS
L.D. SOILEAU, State Wildlife & Fish Comm., *New Orleans, Louisiana* 70130

Objectives: To determine if sprouts produced by 2-4-5-T treated browse species retain the herbicide and if so, the effect it has on their palatability.

Procedure: On the Red Dirt G. M. A. browse plants will be treated by burning, cutting and the application of herbicide on deer range where cattle are excluded. Each treated area will be approximately an acre in size. Sprouts produced by each treatment will be examined to determine if those produced by plants treated with herbicide are used by deer at the same rate as sprouts produced as a result of burning and cutting. Sprouts will be chemically analyzed to determine if herbicide is retained. Upon receipt of analysis, a completion report will be prepared.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0334, INSECTS AFFECTING THE APPLE
L.W. BOWLANGER, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00188)

OBJECTIVE: Control of apple maggot and other pests through chemosterilization. Introduction of predatory parasitic species into orchards devoid of such beneficial forms; subsequent manipulation to achieve integrated control. Changes in present methods of insecticide applications to reduce costs and environmental contamination. Reinforcement of presently available biological knowledge with particular emphasis on behavioral aspects.

APPROACH: Laboratory and field studies will determine acceptability of candidate chemosterilants and feasibility of releasing sterile males into low density field populations. Attractant-sterilant combination will also be evaluated. Parasitic/predatory species will be collected in unsprayed locations and released into commercial orchards where modified chemical programs will be employed. Changes in dosage rates, application patterns, and timing sequences will be used to obtain information on possible reduction in costs and contamination with practical control levels. Ecological and behavioral information will be recovered through sustained and thorough conservations on major pests.

PROGRESS: Apple maggot adult emergence was relatively near normal in terms of initial appearance, peak emergence, and final date of activity. Commercial control efforts were generally excellent with but few occurrences of slight infestation; the latter, in most cases, are judged to have resulted from inadequate coverage and inappropriate intervals between spray applications. In control trials, Lannate and Imidan exhibited acceptable effectiveness under infestation levels comparable to commercial levels. In trials conducted under extreme infestation pressure, Gardona and VCS-506 showed strong capabilities and confirmed their value in normal requirement situations. In plum curculio control experiments, Guthion was considerably more effective than Monitor, the only other compound of comparable value.

Torak, N- 2596, and VCS-506 permitted excessive injury on harvested fruit. European red mite studies confirmed the relatively long developmental periods required for incubation and immature form progress. Fecundity and egg hatch appear to be operating at normal levels.

SUPPORTED BY U.S. Dept. of Agriculture

4.0335, ARSENIC STUDIES WITH BLUEBERRIES AND POTATOES

W.J. KENDER, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00203)

OBJECTIVE: Determine the arsenic content in blueberry and potato soil, plant, fruit and tuber tissue and the rate of absorption, translocation, and accumulation of arsenic in plant tissue. Study the effect of arsenic toxicity on the growth, chemical composition, and physiology of the blueberry and potato.

APPROACH: The study will be conducted in five general phases, including field surveys, greenhouse sand and soil cultures, greenhouse toxicity experiments, and physiological studies of plant responses to applied arsenic. Similar experiments will be conducted on both blueberries and potatoes.

PROGRESS: During the period January to June, 1968 data on the physical and physiochemical changes found to occur in blueberry fruit were evaluated. These changes were used to identify and characterize the development, maturation, ripening and senescence stages of the fruit. Calcium arsenate and various growth regulators were found to disrupt the normal pattern of fruit development resulting in inhibition of enlargement, color development, and respiration. This information will serve as a basis for the evaluation of pre- and post harvest practices for future research.

SUPPORTED BY U.S. Dept. of Agriculture

4.0336, EFFECTS OF NUTRITIONAL LEVELS ON ORGANOLEPTIC QUALITY OF FRUITS AND VEGETABLES

E.F. MURPHY, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00162)

OBJECTIVE: Investigate effects of plant nutrition on flavor and texture of fruits and vegetables. Determine the effect of maturity and storage on sensory quality. Investigate relation of physical and chemical measurements to sensory ratings in fruits and vegetables. Investigate effects of pesticides and/or other chemicals on flavor and texture quality.

APPROACH: Apples from trees differing in nutritional status are being evaluated for flavor and texture preference by taste panels, with an attempt to correlate differences with physical and chemical characteristics e.g. acidity, total solids, sugars. An investigation is being pursued to determine mealiness differences (by taste panel) or certain varieties of processed potatoes as related to chemical components.

PROGRESS: Maine lowbush blueberries: texture preference of pies with frozen stored berries with fillings containing 1, 2, and 3 tablespoons (T) cornstarch per pie were judged by a 31-member panel. The 2T filling was significantly preferred, and the 1 and 3T were not different. The same test with fresh berries (30 judges) showed the 2T texture to be significantly preferred to the others and 1T significantly better than 3T. Flavors of pies (frozen berries) with 3/4 and 1 cup sugar with and without 1T lemon juice were not different as judged by a 32-member panel.

SUPPORTED BY U.S. Dept. of Agriculture

4.0337, AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE

R.L. VADAS, Univ. of Maine, School of Agriculture, *Orono, Maine* 04473

The proposed research plan involves laboratory studies directed at determining the effects of DDT and other chlorinated hydrocarbons on the growth and photosynthesis of euryhaline microalgae. Other pesticides will be investigated.

The main approaches to these problems are as follows: Growth studies will be conducted in light and temperature controlled growth chambers. Periodic cell counts will be used to determine growth rates at varying pesticide concentrations. Photosynthetic rates will be determined by changes in CO_2 concentrations using an infrared gas analyzer. Resistance to pesticides will be determined through long term growth studies at varying pesticide concentrations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0338, QUALITY AND NUTRIENT COMPOSITION OF FOODS TREATED WITH PESTICIDES

E. DAWSON, U.S. Dept. of Agriculture, Human Nutrition Research Div., *Beltsville, Maryland* 20705 (HN3-29A)

OBJECTIVE: See Accession No. 0015593.

APPROACH: See Accession No. 0015593.

PROGRESS: Atrazine had an effect at the 1% significance level on the fructose content of lochief corn, whereas there was no significant difference between replicates. The fructose content was higher which agrees with our findings previously reported that the carbohydrate content of peaches was also higher after herbicide treatment. There was no difference in ash content among controls or treatments, probably indicating that the field has been fertilized so frequently that there is no difference in the soil gross mineral content. The atrazine treatments had no effect on nitrogen content. In the case of the mineral analyses of apples and asparagus from Rutgers University, the calcium content of the 1966 herbicide treated apples was lower than that of the clean cultivated apples. In view of the conflicting data on mineral content of apples and asparagus under herbicide treatment, it would be difficult to conclude that the atrazine had any effect on the mineral uptake of the corn. More needs to be known about the metabolic effects of herbicides. Herbicide treatment had no consistent effect on the mineral content of the asparagus crops.

SUPPORTED BY U.S. Dept. of Agriculture

4.0339, TREATMENTS FOR CONTROL OF POSTHARVEST ROTS AND FUNCTIONAL DISORDERS IN APPLES

R.E. HARDENBURG, U.S. Dept. of Agriculture, Market Quality Research Div., *Beltsville, Maryland* 20705 (HC-2)

OBJECTIVE: Study the compatibility of fungicides and scald inhibitors applied together as postharvest treatments to prevent decay and scald of stored apples and pears grown in the East.

APPROACH: Heated and non-heated solutions and suspensions of fungicides (Benlate, TBZ, etc.) and scald inhibitors (ethoxyquin and diphenylamine) will be evaluated for their combined effectiveness. Fruit of different maturities, especially the injury-sensitive variety Golden Delicious, will be tested and the length and temperature of the dip treatments varied to find safe and effective preservative treatments. The possibility that heated chemical solutions at low concentrations may be as effective as higher concentrations at ambient temperature will be investigated.

PROGRESS: Eastern apples. Postharvest dips (3 min.) of heated (113 F.) suspensions (100 or 500 ppm) of benomyl or TBZ effectively controlled blue mold rot in inoculated Golden and Red Delicious apples during 2 months at 32 F. followed by 1 week at 70 F. Comparable tests with heated (113 F.) tap water did not control decay. Heated fungicides controlled decay in either punctured or bruised apples, whereas unheated fungicides controlled decay only in punctured apples. More fungicide was deposited on apples dipped in heated than in unheated fungicide suspension. Both fungicides at 1000 ppm were compatible with commercial scald inhibitors (2700 ppm ethoxyquin or 2000 ppm diphenylamine). Combination dips of fungicide and scald inhibition were not phytotoxic to Red Delicious or Stayman apples stored 5 months at 32 F. followed by 1 week at 70 F. Effectiveness of the fungicide-scald inhibitor combinations was not affected. Eastern pears. A 10-second dip in a 500 ppm suspension of either benomyl or TBZ greatly reduced blue mold rot in stored Bartlett, Magness, and Moonglow pears. Pears treated with either chemical developed less decay in punctured or bruised areas and in the stem-end than comparable pears dipped in tap water. The fungicides did not control Alternaria tenuis rot.

4. PESTICIDES

SUPPORTED BY U.S. Dept. of Agriculture

4.0340, MECHANISMS OF HERBICIDE ACTION

J.L. HILTON, U.S. Dept. of Agriculture, Crops Research Division, *Beltsville, Maryland* 20705 (0710-01-02)

OBJECTIVE: Discover modes of herbicide action in plants; characterize effects of herbicides on plant nucleic acids, protein and energy synthesis and elucidate effect of herbicides on specific biochemical processes and growth.

APPROACH: Correlate the effects of herbicides on metabolic processes with growth and physiological responses. Isolate, characterize, and determine functionality of specific plant nucleic acids and precursors affected by herbicides using radioisotopes and biochemical techniques. Use inhibition of carbon dioxide fixation to determine factors affecting speed of herbicide action and plant recovery. Use herbicide analogs to distinguish multiple modes of action. Evaluate herbicide-metabolite antagonisms on growth of organisms to detect new sites of herbicide action.

PROGRESS: Asymmetrical triazine herbicides inhibit photosynthesis. They are detoxified by plants. Inhibition of photosynthesis by pyridazinone herbicides is delayed by absorption or translocation barriers which do not affect speed of action of other photosynthesis inhibiting herbicides. A method for measuring ATP in vivo was developed. Chloropropham reduced ATP levels in Chlorella more effectively than it inhibited photosynthesis. Diuron inhibited photosynthesis more effectively than it affected ATP levels.

SUPPORTED BY U.S. Dept. of Agriculture

4.0341, FACTORS INFLUENCING PLANT RESPONSES TO HERBICIDES

L.L. JANSEN, U.S. Dept. of Agriculture, Crops Research Division, *Beltsville, Maryland* 20705 (0710-01-39)

OBJECTIVE: Discover and characterize chemical, physiological, and ecological factors which influence sorption, movement, and action of herbicides in plants; and develop safer and improved uses of herbicides for control of weeds in agronomic crops.

APPROACH: Investigate the effects of spray adjuvants, physiological status, and morphological-anatomical features of plants on the response of plants to herbicides.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

4.0342, EFFECT OF PCNB ON PALATABILITY AND COMPOSITION OF POTATOES

J.P. SWEENEY, U.S. Dept. of Agriculture, Human Nutrition Research Div., *Beltsville, Maryland* 20705 (HN3-31)

OBJECTIVE: Determine the effects of Pentachloronitrobenzene (PCNB), a soil fungicide, on palatability and composition of potatoes.

APPROACH: Samples of untreated controls and of potatoes grown in PCNB-treated soil will be evaluated at the start of storage and after storage at room temperature and at 55 F. Free phenols, tyrosine, ascorbic acid, starch, sugars, selected enzymes, specific gravity, and shear strength will be determined. Structure will be examined histologically. Panel evaluations of color, texture, and flavor will be made on baked and steamed potatoes.

PROGRESS: Pentachloronitrobenzene (PCNB), a soil fungicide, is effective against potato scab and black scurf. Potatoes grown in soil treated with PCNB at 50 pounds per acre were lower in free tyrosine content and showed less enzymic browning than did control potatoes. When the treatment was 25 pounds per acre, tyrosine and enzymic browning were also lowered. However, the decreases were not as great as those obtained when the treatment was 50 pounds. PCNB at 50 pounds per acre appeared to have some adverse effects on flavor and odor, but effects could be detected only by a judge very sensitive to them.

SUPPORTED BY U.S. Dept. of Agriculture

4.0343, CHEMICAL CONTROL OF ORCHARD INSECTS

W.E. BICKLEY, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-H-048)

OBJECTIVE: Test two types of spray equipment and one dust machine. Both machines are of the air blast type; the dust machine is designed to apply both charged and uncharged particles of dust.

APPROACH: Various spray and dust formulations will be tested with these machines. Records will be kept on the control of codling moth and other apple pests. Observations made on the phytotoxicity to both fruit and foliage.

PROGRESS: A twelve acre block of York Imperial and Rome Beauty apples in a 300-acre abandoned orchard was used to compare a full strength and a 3/4 strength program in each of four concentrates, namely 3X, 10X, 33X and 66X. Fruits examined at harvest from the full strength program ranged from 92% to 99% clean while those from the 3/4 strength program ranged from 95% to 98% clean. The unsprayed check had only 7.8% clean fruit. There was no significant difference in the control of pests between any of the concentrates or between the full and 3/4 strength programs used on these tests. This confirmed our finding during the past 7 years that the high concentrates were equally as effective in controlling orchard pests as the standard 3X concentrates now being used. It also showed that with high concentrate sprays the materials going into the tank can be reduced as much as 25%. A 2-acre block of Stayman Winesap apples was used to test the effectiveness of 13 new acaricides in summer applications. Eight materials were found to be as effective in controlling mites as the standard acaricides now being used. A re-examination was made of the armored scale insect genus Melanaspis in North America which resulted in the recognition of 2 new species and the resurrection of one synonym. Detailed life history observations were made on the gloomy scale (M. tenebricosa) and obscure scale (M. obscura).

SUPPORTED BY Maryland State Government

4.0344, HERBICIDE CHARACTERISTICS AND EFFICIENCY IN CORN AND SOYBEANS

G.W. BURT, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-B-094)

OBJECTIVE: Study the effects of formulations, carriers, and methods of application on efficiency; the effects of environment on release and action of granular herbicides; relate prior weed control practices to weed populations in succeeding crops of corn and soybeans; and the effectiveness of cultural herbicide combinations.

APPROACH: The effectiveness of promising corn and soybean herbicides such as atrazine, amiben, and D-326 will be compared with special attention to granular formulations made locally. The latter will be studied from the standpoint of synthesis of granules, release of herbicide, and movement away from the particle. Speed of volatilization will be measured by bioassay methods and by the use of radioactive materials. Replicated field plots will be compared with reference to cropping system, herbicide, and the combination of herbicide and cultural practice for weed control in corn and soybeans.

PROGRESS: Volatility of sprayed application of trifluralin was approximately 25% benefin, 12.5% at 50 C from a Lakeland sandy soil at field capacity under controlled laboratory conditions whereas nitralin volatility was negligible. Decreasing soil cation exchange capacity and increasing soil moisture from air dryness to field capacity increased volatility. However, increasing soil moisture above field capacity did not increase volatility. A granular formulation of trifluralin was effective in reducing vapor losses, but volatility of a granular formulation of benefin was similar to the spray application. Increased spectrum weed control was observed with many of the herbicide combinations investigated in corn. Butylate 3 lb/A and butylate plus atrazine 3lb/A 1 lb/A respectively were the only herbicides preplant incorporated to result in acceptable nutsedge control. This combination and other herbicides with CP 50144 were effective on fall panicum and lambsquarter. Butylate preplant incorporated

plus atrazine with oil postemergence was the only combination which was synergistic for nutsedge control. In soybeans, chloroxuron postemergence effectively controlled ragweed which escaped trifluralin, nitralin, and vernolate without reducing soybean yields.

SUPPORTED BY U.S. Dept. of Agriculture

4.0345, PHYSIOLOGICAL AND BIOCHEMICAL MECHANISMS OF SELECTIVITY OF HERBICIDES
G.W. BURT, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-B-098)

OBJECTIVE: Study factors affecting the selectivity of herbicides on agronomic crops. These factors include penetration and movement, metabolism and detoxification of herbicides in plants and soils. Investigate the use of herbicide combinations for broadening selectivity and reducing residues.

APPROACH: Factors affecting the selectivity of several new herbicides on agronomic crops will be studied using isotopically labelled herbicides and paper chromatography. The fates of the herbicides will be studied in both tolerant and susceptible plants. Herbicides which inhibit photosynthesis will be combined with ones which inhibit respiration.

PROGRESS: For uptake and distribution experiments using trifluralin-C (alpha,alpha,alpha trifluoro-2,6-dinitro-N, N-dipropyl- p-toluidine), treated seedlings were grown in liquid scintillation vials. This procedure eliminated the loss of that portion of the herbicide which remained on the glass walls of containers used prior to transferring to counting vials. To prevent the rapid loss of the herbicide from the open vial, a mixture of Florisil and Sephedex was added to the water-trifluralin solution at seeding time. Another technique for retaining trifluralin was the placement of 1/4 inch thick foam rubber disks at the bottom of the vials. In orde: to increase the recovery of the labelled herbicide, treated plant material was crushed in a separate scintillation vial and at the same time one gram of Florisil was incorporated. Counting solution added, and counted. A 30 to 40 percent increase in counts was obtained when vials were counted approximately 24 hours after adding Florisil. Trifluralin was also lost when using a flash evaporator to remove excess solvent from plant extracts. This was especially true when water was removed. During the evaporation process, the herbicide apparently vaporized and instead of being carried over in the distillate, it adhered to the surfaces of the condensing column and other glass parts. A foam rubber filter at or near the mouth of the flask containing the evaporating extract, greatly reduced losses.

SUPPORTED BY U.S. Dept. of Agriculture

4.0346, COMPOUNDS IN WEEDS RESPONSIBLE FOR DORMANCY AND THE REDUCTION OF CROP YIELDS
G.W. BURT, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-B-115)

OBJECTIVE: Determine the importance of salicylic acid and other compounds in the dormancy of nutsedge tubers. Also to determine the biological significance of toxic compounds excreted by and found in nutsedge, quackgrass and other weeds.

APPROACH: Nutsedge plants will be grown under different conditions of photoperiod, temperature, and gibberellic acid concentrations to induce various degrees of dormancy. Salicylic acid will be spectrophotometrically analyzed to determine if there is a correlation between salicylic acid and dormancy. Toxic excretions will be determined by growing nutsedge in nutrient solution by the split root technique. The growth of a test species will indicate the presence or absence of a toxic exudate. Incorporation of nut dge tissue in soil with subsequent growth of a crop will also be used to determine if nutsedge can reduce yields through the release of toxic compounds. Isolation of these toxins by chromatography will be attempted.

PROGRESS: Studies have been conducted to determine if Johnsongrass rhizomes exude toxic substances. All rhizomes used were collected from the field, selected for uniformity, surfaced sterilized for 2 min. with 5.25% sodium hypochlorite, rinsed with distilled water, cut into pieces containing 2 nodes, and placed in 7 in. plastic petri dishes. These rhizome pieces remained in petri dishes for 1, 3, and 7 days after which they were removed and 20 seeds of the test species were placed in the same petri dish. Percent germination, and shoot and root length were recorded to determine the biological activity of exudates from the rhizome pieces. In studies using 2 rhizome pieces per dish and at room temperature, the response of seedlings to Johnsongrass exudates was found to be very dependent on the species and the plant part being tested. Tomatoes, soybeans, and corn were not effected by Johnsongrass exudates, whereas, only the root growth of millet, cotton, barley, and wheat were reduced by the exudates. Experiments were conducted where the incubation period with rhizome pieces was at 5,24 and 30 C. Toxicity of the exudates was greatest at 5 C. Experiments were conducted using 10 instead of 2 rhizome pieces per petri dish.

SUPPORTED BY U.S. Dept. of Agriculture

4.0347, BIOLOGY AND CONTROL OF ORCHARD INSECTS AND MITES
E.R. KRESTENSEN, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-H-099)

OBJECTIVE: Evaluate new insecticides and acaricides for control of orchard insects and mites. Evaluate pesticide extenders. Test new types of concentrate spray equipment. Study life and seasonal histories of insect pests of deciduous fruits and their predators.

APPROACH: Insecticides and acaricides will be tested in low concentrates of 3X with a John Bean 200TR Speed Sprayer and a high concentrate of 33X with an Econ-o-mist. Extenders will be tested at the low concentrate using reduced pesticide rate programs and by lengthening the time between sprays. Summer applications of new acaricides will be tested as dilute sprays only. Percent insect damage at harvest and mite counts during the season will be used to determine effectiveness of control. Records on phytotoxicity and compatibility will be kept. Life history studies will be made in the field and in the laboratory if adequate facilities are available.

PROGRESS: Five new insecticides, Torak, GS-13005, Zolone, VCS-506, and Fundal, were tested for broad spectrum orchard insect control at a 33X concentrate. Zolone, Torak, and GS-13005 were used as the only insecticide from petalfall through 7th cover. Fundal and VCS-406 were used at half strength with lead arsenate from petalfall through 4th cover. Lead arsenate was then dropped and the test materials increased to full strength through 7th cover. All materials gave orchard insect control equal to that obtained with the standard Maryland lead arsenate-azinphosmethyl program applied at a 33X concentrate. Oil applied at a 33X concentrate in delayed dormant controlled San Jose scale, whereas oil at a 66X concentrate did not. No phytotoxicity to fruit or foliage was observed with these materials. Leaf analysis from plots receiving a pesticide extender, Pinolene, Nu-Film 17, throughout the season showed this material had extended the residual life of both Morestan and azinphosmethyl. Residue analysis data for fruit at harvest, however, were inconclusive. No significant difference in insect control was observed between those plots receiving the standard spray program with Pinolene added and those without the Pinolene.

SUPPORTED BY Maryland State Government

4.0348, PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES
R.E. MENZER, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-H-067)

OBJECTIVE: Investigate residues resulting from the use of pesticides and plant growth regulators applied to plants and animals, determine use with least residue and without undue residues in soil, water, and other parts of the environment. Develop and standardize sampling and analytical methods for the determination of pesticide residues.

APPROACH: Determine the rate and extent of absorption of insecticides by vegetable and forage crops, rate and extent of degradation of insecticides within the plants, period required for the degradation of insecticides, persistence of insecticide within the soil.

PROGRESS: Analyses of soil samples from two different sites to which disulfoton was applied are still being analyzed. The

two soils are of different types: sandy loam and loamy sand. The object of the experiment is to ascertain whether soil type has a marked effect on the rate of degradation in soil. Mocap, O-ethyl S,S- dipropylphosphorodithioate, was applied as a 10% granular formulation at the initial rate of 14.3 ppm to sterile soils in clay pots in which green beans were grown in plant growth chambers. The experiment was conducted in duplicate using both Mocap-ethyl- C and Mocap-propyl- C. The biological half-life of Mocap in the soil varied between 40 and 45 days. This probably represents a maximum half-life to be expected for Mocap in soil since the experiment was conducted in sterile soil under controlled environmental conditions in plant growth chambers. Analyses of commercially frozen samples of squash, carrots, blueberries, turnips, turnip greens, lima beens, green beans, peppers, cauliflower, kale, mustard greens, corn, peas, collards, and spinach revealed no insecticide residues that exceeded tolerances. Canned sweet potatoes were also residue-free. Insecticides found were dieldrin in squash and carbaryl in corn, collards, kale, and green beans.

SUPPORTED BY U.S. Dept. of Agriculture

4.0349, TRANSFORMATIONS OF INSECTICIDES BY PLANTS

R.E. MENZER, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-H-085)

OBJECTIVE: Identify the products of degradation of insecticides by plants and determine the quantitative significance of these products; determine the absorption and translocation of insecticides and their degradation products by plants; investigate the mechanism of decomposition of insecticides by plants.

APPROACH: Metabolic pathways of dimethoate in plants vary with the method of application. The metabolic pathways resulting from different methods of application (cut stem, foliar, soil, and plant macerate) will be studied using C -labeled dimethoate (-CH -side chain). Chromatographic methods and chemical degradation utilized to characterize metabolites. Study made of the persistence of the major metabolites. Enzyme systems that accomplished the metabomate results of this research are to more clearly recognize the mode of herbicidal action. This should be much easier if the selectivity of herbicide is studied in closely related plants.

PROGRESS: Treatment of pumpkin plants with 2-chloroethylphosphonic acid (CEPHA) induced a greater production of female flowers, shorter internodes and earlier fruit set while treatment with gibberellic acid (GA) induced a greater production of male flowers, longer internodes and later fruit set. Although CEPHA induced the production of a greater number of female flowers, the bulk of the flowers aborted and only a slight increase in the number of fruits per pumpkin plant occurred. The addition of equal concentrations of CEPHA and GA resulted in pumpkin plants with longer internodes and a greater number of female flowers than the untreated plants, although GA partially overcame the effect of CEPHA. The use of CEPHA to increase yield of pumpkins does not appear to be practical under Illinois conditions. In studies with cabbage cultivars differentially affected by nitrofen, it was found that a dark period prior to nitrofen application increased the susceptibility of the cultivar Rio Verde to nitrofen phytotoxicity. However, the addition of sucrose before or after nitrofen application to either the upper or lower leaf surface protected against injury.

SUPPORTED BY U.S. Dept. of Agriculture

4.0615, RESPONSE OF RATS TO DIETS CONTAINING MULTIPESTICIDE COMPONENTS

W.W. CARLTON, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01553)

OBJECTIVE: Investigations of the physiological response of rats to diets containing multipesticide components when selected trace minerals are fed at marginal, excessive or deficient levels.

APPROACH: Plan and conduct investigations to determine the physiological response of rats to diets containing multipesticide components using at least two of the trace minerals, copper, zinc and/or manganese, fed at excessive, marginal, and/or deficient levels.

PROGRESS: Studies are continuing on the response of rats to a multi-pesticide mixture of DDT, carbaryl, and parathion and diets containing deficient, marginal and excessive concentrations of copper or manganese. An encephalopathy with signs of neurologic disturbance was induced in off-spring of females fed the copper-deficient diet. In a low percentage of offspring of copper deficient groups heart pathology was observed including cardiac hypertrophy with microscopic lesions of mycardial necrosis and replacement fibrosis. The pesticide mixture did not appear to have an adverse effect on the response of rats to the various diets. Further studies will include the histopathologic examination of animals maintained on the experimental diets for 2 years.

SUPPORTED BY Indiana State Government

4.0616, PHYSIOLOGICAL RESPONSE OF FEMALE RATS AND OFFSPRING TO MULTI-INSECTICIDES AND MINERALS

W.W. CARLTON, Purdue University, School of Veterinary Medicine, *Lafayette, Indiana* 47907 (HN2-54(C))

OBJECTIVE: Determine if maternal diets containing multi-insecticides affect reproductive performance of female rats and growth and tissue structure of offspring when level of dietary minerals vary.

APPROACH: Feed female rats an adequate basal diet or modification with or without insecticides and with minerals such as Zn, Mn, or Cu at minimal or excessive levels. Insecticides to include members of DDT, organic phosphate, or dinitrophenol groups at permissible levels. Feed experimental diets from weaning throughout study or only during gestation and lactation. Determine weight gains, weight, number and skeletal development of young at birth and after several months on diet.

PROGRESS: Feeding studies of the first generation offspring fed the diets containing different levels of manganese with and without insecticides have continued for 68 weeks. Data have also been obtained for the first 12 weeks for rats fed diets containing different levels of copper with and without insecticides. Tissues obtained from first generation females fed the copper and manganese diets have been examined grossly and microscopically. Pesticide analysis of tissues from all groups are underway.

SUPPORTED BY U.S. Dept. of Agriculture

4.0617, TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS

B.J. LISKA, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01427)

OBJECTIVE: Develop methods for preventing and reducing pest damage or pesticide residues in agr. commodities during transportation, processing and/or storage. Develop procedures for the removal, reduction or de-toxification of pesticide residues and conversion products in agricultural commodities. Develop or improve methods for determining pesticide residues in agricultural coomodities in marketing channels. Evaluate costs to implement processing procedures for agricultural commodities to remove, reduce, or de-toxify pesticide residues and/or conversion products. Animal food products with a trace amount of DDT, dieldrin, lindane, heptachlor and endrin will be processed by normal processing procedures. The products will be analyzed for changes in residues during processing and storage. Changes in processing techniques will be made to attempt removal or de- toxification of residues present in the food products.

APPROACH: NOT-PROVIDED

PROGRESS: Research on the effects of heat processing on chlorinated insecticides in animal food products was concluded. The overall results indicated that heat processing does reduce the concentration of chlorinated insecticides especially in spray dried milk, sterilized milk and cooked chicken meat. With some insecticides, as DDT and lindane, virtually 100% of the insecticide was removed by heat processing. Cobalt(60) irradiation of aldrin, dieldrin and DDT in hexane solutions at the 6 megarad level indicated that some insecticide was destroyed and some converted to recoverable breakdown products. One change which occurred was a removal of at least one chlorine molecule during irradiation. There was a temperature effect on the breakdown of aldrin

by cobalt(60) irradiation. Samples irradiated at 30-35 C had more breakdown products than in samples irradiated at liquid nitrogen temperatures. Breakdown products formed from aldrin were effected by the substrate used to carry the aldrin. This effect was related to the number of free radicals formed from the substrate during irradiation. Aldrin dispersed in lard and corn oil was broken down by irradiation the same as when dispersed in hexane.

SUPPORTED BY U.S. Dept. of Agriculture

4.0618, ACCELERATED REMOVAL OF INSECTICIDE RESIDUES

W.J. STADLEMAN, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01423)

OBJECTIVE: Extend present insecticide residue decontamination methods developed with laying hens; develop additional decontamination methods with poultry; adapt methods to other species of farm animals.

APPROACH: Force-molted laying hens contaminated with chlorinated hydrocarbon pesticides will be subjected to factorially arranged dietary treatments. Graded levels of energy, protein, iodinated casein and selected drugs (liver detoxification stimulants) will be administered in the ration. The effect of treatments on the rates of depletion of body fat and egg pesticide residues will be determined. Depletion treatments effective with laying hens will be adapted to, and tested with lactating goats. Effective treatments that do not grossly impair weight gains and feed efficiency in laying hens will be tested on growing swine.

PROGRESS: The DDT residue retention by abdominal adipose tissue was found to be a representative indicator of the DDT residues retained in other tissue lipids. DDT residue retention capacity of abdominal adipose tissue, thigh muscle, and breast muscle tissues was directly related to the lipid content of the tissue. DDT per gram of tissue lipid was slightly higher for muscle tissue lipid than abdominal adipose tissue lipid. A significant (P
05) reduction in retntion of DDT and DDE residues in abdominal fat was observed when activated charcoal was fed to chicks exposed to 0.5 ppm DDT. Charcoal was more effective in reducing residue retention when DDT was added to the ration than when administered by capsule. Dietary charcoal was not effective in reducing residue retention at the 0.1 ppm DDT exposure level. Rate of residue depletion was not affected by feeding charcoal to contaminated chicks for 21 days. DDT did not appear to be associated with the lipoprotein of chylomicron fractions of serum. serum fractions separated.

SUPPORTED BY U.S. Dept. of Agriculture

4.0619, MULTICRITERIAL EVALUATION OF ENVIRONMENTAL PESTICIDES

W.B. BUCK, Iowa State University, School of Veterinary Medicine, *Ames, Iowa* 50010

The principle objective of this research is to develop techniques and criteria for the assessment of subtle effects of environmental neurotoxicants on the central nervous system.

One of the objectives of the proposed research is to determine the lowest exposure level of dieldrin in sheep that will produce the decrements in vigilance and discrimination learning behavior which has been observed in our laboratory. We also intend to investigate the effects of dieldrin on other types of operant behavior in sheep. In addition, we will investigate the neurophysiological mechanism(s) of action of dieldrin in a mammalian (sheep) nervous system, and determine, by means of computer techniques, the relationship between electroencephalographic and behavioral changes observed in sheep following dieldrin exposure.

A major objective of the project is to develop procedures and techniques for obtaining knowledge of the effects of certain key environmental pollutants, especially neurotoxicants, on the central nervous system of man and animals. It is felt that this will provide a more scientific basis for establishing residue tolerance levels.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0620, METABOLIC STUDIES OF INSECTICIDES

UNKNOWN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01351)

OBJECTIVE: Not Provided

APPROACH: Not Provided

PROGRESS: Purification and characterization of organophosphate- metabolizing enzymes are being studied in vitro in rat liver microsomes by means of several methods including sonication, centrifugation, column chromatography, and fractionation by ammonium sulfate and detergents. The first main effort was directed toward delineating the solubilization of enzymes from microsomal membranes. Secondly, attempts were made to study the properties of the enzymes. Thirdly, attempts are being made to resolve a microsomal suspension into two components, cytochrome P-450 and NADPH-cytochrome c reductase. These two components may be related to organophosphate metabolism.

SUPPORTED BY Iowa State Government - Des Moines

4.0621, MECHANISM OF ACTION OF HALOGENATED HYDROCARBON FUMIGANTS ON ANIMALS

A. BONDI, Volcani Inst. of Agric. Res., *Rehovoth, Israel* (SP70(A10-MQ-8(A)))

OBJECTIVE: Determine acute and chronic poisoning of animals of carbon tetrachloride and ethylene dichloride and compare with known results of ethylene dibromide.

APPROACH: Three phases to study: Amount of residue of grains of ethylene dibromide (EDB), ethylene dichloride (EDC) and carbon tetrachloride (CC1(4)) during airing following fumigation by gravity penetration, forced recirculation and vacuum fumigation on laboratory and semi-commercial scale chronic poisoning of rats, chicks, laying hens and sheep with EDC and CC1(4) in long term feeding trials and biochemical mechanism of the poisonous action including comparison of the detoxification mechanism in chicks and rats and causes of disturbances in egg laying produced by EDB. Two leads to be followed on the latter study are differences in egg yolk proteins and damage to ovarian follicular membrane.

PROGRESS: Fumigations with carbon tetrachloride (CTC) were conducted by gravity penetration and recirculation. Only by the second method were homogeneous residues obtained. Preliminary experiments with forced airing did not result in efficient desorption. Samples of fumigated wheat still contained up to 10 p.p.m. after a year of storage. Baked bread contained less than 0.5 p.p.m. Mash fumigated at different levels of CTC was fed to growing male and female rats and lambs to test effects on growth rate and sexual development. Although the amounts fed to rats were small (up to 1 percent of the LD(50)) and only a slight effect on growth rate was observed, the total fat and triglyceride content of the livers increased significantly in all animals, except those fed at 150 p.p.m. The sexual development of male rats seemed unaffected. Lambs were more susceptible to the CTC. Restricted feed intake, leading to cessation of growth, occurred when there was a level of 100 p.p.m. At a level of 35 p.p.m., growth was proportional to the intake. Only when 20 p.p.m. was present in the mash were food consumption and growth similar to those of the controls. Blood transaminase activity and liver fat levels were normal in all treated lambs, indicating no symptoms of CTC poisoning. In contrast to previous findings with bulls, mature ram spermiogenesis was not affected by ethylene dibromide. Further experiments with laying hens confirmed that diminished ovarian follicle growth is the result of ethylene dibromide action.

SUPPORTED BY U.S. Dept. of Agriculture

4.0622, INVESTIGATIONS OF WILDLIFE MORTALITY RELATED TO PESTICIDES

S.W. CAPEL, State Forest. Fish & Game Com., *Pratt, Kansas* 67124

Objective: To determine the role of pesticides as a causative factor in mortalities of wildlife in Kansas and to provide for coor-

dination and liaison with various Federal, State and County agencies regarding pesticide use problems.

Procedures: 1. Inspect areas of reported wildlife mortalities suspected of being caused by pesticides. 2. Determine probable extent of mortality through interviews with persons in area and through ground checks to verify presence and density of dead wildlife. 3. Estimate, if possible, number and species affected. 4. Determine recent and long term pesticide use on area through interviews with landowners and commercial pesticide applicators. 5. If cause of mortality cannot be logically attributed to a non-pesticide cause, specimens of dead and living animals in the area will be collected for analysis. 6. Pesticide residue analyses will be conducted using standardized analytical techniques. Analyses will be performed by private laboratories, Kansas State Board of Health, various State universities, the Bureau of Sport Fisheries and Wildlife, or other agencies as the particular situation warrants and as specific contractual agreements can be arranged. 7. Analyze the data and information obtained through procedures 1-6 and if possible; 1) indentify the pesticide causing the mortality, 2) determine the source or possible sources of the lethal pesticide and 3) make appropriate recommendations of similar occurrences. 8. Coordination and liaison: a) Represent Director on the Pesticide Advisory Board, State Marijuana Control Steering Committee and other similar groups as assigned, to provide guidance in regard to wildlife-pesticide problems, b) act as spokeman for the Commission in liaison with various Federal, State and County agencies concerned with pesticides and their proper use, and c) develop pesticide use recommendations for land managed by this agency.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0623, EFFECTS OF PESTICIDES ON MICROORGANISMS IMPORTANT TO THE DAIRY INDUSTRY

B.E. LANGLOIS, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00417)

OBJECTIVE: Compare the effect of organochlorine pesticides on the growth and metabolic activity of microorganisms in media with and without casein. Determine and characterize the mode of action of organochlorine pesticides in inhibiting growth and metabolic activity of microorganisms.

APPROACH: (a) Milk and broth media will be used to determine the effects of organochlorine pesticides on the growth and metabolic activity of microorganisms isolated from milk as well as those used in the manufacture of various food products. The microorganisms will be divided into groups based on their resistance or sensitivity to pesticide inhibition in order to determine if inhibition is at the species or genus level and if dependent on a particular pesticide. The metabolic activity affected as well as the fate of the pesticide during the growth period will be determined. (b) Sensitive microorganisms from (a) will be used to characterize the mode of action involved in the inhibition. Studies will be made to determine if inhibition is due to action of the pesticides on some structural organization of the cell or to reaction with participants in enzyme systems.

PROGRESS: Species of bacilli are capable of degradating DDT to at least seven metabolites. These bacteria are much more efficient in this degradation than are the coliform bacteriform. The coliform bacteria degradate DDT more effectively anaerobically than aerobically. The pathway involved in the degradation of DDT is presently under study. Heptachlor and heptachlor related pesticides inhibit the growth of Staphylococcus aureus. The greater the level of pesticide the more severe the inhibition. Increasing the number of bacteria added to the medium will reduce to a limited degree the amount of inhibition. The inhibition is completely removed when casein is added to the growth medium. Results appear to indicate that pesticides in milk are tied up by casein and thus unavailable for degradation by bacteria and also unable to inhibit the growth of bacteria.

SUPPORTED BY U.S. Dept. of Agriculture

4.0624, CARCINOGENESIS BIOASSAY OF PESTICIDES AND OTHER ENVIRONMENTAL AGENTS

H.P. BURCHFIELD, Gulf South Research Institute, *Baton Rouge, Louisiana* (NIH-70-2210)

Independently and not as an agent of the Government, the Contractor shall exert its best efforts to: Perform carcinogenesis bioassay feeding tests in mice, rats, or other rodents of pesticides and other environmental chemicals selected by the Project Officer. In performing the above, the Contractor will: 1. Procure chemicals, analyze for amount and types of impurities, determine stability and purify when indicated by the Project Officer. 2. Conduct subacute oral toxicity studies to determine maximum tolerated dose for use in the long-term study. 3. Perform lifetime feeding tests for carcinogenicity studies in groups of 50 mice and 50 rats of each sex at two dose levels. Appropriate positive and negative controls will be used as indicated by the Project Officer. 4. Maintain adequate check of the diet regarding stability of test compound. Observe and record weight gain and health of animals, and acceptance of food. 5. Sacrifice moribund animals and perform complete autopsy on all animals including histologic examination of all indicated target tissues as well as tumors at other sites. 6. Record data on forms provided by the National Cancer Institute. Results will be evaluated for significance.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0625, REMOVAL OF PESTICIDE RESIDUES IN DAIRY PRODUCTS

J.H. GHOLSON, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01206)

OBJECTIVE: Study food and feed products with respect to the location and persitence of pesticide residues in market products, effects of pesticide residues on quality characteristics, and the development of commercial marketing and processing techniques for the detection, removal and/or neutralization of pesticide residue effects.

APPROACH: Milks containing insecticides (e.g., DDT, lindane, methoxychlor and endrin) will be subjected to normal milk plant pocesses such as pasteurization, fat separatiion, condensing, cultured milk products and cheese manufacture. The milk will be analyzed before treatment, after treatment, and after various storage times for the residues.

PROGRESS: Previous work on vacuum concentration of milk containing insecticides resulted in a reduction of insecticide levels as follows: 16-86% for DDT, 23-65% for endrin and 36-100% for lindane. Subsequent work has been on similarly 'spiked' milk concentrated in a 36 inch Rogers vacuum pan at reduced pressures varying from 574 to 698 mm Hg. Various combinations of DDT, endrin and lindane were used in four trials. Reduction in the insecticide levels in the milk after concentration as compared to the unconcentrated were as follows: 2-23% for DDT, 15-32% for endrin and 41-50% for lindane. The remainder of the study on this project (SM-32), which is scheduled to be terminated June 1969, will include work on improved distillate traps to attempt to recover that portion of the insecticide which is removed by reduced pressure distillation. This will be necessary to determine whether the insecticides are truly going over into the distillate or disappearing in some other manner such as break-down products which are not recoverable in the procedure used.

SUPPORTED BY U.S. Dept. of Agriculture

4.0626, REMOVAL, IN MARKET CHANNELS, OF INSECTICIDE RESIDUES FROM MILK AND MILK PRODUCTS

J.H. GHOLSON, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01501)

OBJECTIVE: Develop procedures for removal of insecticides in milk. Determine location of insecticide in product with help of model systems. Examine certain microorganisms for possibility of biodegradation of insecticide.

APPROACH: Cream separation followed by washing and churning will be utilized to determine whether the insecticide is oriented to the surface or to the interior of the fat globule. Additional procedures involving severe agitation of milk, which moves fat globule surface material to the serum phase will be used to further ascertain insecticide location. Model systems will be developed to study various chemical and physical procedures for finding, removal or reduction of specific insecticides. Certain microorganisms will be grown in simple medias to determine relationship between the microorganism and the specific insecticides.

Standard FDA procedures for sample 'clean-up' and electron-capture analysis will be used on all samples.

PROGRESS: A preceding project La. 1206 was terminated June 1969. This project was initiated at that time. Work to date has shown significant reductions in levels of lindane in milk, when subjected to metabolic activity of B. cereus, E. coli and S. lactis of 45, 42, and 39%, respectively.

SUPPORTED BY U.S. Dept. of Agriculture

4.0627, TOXICANTS AND BAITS FOR CONTROLLING NUTRIA IN AGRICULTURAL AREAS

F. SCHITOSKEY, U.S. Dept. of the Interior, Nutria Research Station, *Houma, Louisiana* 70360

Objective: To continue evaluating and improving existing methods and materials for controlling nutria damage, and to develop and evaluate new methods and techniques that show potential for controlling nutria damage.

Procedures: Promising materials, including oral and contact poisons, gases or inhalants, and systemic poisons, will be tested on caged nutria. All materials which appear promising for nutria control will be bioassayed on other animals likely to be endangered. Field tests will include improved bait presentation for extensive area control, testing promising materials in the field, and testing and devising techniques for treating dens and vegetative home sites. Emphasis will be toward testing and developing new techniques for controlling nutria.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0628, TOXICOLOGICAL STUDIES WITH JAPANESE QUAIL

T.E. SHELLENBERGER, Gulf South Research Institute, *New Iberia, Louisiana* 70560

The objectives of this program are to compare toxicity responses of Japanese quail and other wildlife to various chlorinated hydrocarbon and organophosphate pesticides, determine interactions of multiple pesticide exposures in Japanese quail, and evaluate effects of pesticides on reproductive capacity of penned and laboratory housed quail. Results of these studies will provide important information (1) on the effects of pesticides to wildlife, (2) on the utility of Japanese quail as a laboratory tool to evaluate hazards of new chemicals, and (3) provide a basis for comparing laboratory and field toxicity studies on the effects of established chemicals ultimately to improve protocols for evaluating effects of new pesticides.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0629, EFFECT OF PESTICIDES ON ENZYME SYSTEMS

G.G. GUILBAULT, Louisiana State University, School of Science, *New Orleans, Louisiana* 70122

We are studying the effect of various classes of pesticides: insecticides (chlorinated, carbamate and organophosphorus), herbicides and fungicides on various enzymes of all types: esterases (cholinesterase, chymotrypsin, hyaluronidase, phosphatase, sulfatase, lipase, glucosidase, glucuronidase, etc.), oxidases, hydrogenases, anhydrases, kinases and transferases. In addition attention is being paid to other sources of cholinesterase: eel and insect (beetle, roach, etc.).

Attempts are being made to develop sensitive and specific analytical procedures for important insecticides, herbicides and fungicides using ultra sensitive fluorometric procedures.

The effect of pesticides on cholinesterases from insects (cockroaches, fire ants, housefly), from human serum, rat liver, electric eel, bean leaf beetle and white fringe beetle and from bacteria has been studied. The enzyme hexokinase was measured for its sensitivity to pesticides -- only 4 chlorinated pesticides (Aldrin, chlorodane, DDT and heptachlor) were found to affect this enzyme.

Two new enzymes were isolated -- rhodanase and injectase. These enzymes were found to be able to decontaminate water by removal of cyanide. New fluorometric methods were developed for the assay of these enzymes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0630, EFFECTS OF DDT

R.B. ANDERSON, State Dept. of In. Fish & Game, *Augusta, Maine* 04330

Objectives: To monitor the increase or decrease in the DDT,DDD,DDE, Dieldrin, and Endrin content of annual samples of salmon from Sebago Lake.

Procedure: A sample of 30 male age III plus salmon will be collected from the fall spawning migration in the Jordan River. The sample will be divided into two sub-samples, one sub-sample will be 15 poor condition fish and the other will be 15 good condition fish. Good and poor condition will be chosen by visual examination.

All salmon will be analyzed individually and the total insecticide content will be determined for each fish. Insecticide content will be determined on a wet weight basis. The fat content of each sample will be determined.

Insecticide analysis data will be compassed with data collected in previous years.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0631, THE EFFECTS OF DDT AND OTHER PESTICIDES ON SEBAGO LAKE SALMON

S.E. DEROCHE, State Dept. of In. Fish & Game, *Augusta, Maine* 04330

Objectives: To monitor the increase or decrease in the DDT, DDD, DDE, Dieldrin, Endrin, and BHC content of Sebago Lake salmon.

Procedures: Every other year, beginning in 1971, a sample of 30 male, age III plus salmon will be collected from the fall spawning migrations in the Jordan River. Ten salmon from this group will be analyzed individually to determine the variance that may exist within age group III plus salmon. A composite of all 30 salmon will be analyzed to determine the amount of pesticides in the total sample of age III plus salmon. Insecticide levels will be determined on wet weight basis. The fat content of each sample will be determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0632, ECOLOGY OF ANIMALS IN DDT-CONTAMINATED ENVIRONMENTS

J.B. DIMOND, Univ. of Maine, School of Forestry, *Orono, Maine* 04473

A large, forested area of northern Maine has been sprayed serially with DDT at 1 lb/acre for control of the spruce budworm; control projects were carried out in 1958, '60, '61, '63, '64 and 1967. While there was considerable overlap in the different projects, sizable areas remain that were treated only once but in the years indicated above. There are also large blocks which have received two or three treatments and surrounding, ecologically similar areas which have no recorded spray history. The resulting mosaic of forest areas with varying histories of DDT-treatment appears to present a unique opportunity to study persistence and movement of DDT in the forest ecosystem. Such studies have been in progress for three years at Maine university and have demonstrate extreme persistence, beyond ten years, of low levels of DDT in several types of animals following even a single application of the chemical. These highly persistent residues are apparently below lethal levels at least for the forms studied, but the possibility remains that some damage results to the animal populations involved. This proposed research would attempt to determine whether individals and populations of selected animals are affected in any detectable way by continued contamination with sublethal quantities of DDT. It is proposed that the problem be approached primarily by studying the population dynamics of the selected animals in natural environments contaminated with varying levels of this insecticide. Most of the existing work on chronic effects of sublethal residue levels of DDT has involved laboratory studies. While the results have been interesting, it has been very difficult to evaluate the significance of these effects in nature. Only field studies can provide the answer.

4. PESTICIDES

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0633, IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS
J.B. DIMOND, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00202)

OBJECTIVE: Continue studies of the ecological significance of long-lasting DDT residues to contaminated forest animals; monitor the effects on the forest ecosystem of fenitrothion applied for control of the spruce budworm.

APPROACH: As a result of DDT applications for spruce budworm control in several previous years, areas can be found with widely ranging levels of long-lasting DDT contamination in soils and several organisms. Population success of animal species in heavily contaminated areas will be compared to lightly contaminated areas. Special attention will be paid to reproductive effects. Fenitrothion has replaced DDT as the recommended chemical for spruce budworm control. Little is known of the environmental impact of this new chemical. Several phases will be studied including effect on aquatic insect populations, on parasites of the budworm, and the effectiveness of the chemical itself in controlling the target insect.

PROGRESS: Emphasis continued on the determinations of levels of DDT and metabolites remaining in various components of the forest ecosystem up to 10 years following 1 to 3 applications. Monitoring of soils, some plants and many animals is complete for the terrestrial environment. Residue determination in aquatic communities is nearly complete. Residues are seen to persist through 10 years, with some decline, in most animal species and in soils. There is abundant evidence of food chain magnification and of residue build up with successive applications of DDT. A series of 300 brook trout were taken from 50 streams having varying spray histories. The fish can be expected to cover a broad range of residue contamination. We will attempt to correllate differences in growth or anatomical parameters with residue level.

SUPPORTED BY U.S. Dept. of Agriculture

4.0634, TISSUE STRUCTURE AND GROWTH OF RATS FED LARD CONTAINING INSECTICIDES
M. ADAMS, U.S. Dept. of Agriculture, Human Nutrition Research Div., *Beltsville, Maryland* 20705 (HN2-49A)

OBJECTIVE: Determine the influence of feeding lard from hogs that had been fed diets containing DDT, malathion and methoxychlor.

APPROACH: Determine the insecticide present in the tissues of rats fed from weaning diets identical in all respects except for the lard from hogs fed diets containing different kinds and levels of insecticides. Analyses will be carried out on tissues from rats one year old. Analyses will be done on younger animals if the results with the older animals suggest the need. Evaluate results in cooperation with the staff of Columbia University under Cooperative Agreement - HN 2-49(CA).

PROGRESS: See Accession Number 0015580.

SUPPORTED BY U.S. Dept. of Agriculture

4.0635, PHYSIOLOGICAL RESPONSE TO DIETS WITH DIFFERENT FATS AND INSECTICIDES
M. ADAMS, U.S. Dept. of Agriculture, Human Nutrition Research Div., *Beltsville, Maryland* 20705 (HN2-43)

OBJECTIVE: Determine influence of diets containing different fats with low levels of insecticides on fatty acid and insecticide content of tissues of parents and of three successive generations.

APPROACH: From weaning, feed male and female rats diets containing soybean oil, cottonseed oil, lard or hydrogenated vegetable oil with or without chlorinated hydrocarbons. In addition feed diets containing heated cottonseed oil and lard. As insecticides, provide a mixture of chlorinated hydrocarbons (DDT, lindane or methoxychlor) at levels within acceptable limits. Determine fatty acid content of adipose tissues of animals from each diet group and for each generation. Analyze selected tissues for insecticide content.

PROGRESS: See Accession Number 0015576.

SUPPORTED BY U.S. Dept. of Agriculture

4.0636, EFFECTS OF DDT AND ANALOGUES ON REPRODUCTION IN DOMESTIC MAMMALS AND BIRDS
J. BITMAN, U.S. Dept. of Agriculture, Hormone Physiology Laboratory, *Beltsville, Maryland* 20705 (039801421321)

OBJECTIVE: Determine the effects of DDT on reproductive functions of domestic mammals and birds.

APPROACH: The estrogenic activity of o,p'-DDT and its influences upon reproduction will be determined when it is incorporated at low levels in the diet of rats, sheep and poultry. Reproductive tissues will be studied to determine pesticide residues and changes in biochemical composition. Reproductive parameters such as fertility, pregnancy, hatchability, and survival of young will be assessed. Egg production will also be studied in poultry.

PROGRESS: Japanese quail fed p,p'-DDT or o,p'-DDT in a 0.6% Ca diet produced smaller eggs with thinner shells than controls. With 1% Ca, DDT had no effect on egg shell quality. DDT delayed the first ovulation of birds on low (0.6%) or high (2.5%) Ca diets. Carbonic anhydrase activity of shell forming glands of birds fed DDT or DDE was 16 to 18% lower than of quail on a diet free of pesticides. Levels from 5 to 50 ppm o,p'-DDT p,p'-DDT and p,p'-DDE in the diet (2.5% Ca) of leghorn chickens for 7 months had no effect on body gain, egg production, eggshell thickness or calcium, fertility, hatchability or survival of progeny. Uteri from rats, voles, chicken or quail injected with o,p'-DDT showed increases in weight, water content, glycogen and RNA indicating that the o,p'-isomer is estrogenic in these species. 10,000 mug o,p'-DDT was equivalent to 1 mug estradiol. P,p-DDT produced little response. Sheep fed 10 ppm o,p'-DDT in their diet, during the mating season had normal uterine biochemistry, estrous cycles, reproduction and lactation. The condition of the lambs was unaffected. Compounds related to DDT were screened for estrogenic activity. Diphenylmethane, diphenylethane and triphenylmethane compounds were estrogenically active when a p- or p'-position was unoccupied or occupied by a hydroxyl or methoxy group. Halide or alkyl groups in the p,p' positions rendered the compounds inactive. In the rat, DDT, DDE and DDD, stimulated liver destruction of barbiturates so that the rats had a shortened pentobarbital sleeping time. In birds, the opposite effect occurred and DDT, DDE, DDD, methoxychlor and malathion prolonged sleeping time.

SUPPORTED BY U.S. Dept. of Agriculture

4.0637, TISSUE RESIDUE ACCUMULATION AND PHYSIOLOGICAL AND REPRODUCTIVE RESPONSE OF LINDANE-TREATED SWINE
R.J. DAVEY, U.S. Dept. of Agriculture, Animal Science Research Div., *Beltsville, Maryland* 20705 (033204070121)

OBJECTIVE: Determine the rate of accumulation of lindane residues in tissues of swine and the associated effects on blood constituents and reproductive performance.

APPROACH: Thirty-two males and 24 females will be assigned to a control and three treatment groups: lindane sprayed, 0.05% solution; lindane fed, 2 mg/kg body wt/day; and lindane fed, 20 mg/kg body wt/day. Treatment will begin at 3 months of age and samples (blood and backfat biopsy) will be taken at 6-week intervals. Six of the males will be sacrificed at 6 months of age and the remaining will be withdrawn from treatment. Females will be continued on treatment, bred at 10 months of age, and sacrificed after farrowing. Blood and backfat samples will continue to be taken from the remaining males and the females until slaughter. Tissue samples taken at slaughter and biopsy will be analyzed for lindane residues. Plasma amino acids and some other biochemical components of blood will be analyzed to determine the effect of treatment.

PROGRESS: A preliminary experiment was conducted in which 40 mg. of lindane/kg. of body weight per day was established as maximum daily intake. The actual experiment was initiated using a 0.05% lindane solution sprayed on the feed to provide dietary treatments of 0, 2, and 40 mg./kg. body weight

per day. The first half of the experiment has been completed. The majority of the experimental material collected has not yet been analyzed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0638, INSECTICIDE RESIDUES IN TISSUES AND MILK OF DAIRY COWS

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OBJECTIVE: Determine factors affecting insecticide absorption, retention and excretion by dairy cattle.

APPROACH: The conversions and losses of insecticides on forages will be studied to determine how they may be affected by environmental conditions and processing. Studies will be conducted on rats as well as cows to determine what drugs and nutritional or management regimes will reduce insecticide absorption and/or increase the rate of clearance from body fat. The relationship between changes in body energy and insecticide levels in milk and flesh will also be studied.

PROGRESS: Two experiments were conducted to determine the effectiveness of activated carbon in reducing body stores of pesticides from cows. In a 14-day experiment, 1 kg/day activated carbon had no effect on the milk concentrations of dieldrin, DDD or p,p'-DDT. In a 26-day experiment, 1 kg/day activated carbon had no effect on the milk concentrations or the body fat concentrations of dieldrin, DDD or p,p'- DDT. Three experiments were conducted to determine the effect of liver enzyme inducing drugs on the removal of pesticides from cows' body fat. In a 14-day experiment, 5 g/day of sodium pentobarbital had no effect on the milk concentrations of dieldrin, DDD or p,p'-DDT. In a second experiment, 5 g/day of sodium pentobarbital for 14 days and 24 g/day for an additional 14 days had no effect on the milk concentrations or the body fat concentrations of dieldrin, DDD or p,p'-DDT. In a 25-day experiment, sodium phenobarbital approximately doubled the rate of decline of milk concentration of dieldrin and increased the rate of decline of the milk DDE by about 20%. Diphenylhydantion had no effect on either of these pesticides. Experiments with rats indicate that 2.5 ppm o,p'-DDT in the diet exerted no detrimental effect on reproduction and it had no significant effect on the estrogen dependent physiological events which have been effected by o,p'-DDT at higher levels. The eggshell forming glands of Japanese quail fed p,p'-DDT or p,p'-DDE had carbonic anhydrase activity 16 and 19% lower than the shell glands of quail on a diet free of pesticides.

SUPPORTED BY U.S. Dept. of Agriculture

4.0639, LOSS OF BODY FAT AND RESPONSE TO INSECTICIDE RESIDUES

F.L. LAKSHMANAN, U.S. Dept. of Agriculture, Human Nutrition Research Div., *Beltsville, Maryland* 20705 (HN2-44)

OBJECTIVE: Determine whether low levels of chlorinated hydrocarbon insectides produce chemical or structural changes in obese and nonobese rats when maintaining or losing body weight.

APPROACH: Feed male and female rats diets that produce obesity or that do not. Include in the diets of half of the rats levels of chlorinated hydrocarbon insecticdes currently considered safe. Restrict food intake of some rats to induce weight loss. Estimate body composition at intervals. At scheduled periods, kill and note gross abnormalities. Measure serum proteins, cholesterol and fat, liver fat, body composition, and DNA of adipose tissue. Measure oxygen uptake of brain and liver slices as well as response of sciatic nerve.

PROGRESS: In order to determine more specifically the proteins most responsive to diet during growth and development, serum from animals fed the diets without insecticides was subjected to high resolution Disc electrophoresis. Of the twelve protein components normally present in rat serum pre-albumin, transferrin and beta-1 lipoprotein content were affected by diet and/or age. Pre-albumin, a fraction previously shown to be associated with lipid, was affected by level of dietary fat. Content of transferrin, the iron transporting protein of serum, varied with kind of fat in the diet. Regardless of diet beta-1 lipoprotein as well as total lipid content of serum increased with age. Significant variation was observed among these apparently healthy animals. This contributed in part at least to the difficulty in establishing diet differences with a small group of rats examined at 100-day intervals. Feeding the diets with and without insecticides, and K-40 measurements in the live rats have been completed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0640, EFFECT OF MALATHION AND SEVIN ON REPRODUCTIVE PERFORMANCE OF THE HEN

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OBJECTIVE: Determine the effect of long-term feeding of pesticides singly and in combination, on reproductive performance of laying hens and performance of their progeny.

APPROACH: Laying hens will be fed malathion and Sevin singly and in combination at different levels. Egg production, egg weight, fertility and hatchability data will be collected. Unhatched eggs will be examined for embryo malformation. Data on progeny performance to four weeks of age will be collected. Initially, levels of 250 and 500 ppm of malathion alone, of sevin alone, and malathion and sevin in combination will be used in addition to controls. Each of the seven groups will consist of 30 SCWL pullets kept in individual cages and fed a standard breeder diet. Observations will be made on egg production, feed consumption, body weight maintenance, egg weights, fertility, hatchability and subsequent progeny performance. Unhatched eggs will be examined for embryo malformation. If no gross differences or abnormalities are observed in the embryos or progeny as a result of feeding the pesticides to the dams, the levels of pesticides will be determined in the eggs and chicken tissues.

PROGRESS: Malathion and Sevin were fed at levels of 250 and 500 ppm, singly and in combination, to laying hens for 32 weeks. The 500 ppm level of Sevin and the 500 ppm level of the combination of pesticides resulted in a decrease in body weight. There was a slight depression in egg production on the 500 ppm level of the pesticides singly and in combination. There was no effect on egg weight, egg shell thickness, fertility or hatchability. The incidence of malformed embryos was essentially negative, three were found in 2800 incubated eggs. The pesticides had no effect on progeny performance. In studies with DDT op'DDT, pp'DDT and pp'DDE fed singly to laying hens at levels of 5, 25 or 50 ppm for 28 weeks had no adverse effect on body weights, feed efficiency, egg production, fertility, hatchability or progeny performance. When the levels of these compounds were increased for 8 weeks to 150 and 300 ppm in the two groups that had received 5 and 25 ppm, with the 50 ppm group remaining the same, there was no effect on fertility and hatchability.

SUPPORTED BY U.S. Dept. of Agriculture

4.0641, EFFECT OF INSECTICIDES IN FEED ON GROWTH, BODY STORES, AND REPRODUCTION OF SHEEP

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OBJECTIVE: Determine the effects of certain insecticides on growth and reproduction of sheep and to determine the presence of residues of the insecticide in the milk, muscle, fat and certain body organs.

APPROACH: Groups of 12 ewes and 3 rams will be fed in drylot over a 2 year period the following pelleted alfalfa diets: Zero level of insecticides, 2x the tolerance level for a chlorinated hydrocarbon and an organic phosphate, and 10x the tolerance levels for the 2 types of insecticides. Observations will be made on the reproductive performance including lamb production, semen quality and mating behavior. Growth and development of lambs will be measured. Lambs will be slaughtered at 5 months of age or at wt of 45 kg. Tissues of lambs and older animals plus milk of ewes will be checked for residues. Plan of work to be altered as indicated by results.

PROGRESS: Sixty ewes were divided into 5 groups in November 1968. Group I received insecticide free hay; II hay plus 2 X tolerance limit of parathion; III hay plus 10 X parathion; IV hay plus 2 X gluthion and V hay plus 10 X gluthion. Number of parturitions and lambs born during 2 reproductive seasons were 20 and 29; 17 and 24; 18 and 25; 13 and 17; and 19 and 26,

respectively, for the 5 groups. Number of ewes lost between November 1968 and July 1970 were 1, 2, 2, 4 and 2, respectively. Increase in wool clip per ewe between the 1969 and 1970 seasons (matched ewes) was 0.6; 0.4; 0.3; 0.1 and 0.1 kg., respectively, while changes in body weight were 7.6; 7.1; 7.9; 14.7; and 5.6 kg. It appears that the insecticides fed had at least a slight depressing effect on livability and production.

SUPPORTED BY U.S. Dept. of Agriculture

4.0642, PERFORMANCE OF SWINE FED PESTICIDES AND RESIDUES IN BODY TISSUE

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OBJECTIVE: Determine effects of prolonged ingestion of pesticides on growing-fattening swine and breeding females and measure residue accumulation and diet appearance in body fluids and tissues.

APPROACH: Phase I. Nine groups of barrows and gilts, averaging 81-5 pounds are fed either a control diet, one of three levels of heptachlor, one level of DDT or malathion, heptachlor epoxide in either hay or milk or heptachlor and sprayed with malathion. Blood and backfat samples were obtained at regular intervals for residue analyses. Two metabolism trials were conducted. Four swine per treatment were sacrificed after 98 days for tissue analyses. Two barrows in each lot switched to the control diet had backfat samples taken to determine rate of residue depletion. Phase II. Six gilts in each group except the choice fed lot, were continued on their prescribed diets through three reproductive cycles. Pesticides were not added to the lactation diet. Performance data, milk samples, and tissue from newborn and weanling pigs were collected. Body tissues were collected from two sows in each lot sacrificed after weaning their third litter.

PROGRESS: Blood samples were analyzed for heptachlor epoxide, p,p'-DDT, and malathion. Samples were taken at 2-week intervals from pigs fed these pesticides. Maximum residue in blood of swine fed an alfalfa hay diet containing a total of 28 ppm of heptachlor was about 0.01 ppm heptachlor epoxide. In blood from pigs fed an alfalfa hay diet containing 34 ppm DDT, there was up to 0.56 p,p'-DDT. In blood from pigs fed an alfalfa hay diet containing 150 ppm malathion, no malathion or malaoxon was detected. Final results on tissue residues from these pigs are being assembled and will be submitted in the next report.

SUPPORTED BY U.S. Dept. of Agriculture

4.0643, PESTICIDE RESIDUAL ACCUMULATION AND ELIMINATION BY SWINE

D.P. MORGAN, U.S. Dept. of Agriculture, Animal Science Research Div., *Beltsville, Maryland* 20705 (033201870121)

OBJECTIVE: Determine rate of accumulation and elimination of pesticide residues by swine fed or sprayed with coumaphos, malathion, DDT, or lindane.

APPROACH: Five barrows per replication will be allotted as follows: one control fed pesticide for 14 weeks, one fed pesticide forst 7 weeks, one sprayed biweekly for 14 weeks, and one sprayed biweekly first 7 weeks. Your replications per pesticide. Metabolism trials conducted with three replications during 8th and 14 weeks. Backfat samples collected during 9th 11th and 13th weeks for residue analyses. Animals sacrificed after 14 weeks and body tissues collected for residue analyses. Pesticides used for first year are coumaphos and lindane, second year, malathion and DDT.

PROGRESS: A study of residue levels resulting from spraying or feeding lindane to boars of the high-fat and control lines of the Duroc and Yorkshire breeds contained the following treatments: control, sprayed twice with a 0.5% lindane solution, fed 1 mg of lindane per kg of bodyweight per day, fed 2 mg of lindane. There were only small traces of lindane found in urine (1 ppm) and the fecal levels did not exceed 0.61 ppm. Urinary and fecal lindane levels did not appear to be associated with treatment. Liver residues exceeded 0.1 ppm in only one pig, and although average treatment levels increased with dosage, they were all less than 0.1 ppm. Kidney lindane levels averaged 0.01 ppm in controls, 0.10 ppm in sprayed pigs and 0.33 and 0.66 ppm in those fed 1 and 2 mg, respectively. There was a marked accumulation of lindane residues in backfat and loin lean tissue. Levels in backfat and loin lean, respectively, were 0.19 and 0.05 ppm for controls, 5.15 and 0.57 ppm for sprayed pigs, 19.50 and 2.37 ppm for those fed 1 mg, and 44.25 and 6.55 ppm for those fed 2 mg. Lindane residues in excess of established tolerance levels (4 ppm) can accumulate in edible tissue both by feeding and spraying the compound. However, in this study the sprayed level was about 10 times that recommended in practice.

SUPPORTED BY U.S. Dept. of Agriculture

4.0644, EFFECT OF RUELENE (REG. TRADEMARK) ON EMBRYONIC DEVELOPMENT

T.D. RUMSEY, U.S. Dept. of Agriculture, Animal Science Research Div., *Beltsville, Maryland* 20705 (033005621321)

OBJECTIVE: Determine the amount of 4-tert-butyl-2-chlorophenyl methyl methylphosphoramidate (Ruelene(Reg. trademark)) which reaches the fetus and the teratogenic effects of this systemic pesticide.

APPROACH: The study will involve three phases of experimentation: Following dermal application of Ruelene(Reg. Trademark) to beef cows, blood samples will be analyzed for Ruelene(Reg. Trademark) to estimate the amount of pesticide absorbed into the blood stream; pregnant cows, at 35 days gestation, will be injected with Ruelene(Reg. Trademark) and blood residue patterns will be established both in the cow and the fetus; and pregnant cows, at 35 days gestation, will be injected with Ruelene or saline via the jugular vein or directly into the amnionic sac and 100-day fetuses will be examined for abnormalities.

PROGRESS: No abnormally developed fetuses (150 days gestation) have been obtained from cows after intravenous and intrauterine injections of Ruelene(Reg) at 35 days gestation. Preliminary summarization indicates that the crown to rump length and weight of the 150-day fetuses were not affected by Ruelene(Reg). Two intrauterine injected cows, one given saline and one given Ruelene(Reg) lost their fetus after the injection at 35 days gestation which indicated the critical nature of the experimental treatment. The synthesis of C - labeled Ruelene(Reg) has been completed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0645, METABOLISM OF PESTICIDES BY BEEF CATTLE

T.S. RUMSEY, U.S. Dept. of Agriculture, Animal Science Research Div., *Beltsville, Maryland* 20705 (033001627012 1)

OBJECTIVE: Study site of absorption, distribution of tissue residue, pathways of excretion and chemistry of pesticides in beef cattle for the ultimate protection of the animal and the consumer.

APPROACH: Techniques used to investigate the metabolism of pesticides by beef cattle will include cannulation of the portal and ruminal veins to estimate rate of blood flow and pesticide absorption; quantitative collections of feces, urine and respiratory gases; location and concentrations of residues in fat, muscle, blood and milk; and measurements of the general physiological status of animals being exposed to pesticides now in use or about to be used.

PROGRESS: The distribution of total DDT residues in beef cattle at concentrations below 5.0 ppm was found to be similar to the distribution at concentrations of 200 to 300 ppm. Kelthane was accumulated less in the fat depots. Urea and energy level did not affect the distribution of DDT and kelthane residues in cattle. Dieldrin accumulated to comparable levels in the caudal and ruffle fat depots of heifers fed aldrin. Cattle infused with KCl and citric acid showed depressed saliva flow, increased heart and respiratory rates and marked changes in EKG patterns. Cattle adapted to a rapid infusion and diet affected post- ingestion changes. Twenty-two pesticides were tested for their toxicity to rumen bacteria in the presence and absence of rumen fluid in the growth media. The toxicity by the pesticide was reduced among those which caused bacterial growth inhibition as the concentration of rumen fluid in the media increased from 0 to 1 to 10 to 30%. Isopropyl N (3 chlorophenyl) carbamate isopropyl N 3 chlorophenyl carbamate, Stam F34 and A minotriazole at 500 ppm were toxic to the three strains of bacteria tested. None of the nitrogen containing pesticides allowed growth of the bacteria

tested if the other nitrogen substrates were deleted from the media. Nor did any of the 22 pesticides serve as a carbon source for growth of the bacteria tested.

SUPPORTED BY U.S. Dept. of Agriculture

4.0646, EXPANDING REPORT ON EFFECTS OF PESTICIDES
UNKNOWN, Litton Industries Incorporated, *Bethesda, Maryland* 20014 (NIH-71-2258)

Independently and not as an agent of the Government, the Contractor will prepare and furnish a revised final report on 'Carcinogenic, Teratogenic and Toxic Effects of Pesticides.' The revised report will be presented in a form which includes additional histology data, additional information about the chemical structures of agents screened, a revised format for the grouping of tested compounds in the tables, and additional information in support of the teratology portion of the report.

The revised report will consist of the following five volumes: Volume I - Revised original data on screening. Volume II - Additional backup histology data. Volume III - Revised original data on teratology and additional backup information. Volume IV - Original data on microbial genetics. Volume V - Additional data on chemical structures and use.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0647, CONSULTING IN APPLIED MATHEMATICS AND STATISTICS
J.J. GART, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

To provide consulting assistance and collaboration to NCI scientists on the applications of mathematical statistics and applied mathematics to the planning, interpretation, and analysis of scientific experiments. Assumes an essential role in much research within the NCI, activities include not only statistical analysis but also planning valid experiments. Members of the section will be collaborating on projects in cell transformation by chemical carcinogens, the immunology of Burkitt's lymphoma and the screening of pesticides for possible carcinogenesis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0648, ABSORPTION AND EXCRETION OF HEPTACHLOR EPOXIDE BY DAIRY CATTLE
R.F. DAVIS, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (033102870121)

OBJECTIVE: Study management and feeding practices in relation to absorption of heptachlor epoxide and its excretion in milk.

APPROACH: Cows will be fed alfalfa hay contaminated with heptachlor residue. During the feeding, additions of mineral oil, commercial animal fats, commercial vegetable fats, calcium lactate, calcium propionate and bentonite will be made to determine their effect on absorption of the residues as determined by biopsy fat samples. The excretion of the insecticide in milk as affected by feeding iodinated casein, different levels of energy intake and partial starvation will be determined. The effect of feeding contaminated hay to heifers on the subsequent excretion of insecticide into milk will be determined.

PROGRESS: The Research Contract under which this work was conducted has been completed. It was concluded that milk excretion is the major pathway for eliminating the body stores of heptachlor epoxide from dairy cows. Dietary treatments such as feeding iodinated casein and various levels and patterns of energy altered the heptachlor epoxide excretion pattern only insofar as milk excretion pattern was altered. Rate of absorption of the insecticide from feed was not appreciably altered by feeding vegetable fat, animal fat, calcium propionate, calcium lactate, mineral oil or bentonite. A high correlation between heptachlor levels in milk and body fat was established and placental transfer of the material was observed. Thus, an animal may contain measurable heptachlor epoxide although no direct consumption has occurred. The information gained is of value to regulatory officials and will be helpful in avoiding future residue problems.

SUPPORTED BY U.S. Dept. of Agriculture

4.0649, METABOLISM OF PESTICIDES IN CATTLE
R.L. KING, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-G-055)

OBJECTIVE: Determine the chemical and physical mechanisms involved in the movement of chlorinated hydrocarbons in dairy animals. Identify substances which will inhibit the absorption of residue chemicals and accelerate their rate of excretion from body tissue.

APPROACH: Separate and identify various lipid components from body tissue, blood, feces, urine, and milk with respect to their association with chlorinated hydrocarbons. Suitable radioactive tracers may be employed in these studies. Evaluate poorly absorbed feed additives that may exhibit specific association with pesticide chemicals. Evaluate certain hormone and drug-type chemicals for their ability to influence the excretion of pesticide chemicals.

PROGRESS: The absorption of tocopheryl acetate from the dairy ration by the lactating dairy cow is relatively inefficient as compared to chlorinated hydrocarbon insecticides. When tocopherol was incorporated with various emulsifying agents its direct addition to milk was markedly influenced as measured by its distribution in milk. A study was conducted to determine if similar pre-emulsification of tocopheryl acetate would enhance its absorption from the digestive system of the lactating cow. Several emulsifying agents acceptable as food additives were evaluated in a model system. Tween-20 was selected and used as the vehicle for daily supplementation of four Holstein cows in a changeover type design which included semi-balance studies. The results when inconclusive due to large individual differences, but suggested that emulsification with Tween-20 did not influence excretion of Vitamin E into feces nor the transfer of Vitamin E to milk. Since the latter is so inefficient, additional studies are probably warranted.

SUPPORTED BY U.S. Dept. of Agriculture

4.0650, OXIDATIVE DEALKYLATION OF INSECTICIDES
R.E. MENZER, Univ. of Maryland, School of Agriculture, *College Park, Maryland* 20742

Characterization of the unknown metabolites of C-2307/(CH3O)sub2 P(O)OC (CH3) equals CHC(O)N(CH3)OCH3/ will be accomplished and the complete oxidative route of metabolism will be formulated. Once this is done, we will pursue the question of why the insertion of an oxygen atom between the nitrogen and the carbon in the amide moiety causes such a marked increase in the toxicity of the compound to both mammals and insects over that of dicrotophos. This may lead to a further study of the effect of methylene dioxyphenyl synergists on the metabolism of substituted amide organophosphorus insecticides of this type. It is also planned that the studies relating the metabolism of these compounds to their potentiation or antagonism by liver enzyme inducing agents will be continued. A comparison will be made of the effect of the inducing agents and the increased metabolism of the compounds on the blood A- and B-esterases. With these data it should be possible to draw conclusions about the mechanisms for these effects. We will also utilize the primary human embryonic lung cell cultures to investigate the metabolism of the organophosphates.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0651, NUTRITIVE CONTENT OF TYPE A SCHOOL LUNCHES
E.W. MURPHY, U.S. Dept. of Agriculture, Consumer & Food Ec. Res. Div., *Hyattsville, Maryland* 20 '82 (CFE2-14)

OBJECTIVE: Analyze Type A school lunches for selected nutrients and energy value and determine differences in composition related to geographic region and other factors.

APPROACH: With help of Consumer and Marketing Service and State School Lunch Agencies, collect four 6th grade lunches a day for five days at 300 schools representing five geographic re-

gions. Package, freeze and ship to laboratory. Analyze the 300 20-lunch composites for proximate composition, selected minerals, vitamins, fatty acids snd pesticide residues. Calculate average levels of nutrients, energy values, and pesticide residue content for the U.S. and each geographic region. Provide nutritional evaluation of current standards for type A lunch to Consumer and Marketing Service Managers of School Lunch Program. Publish report of study.

PROGRESS: The average Type A lunch contained 31.8 g. fat, which provided 39% of calories and 28.6 g. fatty acids. Fatty acids included 14.6 saturated, 10.2 g. mono-unsaturated, and 3.8 g. polyunsaturated fatty acids. P/S ratio averaged 0.27. Five fatty acids, myristic (C 14), palmitic (C 16), stearic (C 18), oleic (C 18:1), and linoleic (C 18:2), accounted for about 90% of total fatty acids. Linoleic acid about 10% of total fatty acids and 4% of calories. No lunch samples had less than 1% of calories from linoleic acid, but about 1/3 of schools had lunches with less than 3%. Linoleic acid was related to total fat content, to calories, and to % calories from fat, but not to fat-soluble vitamins A or D. Total sterols including but not exclusively cholesterol averaged 112 mg. per lunch with range of 16 to 331 mg. Lunches exceeded 160 mg. sterols for only 6% of schools. Evaluation of data for mineral element content of lunches is currently being made.

SUPPORTED BY U.S. Dept. of Agriculture

4.0652, STUDIES IN CHEMICAL METHODOLOGY FOR DETERMINATION OF PESTICIDE RESIDUES

R.M. PROUTY, U.S. Dept. of the Interior, Bureau of Sport Fish. & Wlfe., *Laurel, Maryland* 20810

Objective: To compare pesticide recovery from tissues by different methods.

Procedures: Preservation methods to be compared include: freezing at 0 degree F., - 70 degrees F., storage at room temperature in formalin, 70 percent ethanol, 95 percent ethanol, dry Na2SO4, or as extracted lipids. Duration of storage will be nine months. Pesticides include DDT, dieldrin, and a DDT metabolite, 4,4'-dichlorobenzophenone. Mallard ducks will be fed a diet containing these compounds to provide tissues for this study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0653, THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS

C.F. COLE, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01002

Saltmarshes and their meandering estuarine streams too often have been considered a biological wasteland and public apathy has allowed these areas to become targets of developers of waterfront properties and uncontrolled use of pesticides. The estuarine environment is breeding ground for commercial and sport fishes and little data are available concerning the influence of pesticides upon their general life history. A program was recently established to obtain detailed data on the interaction of pesticides in the estuarine area of the Weweantic River on the northwestern shore of Buzzards Bay. The pesticide investigation will study the possibility of acute toxic conditions occurring from single instances of pesticide application. As the occurrence of parathion in the estuary is ephemeral at most, and, as parathion is one of the major insecticides now used on cranberry bogs, this study is of major significance. The objectives of this project are to study the larval blackback flounder mortality under controlled laboratory conditions; to study a comparative larval mortality in three widely separated geographical areas; to conduct bioassay studies which will delimit tolerance levels, especially for blackback larval flounder; and to conduct a more critical study of the occurrence of area specificity, as evidenced in previous chromatographic patterns.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0654, PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES

C.F. COLE, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01002

Effects of chronic, low-level pesticide exposures on eggs and larvae of the winter flounder (Pseudopleuronectes americanus, Walbaum) are being evaluated. A previous segment of this project examined chlorinated hydrocarbon residue levels in winter flounder from the Weweantic River estuary, a small tidal tributary of Buzzards Bay, Massachusetts. The effects of these residue levels on the reproductive success of the flounder using this estuary as spawning and nursery grounds is of particular concern. Field investigations have demonstrated that certain insecticides (DDT and dieldrin) commonly used in the watershed by cranberry culturing and mosquito control programs are present in the flounder; heptachlor is also present but its source is unknown. Increasing concentrations of these insecticides were noted in flounder ovaries during the months prior to spawning. Laboratory investigations are presently underway to determine what concentration ranges of the insecticides residues in gonadal tissues generate measurably adverse effects during reproduction. The survival of eggs, larvae, and juveniles spawned from dosed adults is being followed and the reproductive success is then to be evaluated in light of concentrations from gonads of similarly treated adults. Gas-liquid chromatography is the major analytical tool. The flounder dosing and rearing experiments are being undertaken at the Bureau of Sport Fish and Wildlife Laboraory, Narragansett, Rhode Island.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0655, EXPERIMENTAL OPTIC NEUROPATHIES

S. LESSELL, Boston University, School of Medicine, *Boston, Massachusetts* 02215

Having completed pilot studies of the effect of chronic cyanide intoxication upon the anterior visual apparatus of the albino rat, I will proceed to further define the characteristics of the neuropathy. This work will be largely histochemical and will seek to identify the earliest histochemical alterations in cyanide intoxication. Following chronic cyanide administration (by intraperitoneal route), the animals will be serially sacrificed and fresh cryostat sections incubated for the demonstration of succinic and lactic dehydroginase alkaline and acid phosphatase, ATPase and cytochrome oxidase. The corpus callosum will also be studied. An attempt will be made to modify the effects of cyanide intoxication by the concurrent administration of high doses of hydroxycobalomin, a compound which is known to have an enormous affinity for cyanide. It has been suggested that in human optic nerve disorders, thought to be consequent to chronic cyanide intoxication, hydroxycobalomin might be of therapeutic benefit.

In addition to the above studies, pilot experiments into the effect

$ of chronic lead intoxication on the visual apparatus will be initiated. Lead will be administered in drinking water and the peripheral and central nervous system will be examined in collaboration with the Department of Neurology.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0656, FACTORS AFFECTING PESTICIDE TOXICITY

S.D. MURPHY, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

The long term goal of the proposed research is to contribute to the understanding of relationships between metabolism and toxicity of pesticides. Major emphasis will be placed on studies of species comparisons of metabolic and toxic interactions of organophosphorus insecticides with other chemicals and drugs. Species to be studied include members of 4 classes of vertebrates; mammals, birds, fish and amphibians. Chemicals which inhibit tissue hydrolases or which induce or inhibit microsomal enzymes that are involved in the metabolism of phosphorothioates will be studied to obtain time and dose response relationships for both effects on metabolism and effects on toxic interactions in intact animals. A search for a possible physiologic significance for the potent carboxylesterase inhibiting properties of some phosphate insecticides will be made. Newer insecticides which have relatively low acute toxicity will be studied to determine their potential to produce subtle effects that are unrelated to the well known anticholinesterase action of orgnophosphates. It is felt that this research will contribute to the understanding and predictability of

adverse effects of pesticides in man and other desirable species. An indirect, but important objective will be to provide a stimulating research program as a base from which graduate students can develop thesis research projects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0657, BIOCHEMICAL AND PHYSIOLOGIC RESPONSE TO TOXIC STRESS
S.D. MURPHY, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

The broad objectives of this project are to increase understanding of how various industrial chemicals and environmental contaminants affect neural, endocrine, and enzymatic regulatory mechanism. Research has been concerned with the effects of acute exposures to toxic irritant chemicals, organophosphate and organochlorine insecticides, and hepatotoxic chlorinated hydrocarbons on regulatory mechanisms of the pituitary-adrenocortical axis in rats. Relationships between endocrine changes induced by these chemicals and the activities of glucocorticoid- inducible and other liver enzymes have been studied. Interactions of the effects of toxic chemicals with physical stresses and with natural circadian variations which affect adrenocortical function have been studied. Recent research has concerned development methods of evaluating chronic peripheral neuropathy in intact animals that can be used as a clinical correlate to biochemical and histologic changes caused by the neurotoxic chemical acrylamide. Investigation of the similarities and differences of the biochemical effects of carbon tetrachloride and chlorinated ethylenes are in progress. Emphasis will be placed on studies of the mechanisms by which drugs or environmental stress alter the response to these hepatoxic chemicals. These studies provide basic information which may be useful in predicting the capacity of man and other animals to adapt to various stressful stimuli and in anticipating hazardous combinations of toxic chemicals, drugs, and stresses.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0658, OCCUPATIONAL AND ENVIRONMENTAL HEALTH
J.L. WITTENBERGER, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

This research and research training program includes a variety of approaches to the study of the effects of environmental factors on the health of man. Specific examples include the following: metabolism of pesticides in a variety of animal species, toxic effects of combinations of chemical and physical stresses, experimental pulmonary carcinogenesis in response to combinations of particles and known carcinogens; development of methods for testing of mutagens in mammals; physiology and biochemistry of alveolar macrophages and pulmonary clearance. Epidemiologic studies include study of etiologic factors in chronic nonspecific or specific respiratory diseases (occupational, residential and personal smoking exposure), occupational factors in bladder cancer incidence, and evaluation of the risk of childhood cancer from prenatal exposure to radiation.

Other studies involve the development of improved methods for measuring respiratory exposure to atmospheric contaminants and use of systems analysis approaches to managment of environmental problems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0659, SUBLIMINAL PHARMACOLOGY AND CARCINOGENESIS
L. FRIEDMAN, Mass. Inst. of Technology, School of Science, *Cambridge, Massachusetts* 02139

The activities of this research program are concerned with the basic problems of acquiring knowledge of the effects of chemicals on living organisms, particularly the subtle long range effects that may accompany chronic exposure of men and animals. The ultimate aim is the development of procedures which will facilitate evaluation of potential hazard, particularly the hazards of chemical carcinogenesis presented by the entry additives and contaminants into food, and of pollutants into air and water. A major approach is based on the assumption that observed pathological changes result from interference with normal functions of either the metabolic machinery, the various cellular membranes, or the regulatory mechanism that control cell and tissue metabolism and differentiation. Attempts are being made to adapt and refine biochemical and physiological methods to measure changes in function that will be predictive of cell and tissue damage. Compounds with known biological activity are being studied to establish correlation with new approaches being developed. Specific projects include studies of the metabolic machinery of the cell; studies of a model membrane system; studies of adrenal cortical function; transplantation studies after initiation of carcinogenesis; studies of composition of tumor vs. normal tissues; studies of properties of cell surfaces in normal tissues and tumors; nucleic acid metabolism during carcinogenesis; comparative in vitro cytotoxicity of animal and human cells.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0660, NEW APPROACHES TO INSECT CONTROL IN MILITARY INSTALLATIONS WITHOUT THE USE OF PESTICIDES
L.M. ROTH, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Technical Objective: Control militarily important insect pests by methods which avoid use of toxic substances to which insects develop resistance, which are hazardous to man or animals, or which cause pollution.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0661, RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES
R. REINERT, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Ann Arbor, Michigan* 48107

A program to follow the buildup of insecticides in lake trout and coho salmon that have recently been introduced into Lakes Michigan and Superior. The eggs and fry will be studied before the fishes are introduced into the lakes and then as these populations develop they will be sampled periodically. When the fishes reach maturity their eggs and progeny will be examined for insecticide levels.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

4.0662, FIELD STUDIES OF PESTICIDE EFFECTS ON FISHES
M.E. BENDER, Univ. of Michigan, School of Public Health, *Ann Arbor, Michigan* 48104

The objective of this project is to establish acceptable exposure levels of methoxychlor for fish and other aquatic organisms. This objective will be reached by determining the effect of long-term exposure to sub-lethal levels of methoxychlor by laboratory bioassays and in natural stream conditions. Effect on fish growth will be established in the laboratory with bioassays on two species of fish. Effects on fecundity, survival and production of fish populations and production of benthic organisms will be established from studies in controlled stream environments.

Field studies will be conducted at the Michigan Department of Natural Resources, research station in Saline, Michigan.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0663, FUR ANIMAL NUTRITION STUDIES
R.J. AULERICH, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00117)

OBJECTIVE: Devise rations that will use maximum amounts of dry ingredients; determine value of antioxidants; ascertain calcium and phosphorus requirements with respect to fat levels.

APPROACH: Research is underway to develop dry diets for mink. This will bring in many feed ingredients not presently used in the typical ranch ration. New chemicals are being applied to mink husbandry -- antibiotics and stilbestrol are being studied to determine their value or limitations in mink feeding. It is hoped

that basic nutrient requirements can be studied. Presently vitamin K requirements are being evaluated.

PROGRESS: Experimental diets containing presscake (P.C.) made from either alewife, sucker, smelt, bullhead or carp were fed to mink and results compared with control rations containing either raw, cooked or P.C. ocean perch. Growth on the P.C. diets was comparable with that obtained on the control rations. Reproduction was superior on the raw ocean perch diet. None of the females fed alewife P.C. whelped. Field reports during 1968 indicated that mortality of mink kits whelped by females fed diets containing coho salmon was extremely high. To study this problem, mink and rat feeding trials involving coho salmon have been initiated. The effects of feeding DDT, TDE, DDE and dieldrin on mink growth, livability, fur quality and reproduction were studied. Organ histopathology, tissue pesticide residues, lethal dosage and mink milk pesticide residue contamination are also being investigated. Levels up to 100 ppm of DDT, TDE and DDE had no detrimental effects on mink growth, livability or fur quality to that obtained on the control ration. Male mink were subjected to various artificial lighting regimes to study the effect on spermatogenesis. The mink were castrated at frequent intervals. Testes and epididymides weights, as well as histological sections were compared with similar tissues from control animals that received natural light. The artificial lighting regimes had little, if any, effect on spermatogenesis.

SUPPORTED BY U.S. Dept. of Agriculture

4.0664, FUR ANIMAL STUDIES (MINK)

R.J. AULERICH, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL01039)

OBJECTIVE: Develop techniques for semen collection and artificial insemination of mink. Evaluate new sources of low-cost feed ingredients for mink. Study the effects of feed contaminants on mink.

APPROACH: Study the basic characteristics of mink semen and devise methods of obtaining semen and artificially inseminating mink. Compare performance of mink fed 5 freshwater fish diets with that of rations containing marine fish. Conduct mink feeding trials involving pesticides. Determine the lethal dose of pesticides for mink and analyze tissues for pesticide residues and pathologic lesions. Conduct lab tests and mink and rat feeding trials to determine the factor(s) responsible for reproductive failure in mink attributed to the feeding of coho salmon.

PROGRESS: A technique for electro-ejaculation of male mink has been developed and the basic characteristics of mink semen described. The mean semen volume per ejaculate was .021 ml. Methods of artificial insemination for mink are being studied in an attempt to perfect a practical approach to AI in this species. Studies on mink fed freshwater fish presscake (alewife, sucker, smelt, bullhead and carp) have shown that these species generally did not perform as well as raw marine fish (ocean perch and whiting) in the diet of mink during the critical periods of growth and reproduction. Chubs, perch and coho salmon from the Great Lakes are presently being evaluated for mink feeding and an attempt is being made to elucidate the reason(s) for the inferior reproductive performance in mink fed the freshwater fish. Feeding trials involving laboratory rats and mice, Japanese quail and ferrets are also being employed in the investigation. The effects of diets containing various levels of chlorinated hydrocarbon pesticides (DDT, DDE, TDE and dieldrin) on growth, reproduction and survival in mink are being investigated. Lethal dosages for these pesticides for mink have been determined and the symptoms and pathologic lesions associated with pesticide poisoning studied. Selected tissues (brain, fat and liver) and milk from mink fed known quantities of these pesticides are being analyzed. Methods of reducing pesticide residue accumulation in mink fed diets containing 'high' levels of pesticides are also being investigated.

SUPPORTED BY U.S. Dept. of Agriculture

4.0665, EFFECTS OF PHYSIOLOGICAL ENVIRONMENT ON CELLULAR HOMEOSTASIS, PROTEIN METABOLISM AND NUTRITION

W.G. BERGEN, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL03064)

OBJECTIVE: Effects of level of dietary protein or amino acid intake, fasting or glucose supplementation on protein synthesis capacity and structural integrity of protein synthesis machinery. Effect of important commercial pesticides on nucleic acid metabolism, protein synthesis, and mitochondrial energetics.

APPROACH: Dietary protein or amino acid level, energy infusions, experimental protein/calorie imbalance, chronic treatment with important pesticides. Parameters: Protein synthesis capacity, body amino acid pools, mitochondrial energetics, nucleic acid metabolism, structural integrity of polysomes.

PROGRESS: The effect of the pesticide dieldrin on liver mitochondrial metabolism and liver and muscle protein synthesis has been studied. Dieldrin inhibits electron transport in mitochondria but does not cause uncoupling of oxidative phosphorylation. Currently we are locating the site of electron transport blockage by dieldrin in the mitochondrial electron transport system. Dieldrin was injected every other day at a low and high dose level to rats for 2 months. Administration of the low dose level of dieldrin depressed liver and muscle amino acid incorporation while the high dose level did not modify liver or muscle protein synthesis.

SUPPORTED BY Michigan State Government

4.0666, THE ACCUMULATION AND EXCRETION OF DIELDRIN IN DAIRY HEIFERS AND COWS

L.D. BROWN, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (033106870123)

OBJECTIVE: Determine the extent of dieldrin residue carryover from heifers to first lactation and; evaluate the effects of feeding practices on the persistence of dieldrin residues in tissues and milk of dairy cows.

APPROACH: Pregnant dairy heifers will be fed dieldrin at various intervals pre-partum. The level of residue in tissues will be determined pre-and post-partum. The extent of placental transfer of dieldrin to new born calves will be related to the period of dieldrin feeding. Various feeding practices will be studied to determine their effect on dieldrin excretion in the milk of these heifers after parturition.

PROGRESS: A major, previously unreported finding was that significantly greater dieldrin storage occurred in body fat when pregnant dairy heifers were contaminated earlier in gestation. Heifers contaminated at 180 and 120 days prepartum stored three and two times as much dieldrin, respectively, as did animals contaminated starting 60 days prepartum. Once nonlactating dairy heifers were contaminated with HEOD, very little was eliminated from the body until lactation began. Placental transfer of HEOD did occur into calves. A combination of blood HEOD concentration in the dams and length of time the developing fetus is in contact with blood containing HEOD influences the amount of pesticide transferred to the fetus. No difference in fetal levels were noted regardless of stage of gestation during which the dams were contaminated. With levels of contamination used in these experiments female calves contaminated in utero with HEOD will probably not contain sufficient levels of HEOD at parturition to produce detectable levels in their milk. Milk was the primary excretory pathway of HEOD in dairy cattle. Feedstuffs contaminated with chlorinated hydrocarbon pesticides should not be fed to growing dairy heifers as previously recommended in several states.

SUPPORTED BY U.S. Dept. of Agriculture

4.0667, EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS

J.W. BUTCHER, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00720)

OBJECTIVE: Assess the effect of insectide applications on selected species of microarthropods which are important in the process of organic decomposition. Examine the effect of insecticides on selected species of microarthropods under laboratory conditions in regard to their biology, development, and ecological displacement. Investigate the effect of insecticides on the interaction between phytophagons insect species and the plants parasite of jack pine, Melampyrum lineare.

APPROACH: Monitor Collembola, Acari, and Opiliones species within dieldrin treated and untreated woodlots in Monroe

County. Determine changes in abundance and species complex in relation to residue persistance. A series of test plots have been established on South campus study the effects of dieldrin and DDT on the abundance and changes in the species complex of Collembola. Acari, and other soil arthropods. These plots are on cultivated land and will be planted to corn yearly. Collembola and Acari are being cultured under laboratory conditions. Individual species are being used to determine their role in the process of organic decomposition. The consequence of insecticide application on this process is being studied. Studies are underway to determine the effect of feeding of various phytophagous insect species on Melampryum lineare. Field plots have been set up and differences in feeding due to insecticide application are being compiled.

PROGRESS: Field work began in the Summer of 1969, on a project monitoring the degradation and movement of DDT in soil and litter forest microarthropod food chains. The DDT was introduced directly into the food chain by feeding it to a species of collembola which could be reared in large numbers in the laboratory, and then releasing the collembola in enclosed plots in a forest situation. Samples were then taken of the litter and soil at various intervals during the next 30 days to obtain microarthropods for taxonomic identification and analysis of DDT and its metabolites. A concurrent study of soil and litter macroarthropods is also taking place, and field experiments will continue during the Summer of 1970.

SUPPORTED BY Michigan State Government

4.0668, METABOLISM OF PESTICIDES BY RUMEN MICROBIOTA AND FACTORS INFLUENCING ABSORPTION

R.M. COOK, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL03001)

OBJECTIVE: Determine role of rumen and G.I. tract microbiota on metabolism of pesticides; identify any bacteria that degrade pesticides; note if pesticides alter normal rumen metabolic pathways; study site and nature of absorption process of pesticides and factors influencing absorption.

APPROACH: In vitro fermantation using rumen fluid, washed cells or pure cultures will be used to study microbial metabolism of pesticides. Attempts to find bacteria that degrade pesticides will be made. Many known enzyme systems of rumen microbiota will be used to determine if pesticides alter these normal processes. Absorption area in G.I. tract will be determined and attempts to reduce absorption by diet additives, i.e. mineral oil or other antagonists will be quantitated.

PROGRESS: Activated carbon has been shown to bind pesticides in the gut of cattle and increase their excretion in the feces. A field trial was conducted in Michigan to determine the effects of long term activated carbon feeding to lactating Holstein cows on health, milk production and reproduction. The carbon was fed to 12 cows for 1 year at the rate of 1 lb of carbon per head per day. The carbon did not affect health, production or reproduction. Activated carbon was fed to goats along with dieldrin to determine the effectiveness of carbon in binding dieldrin metabolities. The carbon binds the metabolites. Consequently, feeding is more effective in clearing dieldrin than previously thought because part of the dieldrin is changed to metabolites that are adsorbed by carbon. Studies are being conducted to determine whether or not there is selective binding of DDT metabolites by activated carbon.

SUPPORTED BY Michigan State Government

4.0669, FACTORS AFFECTING PLACENTAL TRANSFER, METABOLISM AND EXCRETION OF PESTICIDES IN ANIMALS

R.M. COOK, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00794)

OBJECTIVE: Determine whether body stores of dieldrin in rats can serve as a source for placental transfer. Ascertain effects of various organic compounds on placental transfer of dieldrin. Evaluate the degree of placental transfer of dieldrin when fed either before or during gestation. Explore the possibilties of placental transfer to second generation offspring via turnover of body stores in females contaminated in utero. Investigate specific fraction(s) of lipids responsible for distribution of residues in body fat.

APPROACH: Mature female Spartan rats will be fed dieldrin- containing feed with and without heptabarbital before breeding and during gestation. Fat biopsy samples will be taken at regular intervals and separated into neutral and phospholipids to determine residue distribution in each lipid class. Dieldrin residues will be determined quantitatively in new born pups and correlated with dieldrin intake and body storage in the mothers. Females from contaminated litters will be raised and bred at maturity to investigate placental transfer to the second generation.

PROGRESS: The anticonvulsant drug dilantin has been shown to decrease the storage of DDT in human and rats. Studies were conducted to determine whether or not dilantin will increase the rate of dieldrin clearance from rats. The preliminary data with rats indicate that dilantin will increase dieldrin excretion in rats. Trials are being conducted to determine whether or not dilantin will increase the rate of dieldrin excretion in ruminants.

SUPPORTED BY Michigan State Government

4.0670, PESTICIDE METABOLISM IN BEEF CATTLE

R.M. COOK, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL03039)

OBJECTIVE: Establish conditions under which tissue residues occur in beef cattle; effect of pesticide on feedlot performance; identify metabolites of various pesticides.

APPROACH: Tissue analysis of steers after a prescribed feeding period and dosage; study effect of low level feeding of lindane on feedlot performance; identification of metabolites resulting from the feeding of either lindane or ruelene. Study enzyme system involved in the metabolism of these pesticides.

PROGRESS: Work is in progress to try to develop an assay for the enzyme system in liver microsomes that metabolizes heterocyclic-type pesticides such as dieldrin and also lindane. It is important to isolate and study the control of the enzyme system. This will provide a basis for finding ways to increase the activity of the enzyme. The water-soluble vitamin inositol will cure fatty liver disease in poultry. The vitamin is metabolized to glucuronic acid. These and other aspects of the metabolism of inositol suggest that this vitamin could be effective in increasing the rate of pesticide excretion in ruminants. Preliminary inositol-feeding trials using rats indicate that the vitamin will increase pesticide clearance. These studies are being extended to include goats, sheep and steers.

SUPPORTED BY Michigan State Government

4.0671, FACTORS AFFECTING INSECTICIDE RESIDUES IN MILK

R.M. COOK, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00955)

OBJECTIVE: Determine sources of contamination under high residue conditions; determine the carry over of contamination from young dairy animals to lactating animals; determine the rate of residue disappearance, removal of objectionable residues.

APPROACH: Survey of problem herds to pinpoint contaminated animals; review feed sources, water supplies, pest control programs; determine source of exposure; determine rates of dissipation from the animal under normal and imposed experimental conditions; study growth, gestation and lactation on residue disappearance and evaluate methods of removing contamination.

PROGRESS: HEOD (dieldrin) was fed to 8 lactating Holstein cows at the level of 0.11 mg/kg body weight daily for 6 weeks. One half of the cows were simultaneously fed phenobarbital at the level of 10 mg/kg body weight daily. The objectives of the experiment are to correlate blood levels of HEOD with levels in body fat, to estimate the amount of HEOD excreted and the amount retained in the body, to determine the number and amount of HEOD metabolites stored and excreted and to study the effect of phenobarbital on these parameters. If blood levels of HEOD are correlated with body fat levels, then it may be possible to estimate the total body load of a pesticide by measuring the

level in the blood. A high level of HEOD was fed in order to obtain enough HEOD metabolites to measure readily. Blood, urine, feces, milk and body fat have been analyzed for HEOD and the data is presently being summarized. Analysis of the samples for HEOD metabolites has not been completed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0672, ANALYSIS OF BIO-ACTIVE CHEMICALS FOR POSSIBLE HAZARDOUS PROPERTIES
R.A. HOOPINGARNER, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL03025)

OBJECTIVE: The objectives of this project is to examine insecticides and other pesticides for possible hazard to human health.

APPROACH: The methods used are to examine cells and tissues for cytological and genetic damage. Cell cultures, organ cultures and intact tissues are used depending upon the chemical to be tested. Chromosome damage and other cytological aberrations are used as indication of potential hazard.

PROGRESS: The project examined 40 persons per month for leucocyte chromosome abnormalities. The 20 exposed persons were persons highly exposed from spray operations. The exposed group had more aberrations in the month of July then the control. All other periods were not significantly different. This difference compared favorably with the previous year when July was the most significant month/a period following and during the highest pesticide use.

SUPPORTED BY Michigan State Government

4.0673, BIONOMICS AND CONTROL OF INSECT PESTS AFFECTING SMALL FRUITS
A.J. HOWITT, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00954)

OBJECTIVE: Reduce the cost and hazard of controlling pests through: Insecticides of low mammalian toxicity; Reducing number of sprays reducing the hazard of drifting; Investigate use of attractants, repellents, and resistant varieties.

APPROACH: Bionomics and chemical control with materials of low mammalian toxicity conducted. Includes the grape berry moth, raspberry root borer, raspberry cane borer and and blueberry maggot.

PROGRESS: Work was initiated on a ULV and LV ground sprayer for blueberries and grapes. Three compounds of low mammalian toxicity Imidan, Lannate, and Malathion gave outstanding control of blueberry maggot when applied to blueberries with a low volume ground sprayer. Low volume applications of Guthion and Imidan gave excellent control of grape berry moth when applied with the low volume applicator.

SUPPORTED BY U.S. Dept. of Agriculture

4.0674, MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON
N.C. LEELING, Michigan State University, School of Agriculture, *East Lansing, Michigan* 48823

The proposed research plan involves laboratory investigations aimed at determining the amount of polychlorinated biphenyl (PCB) and terphenyl compounds present in Coho salmon from Lake Michigan and the chemical identity of each major component. The main approach will entail organic solvent extraction of salmon samples, column chromatographic separation of chlorinated components into a DDT-complex fraction and a PCB fraction and a gas chromatographic-mass spectrometric characterization of the individual components.

The data will provide an accurate determination of PCB residue levels and their composition in Coho salmon, thus permitting a rational interpretation of the significance of these compounds with respect to the fish.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0675, PATHOLOGIC EFFECTS OF BIOLOGICALLY ACTIVE CHEMICALS USED IN THE ENVIRONMENT - THE TOXICITY OF NITRATES
S.D. SLEIGHT, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00964)

OBJECTIVE: Determine the pathologic effects chemicals used in environment. Characterize lesions produced by experimentally administering nitrates and related compounds to animals. Obtain information on the toxic levles of these compounds and/or factors that retard or enhance toxicity. Determine, methods of prevention and control. Improve methods of diagnosis.

APPROACH: Administer nitrogenous compounds to groups of animals. Animals will be necropsied and selected tissues will be processed by histological procedures, biochemical and histochemical determinations will be conducted.

PROGRESS: Studies of dieldrin toxicosis in swine and guinea pigs have shown that the compound can cross the placental barrier in both species. In swine, repeated doses of relatively high levels of dieldrin failed to cause abortions or fetal deaths. Similar doses in guinea pigs resulted in abortions. Concentrations of dieldrin were determined in maternal and fetal tissues of both species with emphasis on brain levels. Simultaneous administration of nitrite apparently did not increase or decrease dieldrin toxicosis. Mild degenerative changes were present in the liver, kidney and adrenals of guinea pigs poisoned with dieldrin. Electron microscopy is being used to evaluate changes in the brain and liver due to acute dieldrin toxicosis. These studies are in progress. Initial studies have shown no evidence of toxicosis in guinea pigs, voles, or sheep fed plants containing high levels of nitrates. This work is being done in cooperation with the Dr. Ries of the Horticulture Department as part of the Pesticide Project and is continuing.

SUPPORTED BY U.S. Dept. of Agriculture

4.0676, THE UPTAKE OF INSECTICIDES BY FRESHWATER MUSSELS AND THE EFFECTS OF SUBLETHAL CONCENTRATIONS OF INSECTICIDES ON THESE MUSSELS
M.E. ZABIK, Michigan State University, Graduate School, *East Lansing, Michigan* 48823

The study will involve the exposure of freshwater mussels to sublethal concentrations of various insecticides. The principal objectives will be: 1) to correlate the amount of insecticide concentrated by the mussel with the concentration in the water; 2) to determine the principal source of insecticide concentrated by the mussel, i.e. from the water directly or from that absorbed by or adsorbed on their food; 3) to determine the main locations in the mussel where insecticides and any metabolites formed are stored; 4) to determine the effect of the insecticides on the filtering rate of the mussels.

From the results obtained it is hoped that the usefulness of the freshwater mussel as a biological monitor of insecticides can be further evaluated.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0677, POTENTIALS FOR REMOVING OR REDUCING PESTICIDE RESIDUES IN FOODS
M.E. ZABIK, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL01043)

OBJECTIVE: Determine the potentials for destroying or lessening pesticide residues in foods prepared by various methods of processing and/or cooking.

APPROACH: Raw and cooked foods will be analyzed after physical separation into appropriate components. Processing and/or cooking procedures will follow standard practices. When feasible, foods will be subjected to chemical and physical measurements and/or sensory evaluations to assess quality.

PROGRESS: For the initial phase of this study, pork loin cuts from animals fed known quantities of Dieldrin were compared with like cuts from an animal fed no Dieldrin. Samples were

cooked by roasting, braising, microwave energy and broiling. Dieldrin residue levels were determined by electron capture gas chromatography following extraction on raw and cooked meat samples as well as braising media and/or drip. The data showed samples cooked by the four methods contained lower Dieldrin residue levels than raw samples. Drip from all cooking methods contained Dieldrin. From the limited data, roasting and broiling appear to be more effective in reducing pesticide levels than braising or microwave energy; however, more research is needed before definite conclusions can be made.

SUPPORTED BY U.S. Dept. of Agriculture

4.0678, THE EFFECTS OF METHOXYCHLOR ON PERCH AND FATHEAD MINNOWS

J.W. MERNA, State Res. & Dev. Division, *Lansing, Michigan* 48926

Objectives: To establish acceptable exposure levels of methoxychlor for fish and other aquatic organisms. This objective will involve long-term exposure to sublethal levels, and their effects on fish growth, on fecundity, survival and production.

Effects on benthic organisms and algae will also be studied by University of Michigan graduate students, but not as part of this research job.

Procedures: Laboratory bioassays of mean tolerance limits of methoxychlor for yellow perch and fathead minnows are being done in aquarium tests at the Saline station. (The tests were started during fiscal 1969-1970, will be completed shortly after July 1, 1970.) The results of these short-term (96-hour) bioassays will be used to select, later, the low-level concentrations which will be dosed to perch and fathead minnows held in experimental streams for 2 years or more.

A raceway is being constructed at the Saline station for the present study, with funds from a FWQA grant. A stream channel will be divided lengthwise (by a concrete wall), and each twin channel will be divided into three segments. The result is a series of 6 experimental stream sections (each 15 feet x 120 feet). Yellow perch and fathead minnows will be established in each of the six stream sections. Two sections will be exposed to a low-level dose of methoxychlor; two, to a higher level; and (as stated above) two receive no dosage. Studied in relation to methoxychlor dosage will be: fecundity, production of young, growth, and fish population level. Brood stock of perch and fatheads will be stocked in September to produce a population of carrying capacity (est.100 lb. per acre) the following spring. Each stream section will get 50 adult perch (6-7 inches) and 300 fatheads; about half will be removed, before spawning, for special studies

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0679, EFFECTS OF METHOXYCHLOR ON FISH

J.W. MERNA, State Res. & Dev. Division, *Lansing, Michigan* 48926

Project and Job Objectives: To establish acceptable exposure levels of methoxychlor for fish and other aquatic organisms.

Procedures: Acceptable exposure levels will be determined by measuring the effects of long-term exposure to sub-lethal levels of methoxychlor by laboratory bioassays and in natural stream conditions. Effects on fish growth will be established in the laboratory with bioassays on two species of fish. Effects on fecundity, survival and production of fish populations, and production of benthic organisms, will be established from studies in controlled stream environments. The laboratory bioassays should be completed by June 30, 1970. However construction of the stream facilities will require most of this year (1960) and the experimental work may not begin until the following fiscal year.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0680, EFFECTS OF DISSOLVED OXYGEN, TEMPERATURE AND POTENTIAL TOXICANTS UPON MACROINVERTEBRATES (NON-ARTHROPODS)

M.J. IMLAY, U.S. Dept of the Interior, Federal Water Quality Admin., *Duluth, Minnesota* 55804

Effects of dissolved oxygen, temperature and toxicants (such as $CuSO_4$) on commercially valuable fresh-water clams and on fish food chain macroinvertebrates such as snails, leeches, scuds, insects, and flatworms will be studied.

Relation of cellular changes and daily activity patterns to toxicant or environmental stress and relation of mass filter-feeders (clams and sponges) to bacterial water quality will also be investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0681, A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES

L.K. CUTKOMP, Univ. of Minnesota, School of Agriculture, *Saint Paul, Minnesota* 55101

The objective is to determine whether the sensitivity of the ATPase enzyme system in fish can be used to measure toxicity or adverse effects of chlorinated hydrocarbon insecticides in pesticide-polluted waters.

ATPase enzymes have been shown to be sensitive to DDT and related chemicals, with some metabolites, such as DDA, having virtually no effect.

Other chlorinated hydrocarbons, the cyclodienes, also affect the enzyme system, but in a way which is usually distinguishable from DDT inhibition. Organophosphate and carbamate insecticides have not been found to effect ATPase significantly.

A secondary objective is to determine which tissues and subcellular fractions are the most sensitive to the compounds. Tissues being studied are brain, muscle, liver, and kidney. Because DDT, in particular, shows some different activity due to temperature, this aspect is also being studied.

Assays for enzyme activity are being carried out on the blue gill fish and studies will continue on this species which is sensitive to the insecticides, easily reared and collected, and occurs in rather diverse aquatic environments.

Acute and chronic exposure of the fish will be employed to relate to the findings of inhibition of the enzyme system.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

4.0682, MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR

L.K. CUTKOMP, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-17-047)

OBJECTIVE: Determine the effects of insecticides, particularly chlorinated hydrocarbons and pyrethrum on the enzyme systems, adenosine triphosphatase (ATPase) both in vitro and in vivo. The insecticidal effects and the ATPase enzyme activity will also be related to periodic (rhythmic) physiological events in the insect.

APPROACH: Accepted current biochemical determinations will be made of the ATPase enzyme system in nervous and muscle tissues of American cockroaches, honey bees and other insects. Known dilute concentrations of DDT, other chlorinated hydrocarbons and pyrethrum will be tested for specific inhibitory effects on the enzyme system. In addition, the specific activity of the enzyme system and insecticide sensitivity will be related to periodicity in the American cockroach, using established light and dark lighting regimes during a 24-hour day.

PROGRESS: Basic information on the activity of the ATPase enzyme system has been determined in muscle and nerve cords of American cockroaches. The inhibition of the enzyme has been determined by in vitro and in vivo experiments. Alpha and gamma chlordane gave much greater inhibition of the ATPase enzyme in vitro than in vivo. When roaches were injected the maximum inhibition was about 33% in roach muscle compared to over 85% inhibition on the isolated enzyme system. DDT at 1 part per million also inhibits Mg research pertains to development of a tissue enzyme assay for chlorinated hydrocarbon insecticides in fish. Five tissues in bluegill fish have been tested for ATPase activity and sensitivity to p,p'DDT. The highest enzyme activity is greatest in kidney and brain, but the greatest enzyme sensitivity to DDT occurred in muscle of fish as well as in cockroach, honeybee, and rabbit. Muscle ATPase from lake trout muscle was also more sensitive to DDT when compared to brain ATPase. The percent of Na-K ATPase (ouabain inhibited) in relation to total ATPase was

as follows: brain, 56.3%; kidney, 53.5%, liver, about 11%, muscle 7.4%; testis, 9.9%. A comparison of effectiveness of insecticides on corn rootworm adults has indicated increased resistance of insects to diazinon and phorate when compared to determinations in 1968. Some rhythmicity studies on oxygen consumption have been carried out with Tribolium confusum.

SUPPORTED BY U.S. Dept. of Agriculture

4.0683, HERBICIDE STUDIES EMPLOYING IN VITRO CULTURE METHODS

A.J. LINCK, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-21-077)

OBJECTIVE: Study of the physiological action and effects of selected herbicides in tissues or intact organs isolated from plants and cultured in vitro.

APPROACH: Standard methods of procedure for callus and organ culture will be used. These methods involve the sterile isolation of either stem tissue (for callus culture) or the fruit (for organ culture) from plants and their transfer to artificial media. Callus culture will be carried out with tobacco stem tissue grown on a modified White's solid medium and the culture of excised tomato fruits on a similar liquid medium, with the appropriate basal hormones as additives. Each herbicide in the study will be tested over a range of concentrations. After the initial technical problems have been worked out several herbicides will be selected for studies on their physiological effects and persistence in tissue or organs cultured in vitro under sterile conditions.

PROGRESS: A complete tissue culture laboratory was set up and included culture room, sterile transfer room and facilities for growing callus at high and low light intensities and in darkness, with humidity and temperature control. The effect of N-1-naphthylphthalamic acid (NPA) on callus growth and bud formation was studied mainly using tobacco pith callus. The effect of the interaction of NPA with IAA and kinetin was studied. It was found that callus growth was promoted when NPA was supplied at a concentration of 0.5 mg/l with 0/4 mg/l of kinetin; or, when NPA was supplied at a concentration of 5 mg/l in the absence of kinetin; in both cases the concentration of IAA was 2 mg/l. When the IAA concentration was at 2 mg/l and without kinetin, NPA at 50 mg/l inhibited growth. Without kinetin, in the presence of 2 mg/l IAA, NPA at 50 mg/l caused a reduction in amino acids, protein and nucleic acid in calluses grown on test medium for 5 weeks. However, with the same concentration of IAA and kinetin, NPA at 5 mg/l promoted the nucleic acid content in callus compared to the control. Based on the growth tests and the nucleic acid analyses kinetin was found to counteract NPA inhibition. Hence, NPA might affect growth by interfering with auxin-cytokinin controlled nucleic acid synthesis.

SUPPORTED BY U.S. Dept. of Agriculture

4.0684, CONTROL OF INSECT PESTS OF VEGETABLES BY INSECTICIDES AND PLANT RESISTANCE

E.B. RADCLIFFE, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-17-042)

OBJECTIVE: Contribute to the development of improved control measures for the insects affecting vegetable production through research on insecticides and insect resistance in crop plants.

APPROACH: New insecticides, formulations, rates, methods and timing of application will be investigated. Present control practices will be continually evaluated that we may be alert to the development of new problems, e.g., development of resistance, pest resurgences, occurrence of new or traded pests, accumulations of insecticide residues. We will investigate the inherent resistance of certain plants to insect attack. Emphasis will be given to research on insect resistance in the wild Solanum species. We intend to investigate the inheritance of aphid resistance and possible incorporation of this characteristic into the cultivated potato from wild sources. The mechanism of this resistance will be investigated.

PROGRESS: 379 Solanum introductions including approximately 300 never previously evaluated were tested as possible sources of resistance to green peach aphid, Myzus persicae, and potato aphid, Macrosiphium euphorbiae. Species typically resistant to M. persicae included brachistotrichum, bulbocastanum, cardiophyllum, michoacanum, sanctae- rosae, stenophyllidium and stoloniferum; to M. euphorbiae, bulbocastanum, canasense, cardiophyllium, chomatophilum, commersonii, hjertingii, multidissectum, polytrichon, and stoloniferum. F(1) hybrids incorporating stoloniferum and tuberosumphureja were as resistant to M. persicae as the wild parent, similarly F(1) OP progenies incorporating stoloniferum or sanctae-rosae were resistant. Carbofuran and phorate gave wireworm (Limonius and Melanothus spp.) control approaching that obtained with the same rate AI/A of chlordane. M. persicae was most effectively controlled with 1/2 lb. Monitor or 3/4 lb. endosulfan. Presently recommended materials gave excellent potato flea beetle, Epitrix cucumeris, control. Larvae of imported cabbageworm, Pieris rapae, and adult cabbage maggot, Hylemyia brassicae, differ significantly in their susceptibility to topical applications of parathion according to the species and variety of the host from which they were collected. Cabbage selections made in 1968 on the basis of differential resistance to P. rapae showed consistent differences for this character in 1969.

SUPPORTED BY U.S. Dept. of Agriculture

4.0685, FACTORS INVOLVING PESTICIDES IN MILK PRODUCTS

B.F. BARRENTINE, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-3-206-0739)

OBJECTIVE: Study on-the-farm practices which contribute to pesticide residue occurrence in milk. Pesticide residues will be determined in forages following cotton crops where known insecticide applications have been made: determined in feeds and forages grown to determine the importance of drift from applications made on other crops; determined in commercial feeds and forages.

APPROACH: Samples will be analyzed for DDT at various stages of growth of oats planted on land with several levels of contamination. Samples of forage crops taken for pesticide analysis at several distances from fields where pesticides were used. Samples taken of commercial feeds and forages for analysis.

PROGRESS: Milk samples from both Grade A and commercial producers throughout the State have been analyzed for pesticides. The north-east portion of the State is the only area that has a problem with pesticides in milk. This is an area where cotton production and dairying occurs on the same or adjoining farms. Producers whose milk was high in pesticides have been interviewed to determine their pesticide practices. Misuse of pesticides on and around the dairy farm appears to be the major cause of excessive pesticide residues in milk. This misuse, in spite of various educational programs, continues to occur. The misuse referred to varies from direct application on non-approved pesticides to dairy cattle to inadvertent aerial spraying of pastures and feeds to be used by dairymen.

SUPPORTED BY U.S. Dept. of Agriculture

4.0686, COMMUNITY STUDY ON PESTICIDES

B.F. BARRENTINE, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-8-240-0782)

OBJECTIVE: Determine types of pesticides to which the human population is exposed, the nature and degree of exposure, ecologic factors which affect their exposure, and characteristics of the subject population. Determine levels of selected pesticides in human tissues and the environment. Determine consequences of chronic and acute exposure and relationships of factors and conditions affecting frequency, distribution, severity and long-term consequences of pesticide-caused illness, or of pesticide-caused biochemical changes.

APPROACH: Investigate acute pesticide poisoning in Washington, Bolivar and Sunflower counties. Undertake a long-term intensive physical, neurological, chemical and medical surveillance of approximately 145 persons exposed to pesticides and 20 persons not exposed. Investigate the relative toxicities of the metabolic products of parathion and methyl parathion.

PROGRESS: In accordance with the long range objectives of the project, the study of people occupationally exposed to pesticides has continued. Exposure groups are characterized as heavy,

medium, and controls. These groups are represented in the same order by pesticide ground applicators, managerial personnel, and people not working with pesticides. It has been shown that there is a seasonal trend in the amount of DDT found in the blood of these study groups. The DDT blood levels reach a peak in July and August for the exposed population and drop to a minimum around mid-winter. The control population shows the same trend, but to a lesser degree. Studies are underway to determine the source of pesticide exposure in the control group. A study of the clinical findings has not revealed any significant differences between exposure groups. Clinical and enzyme tests on the blood of exposed and control participants will be continued. The procedures will be more rigidly controlled and made more precise. Efforts to detect subtle blood chemistry differences will be intensified.

SUPPORTED BY Mississippi State Government

4.0687, CONTROL OF THE IMPORTED FIRE ANT

H.B. GREEN, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-3-206-1041)

OBJECTIVE: Test for insecticides that leave no harmful residue. Test baits, attractants and methods of application. Make harmful studies. Study effect of fire ant venom on several forms of life.

APPROACH: Mounds in pasture and meadow land will be treated with various insecticides. Lab and field studies will be made with baits and attractants. Biological observations will be made. Fire ant venom will be isolated and tested on fish and other vertebrae animals.

PROGRESS: Studies of the changes in nutrient levels each month of the year were made for the castes of workers. The major form had the highest levels. The highest lipid level was during the fall and winter. Glycogen was similar, but the increase was less. Proteins were similar, except that there was a sharp drop in May through July. It may be that the high levels in the fall of the year are in preparation for winter; but it is possibly as a result of a lower level of brood production at a time when there is an abundant supply of food. The lower levels of protein in early summer may be a reflection of a high replacement of workers following the spring late brood production. Further studies of this work may be of value in future bait acceptance. During collection of males in the laboratory from field reared captive colonies, it was noted that females started their flights later in the day than did the males. No evidence of copulation was noted in any of the laboratory collections.

SUPPORTED BY U.S. Dept. of Agriculture

4.0688, BIOLOGY AND CONTROL OF THE HELIOTHIS COMPLEX ON COTTON

F.A. HARRIS, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-3-206-1035)

OBJECTIVE: Determine the relative incidence of Heliothis zea and H. virescens on cotton during the season and the role of alternate host plants on populations on cotton. Determine the effectiveness of chemicals for control of Heliothis species. Study the basis of DDT resistance in Heliothis species. Evaluate the role of predators and parasites in bollworm control under various insect control programs and other cotton production practices. A comparative study of the basic biology of the Heliothis species on cotton and other host.

APPROACH: Larval collection will be made at periodic intervals from cotton in selected areas of the state throughout the growing season and identified. Eggs will be collected and larvae reared to eliminate the selection effect of insecticides on the two species. Dosage- mortality curves will be obtained for all currently used chemicals on selected populations collected throughout the state. Collections for tests will include larvae collected from cotton as well as other host plants and of wild adult populations. Laboratory strains of DDT resistant and susceptible strains of bollworm and tobacco budworms will be maintained. The fate of various insecticides applied to the larvae will be studied by various chemical analyses, radioassay and chromatographic techniques. Ecological studies will be conducted in fields subjected to various control and cultural programs to determine their effects upon natural control factors.

PROGRESS: Comparison of Heliothis larval infestation in cotton fields not treated with insecticide and cotton fields treated with aldicarb indicated that predators in the untreated fields reduced Heliothis larvae population by as much as 50%. A preparation of delta- endotoxin of Bacillus thuringiensis (HD-1) tested as a spray application to cotton showed promise for Heliothis control. New Heliothis nuclear polyhedrosis virus formulations showed improved activity in Heliothis control over the old preparations. H. virescens populations in the Mississippi Delta show increased levels of resistance to Toxaphene-DDT and the initial stages of development of resistance to methyl parathion is indicated.

SUPPORTED BY U.S. Dept. of Agriculture

4.0689, DISTRIBUTION, ABUNDANCE AND CONTROL OF HELIOTHIS SPP. IN COTTON

F.A. HARRIS, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-3-207-1032)

OBJECTIVE: Determine the importance of the various host plants in contributing to the seasonal and long term abundance and the local dispersal patterns of each Heliothis species among the host plants. Study the occurrence and biochemical basis of insecticidal resistance in Heliothis populations within the Southern Region. Develop procedures for using parasites, predators, pathogens, plant and insect hormones, sterile males, pheromones and insecticides for Heliothis control. Screen and evaluate the cultivated and wild species of Gossypium and Glycine for morphological and physiological plant characters which provide plant resistance, tolerance, and 'nonpreference' to Heliothis species. Integrate information obtained in the objectives into new pest management systems which will place less dependence on chemical pesticides.

APPROACH: Heliothis population surveys in cotton and soybeans. Monitor insecticide resistance. Study levels of biological control in cotton and screen insecticides. Screen cotton and soybeans for host plant resistance. Integrated control research.

PROGRESS: Late season survey of Heliothis larval populations in cotton in Mississippi showed the portion of H. virescens to range from 10% in light insecticide use areas to 100% in heavy insecticide use areas. The Heliothis population on soybeans in Mississippi was found to consist of 10 to 17% H. virescens. Aldicarb systemic insecticide applied sidedress to cotton reduced insect predators and resulted in an increased Heliothis infestation. A preparation of delta-endotoxin of Bacillus thuringiensis (HD-1) showed promise for Heliothis control in cotton and soybeans. New Heliothis nuclear polyhedrosis virus formulations showed increased activity over the old formulations. H. virescens in the Mississippi Delta show increased resistance to Toxaphene-DDT and initial development of resistance to methyl parathion is indicated.

SUPPORTED BY U.S. Dept. of Agriculture

4.0690, BIOLOGICAL AND INTEGRATED CONTROL OF COTTON INSECTS

M.L. LASTER, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUI-0014)

OBJECTIVE: Determine seasonal populations and fluctuations of major predators in cotton fields; study the role of specific predators in cotton insect control; study surrounding areas as reservoir habitats for predators and to study the effects of insecticides on predator and pest species.

APPROACH: Samples will be taken to determine predator populations. Close observations to determine the role of specific predators in cotton insect control. Samples will be taken to determine reservoir areas for predators. Effects of insecticides on predators will be studied.

PROGRESS: Seasonal collections indicated that lady beetles, Nabis, and Geocoris species were the dominant predators in cotton fields during early season and spiders, 90% of which were the striped lynx, Oxyopes salticus Hentz, became dominant in mid- and late-season. All predators were adversely affected by applications of insecticides and were almost eliminated from the fields after two applications to control plants bugs. Spiders were less affected by methyl parathion than by carbaryl, toxaphene plus DDT, and azinphosmethyl.

4. PESTICIDES

SUPPORTED BY Mississippi State Government

4.0691, ROLE OF BENEFICIAL INSECTS IN COTTON INSECT CONTROL
M.L. LASTER, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUI-0107)

OBJECTIVE: Determine species of predators in cotton fields and their abundance throughout the season. Evaluate effectiveness of beneficial insect populations in the overall cotton insect control program. Determine effects of various insecticides on beneficial and pest species.

APPROACH: Seasonal populations and fluctuations of major predators in cotton fields will be determined. Beneficial species in the field will be studied from the standpoint of abundance, feeding habits, and ability to suppress a pest population. The effects of different insecticides and dosages on both predator and pest species will be studied in the field.

PROGRESS: Heliothis larvae were collected from a measured area of re-growth cotton in 10 fields during mid-October, 1969. These larvae were held in 1 oz plastic cups, on artificial media. Periodic observation revealed that 28 percent of the larvae were parasitized by Hymenoptera and Diptera species which have not been postively identified.

SUPPORTED BY Mississippi State Government

4.0692, EFFECT OF CHEMICALS ON BENEFICIAL INSECTS
T.R. PFRIMMER, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUI-013)

OBJECTIVE: Study the reduction of species of beneficial insects by the use of various toxicants applied for control of cotton insects. Determine the relative toxicity of the chemicals tested to specific beneficial insects.

APPROACH: Insecticides are sprayed with conventional ground equipment. Sweeping records made at periodic intervals to determine the kind and number of beneficial insects which are killed. Speed of kill as well as residual toxicity of the compounds are compared.

PROGRESS: The use of systemic insecticides as granules at planting or as seed treatments has little effect on populations of beneficial insects and spiders present in the cotton field at the time squaring begins. Any effect on the population seems to be an indirect one caused by the removal of the prey of the predators and parasites. In some cases there have been more beneficial insects on systemic treated cotton early fruiting than on untreated cotton. This appeared to be due to bigger, more vigorous plants in the treated plots resulting from thrips control. The use of systemic insecticides at early fruiting as granule side-dress treatments or liquid stem treatments results in a reduction of certain predators. Insecticide sprays on seedling cotton have little effect on the population of beneficial insects and spiders present when squaring begins. Spray applications after squaring begins will greatly reduce the population of beneficial insects. Following 1 application beneficials will move back into the field if there is a source of supply outside the treated area. This is especially true following the use of a short residual material such as methyl parathion. Various insecticides have differing degrees of effect on beneficial population. In general, the insecticides which are the least toxic to the beneficial insects are also less toxic to harmful insects. Two or more spray applications of most insecticides will completely eliminate the beneficial insect and spider population.

SUPPORTED BY Mississippi State Government

4.0693, A STUDY ON THE CORRELATION BETWEEN INSECT CONTROL AND BEEF PRODUCTION
R.H. ROBERTS, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUTLP-1)

OBJECTIVE: Investigate the effects of insect control on beef animals under typical pasture grazing conditions. Individual weight gains will be compared between two groups of yearling beef steers. One group will be treated twice daily with insecticide to protect them from insect attack. The other group will be untreated. Weight gains will be obtained every two to four weeks. The effect of insect control will be followed through to the end of feed lot testing.

APPROACH: Two groups of 10 yearling beef steers will be placed on grazing pastures. Each pasture will be 4 acres in size and grazing cover consists of Coastal Bermuda or Coastal Bermuda plus clover and fescue. Weekly observations will be made on the animals to determine the type of flies present and the degree of control obtained by the treatment. Also, bait traps will be run in the same vicinity. The basic criteria for measuring the efficiency of the insect control will be the comparison between the individual weight gains of the two groups.

PROGRESS: The data from several year's study on this project has shown that the method of treatment bears an important relationship to the weight gains of the animal. The data from the first year's study indicate that the method used to treat the cattle for insect control had a detrimental effect on weight gains. In that study, an automatic sprayer using an oil-base spray was used to treat the animals. The treated groups at times showed a great reluctance to pass through the spray unit to obtain water. In addition, a number of animals had epidermal reactions that were quite severe caused by the oil-based spray. During the following year when a water-based spray was used, the animals were not sufficiently protected from insect attack. In the third year of this study, animals were pen-sprayed. Two groups of 14 steers were used; half the steers in one group were sprayed weekly, half the steers in the other group were sprayed bi-weekly. No difference in weight gains was found between the treated and control in either group. After 84 days in a feed lot, the weekly sprayed group averaged 3.3 lbs per day gain, while the bi-weekly group averaged 2.94 lbs. In a separate group of steers that were pen-sprayed every three weeks, the treated animals had higher weight gain than pasture mates that were not sprayed.

SUPPORTED BY Mississippi State Government

4.0694, BIOENVIRONMENTAL CONTROL OF COTTON BOLLWORMS
D.F. MARTIN, U.S. Dept. of Agriculture, Entomology Research Division, *Stoneville, Mississippi* 38776 (00ENTCO217250500)

OBJECTIVE: Develop ways of meeting cotton bollworm problems that will avoid or minimize the use of broad-spectrum, residue forming, and persistent insecticides which may pose immediate or long-range hazards to man, fish, wildlife, beneficial insects and other organisms in the environment.

APPROACH: Field research will be conducted on the ecology, population dynamics, and control of bollworms by bioenvironmental methods. Stress will be placed on practical bollworm control through research on biological, physical, and specific chemical methods in lieu of conventional insecticides.

PROGRESS. No Progress Reported this Period (New Project). Facilities still under construction.

SUPPORTED BY U.S. Dept. of Agriculture

4.0695, THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH
J.G. ARMSTRONG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Doses of Aroclors 1232, 1248, 1254, and 1260 will be individually administered daily by diet to groups of immature channel catfish. After 6 months, fish from each treatment will be examined for histopathology and for changes in blood serum constituents. Skeletal weights and thyroid activity will be estimated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0696, SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA. TOXICITY OF PESTICIDES TO FRESHWATER FISHES
J.G. ARMSTRONG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The purpose of this work unit is to screen carbamates, fungicides, insect repellents, herbicides and polychloro biphenyls for possible teratogenic effects.

The mosquitofish, 'Gambusia affinis' will be used as a test animal. Groups of mosquitofish containing both male and female subjects will be fed formulations of the above compounds through their diet both alone and in combination. Whole, cleared

specimens of the resulting progeny will be examined for anomalies and histological sections will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0697, PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS
B.F. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Adult rainbow trout will be exposed to endrin or dieldrin in the diet for 6 months. On the day of autopsy, the fish will be forced to swim for 1 hr. The above constituents are to be studied. Serum Na, K, Ca, Mg, Cl, PO4, osmolality, NPN, total protein, electrophoretic analysis, cholesterol, creatinine, total amino acids, cortisol, lactate, glucose, and liver glycogen of the rainbow trout are to be studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0698, EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES
B.F. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Adult male goldfish with developed testes will be injected with the spermiation gonadotrophin isolated by Sephadex G-100 gel filtration to induce the 24-hr spermiation response after having received six days exposure to various selected pesticides by bath in a metered continuous- flow system. A range of four half-log increments of dosage are given. The response in treated fish will be compared to the response of controls.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0699, NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES
B.F. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Pilot studies on intact and isolated nerve preparations are carried out using the Beckman Dynagraph II. Thresholds, action potentials, accommodation, inhibition, refractory periods, and other associated neurological phenomena in the presence of encountered levels of certain organochlorine toxicants in trout, catfish and tilapia in nature are estimated. Definitive work will follow as indicated by evaluation of preliminary studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0700, 72-HR THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO 5 DOSES OF SELECTED TOXICANTS (ABBREV.)
B.F. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Immature channel catfish will be exposed to doses of toxicants such as insecticides and polychlorobiphenyl compounds with a continuous-flow dilutor. Survival conditions are kept optimal with respect to oxygen and waste accumulation. Organochlorine residues in the water and in the catfish are estimated when appropriate. After 30 days exposure, the fish are injected, 1 ul (0.01 uc)/gm, intraperitoneally with I125. The ability of the thyroid to fix radioiodine in 72 hr will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0701, SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS
F.B. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The serum of cutthroat trout will be studied during extended bath and feed treatments carried out at Jackson, Wyoming. The parameters to be measured are: Na, K, Ca, Mg, Cl, HCO3 (equilibrated with 5% CO2), NPN, urea, uric acid, creatinine, creatine, amino acids, cholesterol, total protein, and osmolality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0702, COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS
J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This work unit will attempt to correlate results of esterase activity measurements obtained by two colorimetric methods and by a manometric method. Brain tissue from three species of fish, cutthroat trout (Salmo clarki Richardson), bluegill sunfish (Lepomis macrochirus Rafinesque), and channel catfish (Ictalurus punctatus Walbaum) will be analyzed for acetylcholinesterase levels. The entire brain will be removed from the fish, homogenized in deionized water, divided into aliquots, and diluted with the appropriate buffer. At least triplicate samples of each homogenate will be analyzed by all methods. Also, effects of storage by freezing will be studied. In vitro inhibition will be determined. Samples of homogenate will be incubated with various anticholinesterase agents and the resultant decrease in acetylcholinesterase activity will be measured. Brains removed from fish which have been exposed to various anticholinesterase agents will be analyzed to correlate in vivo inhibition. All results will be analyzed statistically to determine if there are any significant differences.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0703, SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS
J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Samples of adult bluegill and at least one species of aquatic invertebrate will be collected at monthly intervals and assayed for acetylcholinesterase activity. The initial study will continue for at least one year. If statistically significant changes in esterase activity are found to be correlated with sampling date the study will be extended for a second year and may be expanded to include additional species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0704, INTERACTIONS BETWEEN PESTICIDES AND FISH ENZYME SYSTEMS
J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Different species of fish exhibit considerable variation in their susceptibility to organophosphate pesticide poisoning. It has been proposed that the effect of varying: (1) the chemical nature of the phpsphorus in the toxicant, i.e., dithionate or thionate, or, (2) the larger organic functional group should be examined in an attempt to explain species differences in susceptibility. The object of this work unit, therefore, will be to compare the toxicity of thionate and dithionate compounds with identical organic functional groups to species of fish having differing suspectibilities to anticholinesterase agents. Also, the effect (on toxicity) of varying the larger organic functional group will be determined. Acute and chronic toxicity, in vitro and in vivo brain acetylcholinesterase inhibition, and residue levels will be made to relate total alpha-amino acid nitrogen levels with each treatment and species. If significant correlation is observed individual amino acid analyses by GLC will be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish

4.0705, INTERACTIONS BETWEEN PESTICIDES AND FISH ENZYME SYSTEMS
J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Use of fish brain acetylcholinesterase to assess the magnitute of environmental contamination resulting from organophosphorus pesticides is well documented. However, very little work has been directed toward the biochemical level with other members of the aquatic ecosystem. With this work unit we will attempt to characterize the esterase(s), present in an inver-

tebrate member of the aquatic environment. Crayfish 'Orconectes nais' was selected for this study due to its availability and importance as a source of food for certain game fish. Initial work will be concerned with methods used to obtain and maintain sufficient numbers of crayfish for further experimentation. Various tissues will be dissected from the crayfish and homogenized in an attempt to obtain an active enzyme preparation. Esterase characterization will be initiated as soon as the above work is completed. Characterization will include establishment of assay conditions such as optimum substrate and optimum substrate concentration. In vitro and in vivo esterase inhibition by organophosphorus pesticides will be examined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0706, INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES
B.T. JOHNSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Axenic cultures of a broad spectrum of free living freshwater protozoans will be studied in vitro with selected insecticides.

The parameters of this investigation will be as follows: 1. Effects on protozoan population of the insecticide. 2. Ability of the organism to utilize the pesticide as a sole carbon source. 3. Role of protozoans in degradation of halogenated hydrocarbon pesticides. 4. Study possible use of protozoans as bio-indicators of low concentrations of pesticides.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0707, THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM (ABBREV.)
B.T. JOHNSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Axenic phytoplankton cultures are exposed to different insecticides and herbicides, alone and in combination at environmental concentrations. The polychlorinated biphenyl Aroclor series are studied also in conjunction with pesticides.

Effects on photosynthesis are measured by changes in C14-uptake using a liquid scintillation method. Biomass is determined by direct cell count, dry weight and ATP content. ATP is quantitatively determined utilizing the luciferin-luciferase enzyme system.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0708, THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES
H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of the work is to investigate the effects of variations in bioassay conditions on the toxicity of pesticides to fish. Controlled variation of temperature, water quality, mass-volume relationships, and other factors will provide information concerning the influence of such factors on fish-pesticide relationships.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0709, THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FISH TO SOME COMMONLY USED PESTICIDES
H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of this work is to determine whether the uptake and activity (consequently the toxicity) of various pesticides differs among eggs, fry, various sizes of immature fish, and various sizes of mature fish. Representatives of the salmonids, centrarchids, and other families will be studied. The work will involve exposing the various life stages to the pesticides and determining relative toxicity indices.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0710, RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES
H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of the work is to establish a hierarchy, in terms of relative susceptibility to herbicides, for the families Salmonidae, Centrarchidae, Cyprinidae, Ictaluridae, and Percidae. Standard bioassay methods, under both static and continuous flow conditions, will be used to determine 24- and 96-hour TL50 values as indices of the susceptibility of the various taxonomic groups to representative herbicides.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0711, THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS
H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This work attempts to evaluate differences in the uptake activity of various pesticides among various sizes of fish from egg to adult. Representatives of the salmonids, ictalurids, centrarchids, and other families will be studied. We will expose fish of particular lots or strains in size categories between 1-80 gm to antimycin, chlordane, and Abate 4-E in static or flow-through bioassay test systems to determine relative toxicity indices. Tests will be conducted under standard as well as altered conditions of temperature and water quality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0712, RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES, FY 1971 (ABBREV.)
H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This study attempts to evaluate phylogenetic differences in the susceptibility of the families Salmonidae, Cyprinidae, Ictaluridae, Centrarchidae, and Percidae to herbicides. Bioassay methods with standard and altered conditions of temperature and water quality under both static and flow-through systems will be used to determine 24 and 96-hr TL sub 50 values.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0713, SCREENING OF PESTICIDES AGAINST FRESHWATER FISHES, FY 1971
H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This study is a continuing effort in deriving toxicities of various pesticides and combinations of pesticides to freshwater fishes. Static bioassays will yield TL sub 50 estimates and their confidence limits for 24, 48, 72, and 96-hr exposures under standard and altered conditions of temperature and water quality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0714, INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH
K.J. MACEK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objectives of the work are to determine if mobilization of insecticide residues, similar to that reported for higher vertebrates, does occur in fish during periods of stress, what the effects of such mobilization are, and what organs are involved in producing such effects. The work will involve feeding DDT and dieldrin to fingerling chinook salmon for approximately 200 days. After the exposure period, the fish will be subjected to several combinations of degrees of starvation and temperature fluctuations. Residue concentrations will be measured in whole fish and various organs and tissues to determine amounts accumulated

and metabolized during exposure, as well as the activity of such residues during stress.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0715, CHRONIC TOXICITY OF PESTICIDES TO FISH
K.J. MACEK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objectives of the work are to determine the major source of DDT for salmonids existing in environments containing low levels of DDT in the water (pptr) and high levels in the food chain (ppm). Brook trout will be exposed to 5 pptr C14-DDT on a continuous flow basis, or to 3ppm C14-DDT in the feed on a daily basis, or to a combination of both treatments. Rates of accumulation and total amounts of DDT and its metabolites accumulated will be monitored for approximately 150 days. Organ distribution of DDT and its metabolites will be evaluated at the end of the study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0716, CHRONIC EFFECTS OF DURSBAN O'I WARM-WATER FISH
K.J. MACEK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Objective: To assess the chronic effects from contact exposure treatments of pesticides to warm-water fish in six one-tenth acre ponds at Columbia, Missouri. The fish will be exposed to various treatments of different concentrations. Samples of fish will be taken at predetermined times for chemical residue analysis, stomach samples, and for histopathological examination. Measurement of fish growth, survival, and reproduction will be made. Effects on other factors of the pond ecosystem: aquatic invertebrates, vegetation, plankton, and water quality will also be measured.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0717, EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS
K.J. MACEK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Objective: To assess the chronic effects of the insecticides malathion and parathion, alone and in combination, on the ecology of warm-water fish ponds. The ponds will be treated at approximately 28 day intervals with 0.5 lbs/acre of either or both of the insecticides. Chemical analysis will be performed on fish, water, mud and vegetation to measure insecticide residues. Effects on cholinesterase activity, histology, growth, feeding habits, and survival of green sunfish and channel catfish will be evaluated. Changes in structure of the invertebrate populations will be measured.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0718, UPTAKE, PERSISTENCE AND METABOLITES OF SEVIN BY CHANNEL CATFISH
K.J. MACEK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objectives of this research are to determine the kinetics of uptake, metabolism and distribution of Sevin. Adult channel catfish are exposed to 14C Sevin either by continuous flow bath or daily in their feed. Two treatments levels in duplicate are used for bath and feed exposures. Rates of accumulation and total amounts of Sevin and it's metabolites are monitored at 3, 7, 14, 28, and 56 days. Chemical distribution and half life will be evaluated at the end of the study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0719, CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES
F.L. MAYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This work is a continuing program for deriving toxicities of various pesticides against freshwater fishes in a flowing-water system. The exposure interval may be as brief as 96 hr, but mostly dosages are adjusted to allow the test to go 21-30 days or, in some instances, longer. Tests will be conducted under standard, as well as varied, conditions of temperature and water quality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0720, POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE
F.L. MAYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Five quarter-acre ponds will be stocked with bluegills, 'Lepomis macrochirus', and treated with 0, 0.1, 0.3, 1.0, and 3.0 micrograms of Simazine per liter, respectively. The herbicide will be applied once per year (late March) for two years.

Serial samples will be taken to evaluate the following: fish growth and reproduction, pathology, residue levels (fish, invertebrates, plants, mud, and water), invertebrate population characteristics, plant pigment ratios, pond productivity, and water quality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0721, EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS
F.L. MAYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Patterns of early scale development will be studied on bluegill and fathead minnows receiving selected levels of the Aroclors 1242 and 1254. Chronic exposures will be given by bath. The fish samples will be sampled at pre-determined intervals, cleared with a 10% solution of concentrated hydrogen peroxide, stained with alizarin red, and their squamation compared with known patterns of development.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0722, FISH REPRODUCTION AS AFFECTED BY ORGANOCHLORINE INSECTICIDES
F.L. MAYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Brook trout will be exposed to methoxychlor or chlordane and bluegill to endrin or dieldrin through food for three months prior to spawning. Eggs will be taken, artificially fertilized and allowed to hatch. Egg and offspring mortality will be observed as well as growth rates of offspring. Whole adult fish, gonads, eggs, fry, and fingerlings will be taken periodically for insecticide residue analysis. Residues are to be correlated with hatching success and offspring mortality. Observations for teratogenic effects will be emphasized.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0723, CHRONIC TOXICITY OF PESTICIDES TO FISH
F.L. MAYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The effect of Aroclors 1242 and 1254 on residual storage of DDT and dieldrin in bluegill, channel catfish, and rainbow trout will be determined. Fish will be treated via food or bath for four weeks. Liver detoxifying enzyme activities will be determined at selected intervals. Fish will be killed and analyzed for organochlorine residues at 0, 1, 3, 7, 14, and 28-day intervals.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0724, PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS
P.M. MEHRLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Rainbow trout will be exposed to six months of DDT, dieldrin, and a combination of the two and subjected to 4 weeks of forced swimming. Seven samples will be taken at intervals of 6 hr., 24 hr., one wk., two wk., three wk., and four wk. Serum glucose, liver glycogen, and total serum amino acids will be deter-

mined to relate to estimations of total body lipid, total body nitrogen, and pesticide residues.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0725, PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS
P.M. MEHRLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Parameters of nitrogen metabolism will be studied on fish receiving various doses of selected pesticides. Chronic and acute exposures of pesticides will be given by feeding and bath. Blood serum and liver preparations will be analyzed for specific amino acids, total protein, and collateral constituents related to lipid and carbohydrate metabolism. Biological activities of oxidative diaminases and amino tranferases are studied to elucidate mechanisms of induced dysfunction of intermediary nitrogen metabolism by selected pesticides. Chemical assays for amino acids will be carried out by GLC.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0726, PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS
D.S. MINTZ, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Pilot studies of intact and isolated nerve preparations are to be carried out using the Beckman Dynagraph II, oscilloscope, and photographic recording equipment. Thresholds, action potentials, accommodation, inhibition, refractory periods, and other associated neurological phenomena will be studied. Changes of normal characteristics induced by neurological toxicants will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0727, MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH
E.T. OBORN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

For acute concentrations of malathion - Sexed bluegills would be exposed to acute or near acute concentrations of malathion in either/or both bath water or from capsule ingestion. Sample harvest would follow 24 hours later.

For chronic concentrations of malathion - Sexed bluegills would be exposed to chronic concentrations of malathion for 30 days in either bath water and/or in the feed. Sample harvest would follow the 30-day exposure.

After both acute and chronic exposures to malathion, brain and blood would be incubated and measured for acetylcholine hydrolysis. Additional procedures followed and methods used would be in accordance with standard colorimetric analysis. Blood smears would be taken and blood coagulation time and hematocrit percent would be measured. After dissecting and proper processing, the tissues would be examined for iron, manganese, copper, zinc, phosphorus, calcium, and magnesium content.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0728, 2,4-D UPTAKE AND METABOLISM - METABOLISM OF PESTICIDES IN FISH
C.A. RODGERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Rainbow trout, channel catfish, and goldfish will be exposed to 0.1 and 1.0 ppm of 2,4-D butoxyethanolester under laboratory conditions. Carbon 14 labeled 2,4-D will be used as a tracer to determine the areas of storage of the herbicide. Two to four gram fish will be used for the test program and the following organs will be analyzed for 2,4-D: head, liver, kidney, and muscle. Blood will also be analyzed. In addition to individual parts, an autoradiograph of the whole body will be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0729, DDT AND DIELDRIN METABOLISM AND STORAGE BY CHINOOK SALMON UNDER LABORATORY CONDITIONS
C.A. RODGERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This work will be a preliminary investigation involving DDT and dieldrin. Various organs and tissues of the fish will be analyzed for storage, buildup, and metabolism of the pesticides. This study will involve only the following organs: brain, heart, liver, kidney, blood, storage fat, lateral line muscle, body muscle, gill, stomach and hind gut. This study may indicate if it will be meaningful to select only a few primary target organs or tissues for future work with chlorinated hydrocarbons.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0730, UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT
C.A. RODGERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Rainbow trout, channel catfish, bluegills, and bass will be exposed to 1.0 and 5.0 ppm of the Dimethyl Amine Salt of 2,4 Dichlorophenoxyacetic acid under laboratory conditions. 14C ring labeled 2,4-D will be used as a tracer to determine total residue levels and distribution in organs. Exposure will be for three weeks with variable sampling intervals. Tissue extracts with high residue levels will be examined by TLC.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0731, DEVELOPMENT OF A STRAIN OF FISH RESISTANT TO AN ORGANOPHOSPHATE PROJECT - INTERACTION BETWEEN PESTICIDES AND FISH ENZYME SYSTEMS
C.A. RODGERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The current decline in use of organochlorine insecticides, and the anticipated increase in use of organophosphates suggests that the latter may become an increasing problem in aquatic ecosystems. Therefore, organophosphate-resistant strains of fish would be a useful tool in fish management. Such fish could survive accidental contamination or be restocked in polluted waters which would not support non-resistant populations. Past research has shown that fish develop a resistance to organochlorine pesticides. In addition, limited evidence indicates that development of resistances to organophosphate pesticides may also be possible. To data, however, no research has been directed towards studying the biochemical basis for pesticide resistance in fish. The object of this work unit, therefore, will be two fold: 1) to develop a strain of fish having greater resistance to organophosphate pesticides, and 2) to study the biochemistry of this resistance.

An attempt to develop one or more resistant strains of fish will be made by exposing large numbers of mature individuals to acutely toxic levels LC sub 80 or LC sub 90 of selected organophosphates. Survivors will be allowed to reproduce and their offspring challenged with the same organophosphate pesticide. Resistance will be measured by percent survival in succeeding generations.

A limited study of the biochemical basis of pesticide resistance will be made by assaying various enzyme systems. For example, the esterase enzymes have been found to be important in invertebrate pesticide resistance and similar mechanisms may exist in fish as well.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0732, INTERACTION BETWEEN PESTICIDES AND FISH ENZYME SYSTEMS
C.A. RODGERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Previous research into pesticide resistance in fish has indicated that such resistance is genetically based. It seems possible, however, that pesticide resistance may also result thru the induc-

tion of one or more pesticide-degrading enzymes. The object of this work unit, therefore, will be to study the effect one or more pesticides has on the specific activity of selected enzymes.

Fish will be continuously exposed to sub-lethal concentrations of one or more pesticides, sampled at pre-determined intervals, and selected enzyme systems assayed. Enzyme induction will be determined thru comparison of the specific activity of a given enzyme over a long period.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0733, DETERMINATION OF ORGANOPHOSPHATES AND THEIR METABOLITES IN FISH BLOOD SERUM AND THEIR EFFECT ON CHOLINESTERASE ACTIVITY
C.A. RODGERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Use of cholinesterase in conjunction with other analytical chemical techniques to assess the degree of environmental pollution resulting from organophosphate insecticides is well recorded. However, limited research has been directed toward the use or organophosphate residues in blood to determine the amount of these chemicals present in aquatic ecosystems. To evaluate this aspect, fish will be exposed to one or more organophosphate insecticides. Blood samples will be taken periodically and attempts made to correlate residue levels of organophosphate pesticides in the blood with treatment levels and plasma cholinesterase activity.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0734, STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970
H.O. SANDERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of this work is to study the role of invertebrate pesticide interaction in the aquatic ecosystem. Pesticide bio- amplification, using aquatic invertebrates in a simple food chain will be investigated. Invertebrate food chains will be established in the laboratory to investigate potential biopassage of labeled insecticides and herbicides from one ecological trophic level to another. Studies will include the following fish-food organisms: scud, glass chrimp, daphnia, fairy shrimp, crayfish, damselflies, mayflies, and mosquito larvae. When available, other organisms will be investigated. The study will also include the effects of continuous exposure of invertebrates to sublethal concentrations of pesticides, which may influence reproduction, life cycle stages, vigor, and resistance of the organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0735, TOXICITY OF POLYCHLOROBIPHENYL (PCB) COMPOUNDS TO FRESHWATER INVERTEBRATES
H.O. SANDERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

We plan to obtain acute and long-term toxicity estimates for a variety of PCBs, singly or in combination with various organochlorine insecticides in several species of aquatic invertebrates. Invertebrates and PCB compounds are to be tested in static and continuous-flow bioassay systems in the laboratory. We will derive TL sub 50 estimates at various time intervals under static and continuous-flow conditions varying temperature, water quality, and animal age.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0736, STATIC BIOASSAY OF PESTICIDES USING FRESHWATER INVERTEBRATES TO OBTAIN PRELIMINARY ACUTE TOXICITY ESTIMATES (ABBREV.)
H.O. SANDERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of the work is to obtain preliminary acute toxicity estimates for a variety of pesticides and combinations of pesticides, tested against several species of aquatic invertebrates. Invertebrates and pesticides are tested in static bioassay systems in the laboratory. TL sub 50 estimates will involve various time intervals under static conditions with controlled variation of temperature, water quality, and animal age.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0737, CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES (ABBREV.)
H.O. SANDERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The proposed research will evaluate the acute and chronic effects of pesticides and combinations of pesticides on aquatic invertebrates exposed in continuous-flow systems. We will derive estimates of TL sub 50's for various periods of exposure under standard conditions of temperature and water quality. Particular emphasis is to be placed on sensitivity of different life cycle stages, molting, and emergence success.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0738, RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES
H.O. SANDERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Invertebrates are to be exposed to varying concentrations of several pesticides for short durations. Oxygen uptake and carbon dioxide liberation will be estimated with a Warburg apparatus fitted with macro-vessels. All major pesticide groups such as organochlorines, organophosphates, and carbamates will be investigated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0739, UPTAKE, DEGRADATION, AND RETENTION OF C14-METHOXYCHLOR IN INVERTEBRATE POPULATIONS
H.O. SANDERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Invertebrate members in fish food chains will be exposed to C14- methoxychlor in static and continuous-flow systems and we will evaluate the following parameters: rates of uptake from the water and through the diet, localization of methoxychlor in organs and tissues, degradation of the compound, and residue retention. Tests are to include 8 species of freshwater invertebrates distributed among 4 orders of aquatic insects, Diptera, Plecoptera, Ephemeroptera, and Megaloptera, and two orders of crustacea, Eubranchiopoda and Decapoda. Scintillation radiometry and autoradiograms will provide information on rates of accumulation, retention, and degradation of C14-methoxychlor.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0740, METHOXYCHLOR-CAUSED EFFECTS ON CUTTHROAT TROUT PHYSIOLOGY - CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH
D. SWEDBERG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The purpose of the work is to measure chronic effects from the exposure of cutthroat trout to methoxychlor at Jackson, Wyoming. Fish will be divided into lots and sub-lots and held in pens in hatchery raceways. Some groups will be given no methoxychlor, some given methoxychlor in feed at two levels, and some given methoxychlor baths at two levels. Samples will be taken according to a pre-arranged schedule, and fish will be examined and measured for growth, pathology, incidence of disease, blood chemistry, insecticide residues, mortality, reproduction, and quality of offspring. Comparisons among lots will be made to assess effects of methoxychlor.

4. PESTICIDES

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0741, MULTIPLE EXPOSURES OF ABATE TO BLUEGILL, LEPOMIS MACROCHIRUS, AND INVERTEBRATES IN WARM-WATER PONDS
D.F. WALSH, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Four ponds will receive three treatments at 28-day intervals. Duplicate concentrations of 0.1 lb/acre and 1.0 lb/acre will be applied. Two additional ponds will serve as untreated controls. The first treatment will be applied April 13.

Samples will be taken at regular intervals to evaluate the following: brain cholinesterase activity, gonadosomatic index, vitellogenesis, pathology, residue levels (fish, selected components of habitat, and fish food organisms), structure and composition of invertebrate populations, and water quality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0742, EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS
M.L. FAIRCHILD, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00572)

OBJECTIVE: Evaluate effects of various insecticides and rates and methods of application on the activity of soil inhabiting insects in corn fields at certain intervals of time following applications; determine possible lateral or vertical movement of insecticides in soil by measuring biological activity; study the effect of soil type, moisture content, and organic content on insecticidal activity through bioassay.

APPROACH: Soil samples will be taken from numerous soil treatments in corn fields, and the insect activity will be examined. Samples will be taken at various locations in the soil and at several intervals following treatment. A screening-flotation technique will be utilized to remove insects from soil and species and numbers will be recorded.

PROGRESS: Plots at Columbia, McBaine, and McCredie and broadcast- treated with six different insecticides. An infiltrometer was used at two locations near McBaine and one location near Columbia to simulate rainfall on the plots. Soil and water run-off samples were collected from each plot for analysis. The plots at McCredie were used to collect water run-off from natural rainfall. Soil samples were bioassayed and the water run-off samples were analyzed by gas chromatography. Other plots near Rock Port and Tarkio were used to compare insecticide sprays, granular formulations, band width, incorporation methods, layby treatments and dates of application. Soil samples were collected at 14- day intervals. The samples were three inches in depth and three inches in diameter taken from the center of each row. Homogenized samples from each entry were bioassayed. A total of 247 samples were tested. Methods of mass rearing of the black cutworm are being developed for bioassay of soil insecticide activity. Methods of eliminating or reducing incidence of disease and cannibalism are being studied. Studies on effect of temperature, humidity, diets, and various rearing containers on larval growth, pupation, and egg production are underway. Excellent results have been achieved through the third generation.

SUPPORTED BY U.S. Dept. of Agriculture

4.0743, EFFECT OF PESTICIDES ON INSECT PARASITES AND PREDATORS
F.R. LAWSON, Univ. of Missouri, U.S.D.A. Entomology Res. Div., *Columbia, Missouri* 65201 (00ENTJ0206260100)

OBJECTIVE: Determine the toxicity of candidate insecticides to the predators and parasites of insects and spider mites.

APPROACH: Colonies of representative species of insect predators and parasitic and predaceous mites will be set up and maintained in the laboratory as stock cultures. New chemicals that show promise as insecticides will be tested against these species by standardized procedures.

PROGRESS: No progress reported this period (Active Project).

SUPPORTED BY U.S. Dept. of Agriculture

4.0744, PESTICIDE-WILDLIFE RELATIONSHIPS - REPRODUCTION, GROWTH, AND PHYSIOLOGY OF DEER FED DIELDRIN CONTAMINATED DIETS
L.J. KORSCHGEN, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Procedures supplement and continue progress of this study during 1964-1968 when continuing phases of this study were conducted. Field aspects of the investigation were completed during fiscal year 1968- 69, with sacrifice of the experimental herd of treated and control animals. Laboratory analyses for residues in brain, liver, and muscle tissues were performed by WARF Institute, Inc., Madison, Wisconsin, for 140 animals which survived to termination date or were lost during 4 years of herd maintenance and 3 years of production.

Objectives and procedures for the year are to compile, analyze, and interpret data from the five-year investigation and prepare a final report of results.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0745, A STUDY OF THE DEGRADATION RATE OF ALDRIN
L.J. KORSCHGEN, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Procedures and objectives of this investigation continue progress of a phase of study initiated in 1964-65, otherwise titled 'Soil- Food Chain-Pesticide Wildlife Relationships', primary objectives of which were fulfilled during fiscal year 1968-69. The objective of this phase of study is to obtain residue data from soil and earthworms during the fifth year following five annual applications of aldrin at recommended rates for pest control with no further treatment. Increased knowledge relative to the degradation rate of aldrin and its metabolite, dieldrin, will be gained from the investigation.

Procedures: (1) Collect two each of pooled soil and earthworm samples during October 1969 and April 1970. (2) Submit samples to WARF Institute, Inc . Madison, Wisconsin, for residue analyses. (3) Compile and compare residue results with previously accumulated data to show trend in rate of aldrin degradation, and prepare annual report.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0746, DEGRADATION AND PERSISTENCE OF ALDRIN
L.J. KORSCHGEN, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Previous work on this investigation, initiated in 1965, has involved collection of soils and earthworms from one field after five annual aldrin treatments and no further applications. Results from spring and fall sampling through spring 1970 provide data for year to year comparisons of aldrin and dieldrin residues and a basis for determining potential hazards to wildlife from the utilization of foods obtained from pesticide-treated habitat.

The objective of this segment of work is to compile data collected semi-annually for 5 years to show the rate of aldrin disappearance, and to prepare a final report.

Procedures: 1. Assemble aldrin-dieldrin residue data derived from analyses by WARF Institute, Inc., Madison, Wisconsin, of 22 pooled samples each of soils and earthworms collected from spring 1965 through spring 1970. 2. Analyze and interpret data to show rate of aldrin degradation and persistence. 3. Prepare final technical report for publication.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0747, EFFECTS OF A PESTICIDE ON REPRODUCTION OF CONFINED COTTONTAILS
K.C. SADLER, State Dept. of Conserv., *Jefferson City, Missouri* 65102

The purpose of this investigation is to test the effects of dieldrin, administered at 0.5 and 2 pounds per acre, on reproduction of confined cottontails.

This is the fourth year of a five-year study supported by a grant from the U.S. Bureau of Sport Fisheries and Wildlife and is a cooperative project involving Clinton H. Conaway, Professor of Zoology, University of Missouri; W. Reid Goforth, Biologist, Bureau of Sport Fisheries and Wildlife, and the writer; with John Elliston as research assistant.

Experiments are being carried out in pens on the University of Missouri's Ashland Wildlife Area, Ashland, Missouri. Reproductive performance of cottontails held under semi-wild conditions are being analyzed after exposure to dieldrin for one or more years. Of special interest will be the sub-lethal effects of dieldrin on timing of the onset of reproduction, ovulation rates and embryonic mortality under the two experimental pesticide levels and the control population.

Tissue analyses will be made to note differences in pesticide levels detectible in rabbits under different applications.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0748, MAMMALS, FISHES AND BIRDS OF MONTANA

C.J. BROWN, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715 (MONB00400)

OBJECTIVE: Secure basic biological information on mammals, fishes, and birds of Montana which can be used as a basis for the management of these groups. Since the management of these animals is the responsibility of the State Fish and Game Department, it is desirable that research be conducted in cooperation with that agency.

APPROACH: Standard procedures will be followed to study natural populations of fish, birds, and game, including habitat, competition, food habits, reproduction, growth and losses. Man-made effects on environment, including pollution, dam construction, pesticides, hunting, etc. will be examined.

PROGRESS: C.J.D. Brown-Fishes: I. Projects completed during past year: A. Two fish parasite studies; (1) Migration routes and pathological effects of larval trematodes, (2) Life cycle and sub-lethal effects of a heart-infecting trematode; B. Movement behavior of cutthroat trout; C. Acoustical phenomena in relation to cutthroat trout movement; D. Serological study of cutthroat trout; E. Distribution and ecology of trout fingerlings; F. Life history of the mountain sucker; II. Projects continuing during next year: A. Movement behavior of cutthroat trout; B. Stream limnological studies; C. Parasitic fauna of cutthroat trout; D. Movement behavior of mountain whitefish; E. Life history of river-dwelling lake sturgeon; F. Montana Fishes (Bulletin). D.C. Quimby-Mammals: (1) Effects of chemical control of sagebrush on small mammal populations*, (2) Effects of chemical control of sagebrush on pronghorn antelope populations*, (3) Mule deer-whitetail deer range relations in Snowy Mts.*, (4) Relationship of mule deer to summer range and livestock in the Pryor Mts.*, (5) Elk-livestock relations in Crow Creek Drainage (terminated 9/30/68), (6) Food habits, range-use, movements, and relationship of antelope to livestock SE Montana*, (7) Populations, range-use, and distribution of moose in the upper Centennial Valley SW Montana*. Robert L. Eng: A. Small bird population with respect to sage brush manipulation - continuation (post- spray phase). B. Bluegrouse behavior and territorial requirements - continuation. C. Juvenile sage grouse food habits - continuation.

SUPPORTED BY Montana State Government

4.0749, EFFECTS OF CHEMICAL SAGEBRUSH CONTROL ON MULE DEER IN THE MISSOURI RIVER BREAKS, MONTANA

E.F. SCHLATTERER, State Fish & Game Department, *Helena, Montana* 59601

Objectives: To determine the effects of chemical sagebrush control on mule deer habitat in the Missouri Breaks.

Procedures: 1. Attach radio transmitters on two or more deer and mark others with collars that regularly use the study area. Weekly observations will be made of these deer to determine key areas of seasonal use within the study area. Particular attention will be given to the late winter and early spring period when more intensive use of sagebrush has been previously noted 2. Sample the vegetation on treatment and control areas prior to and after sagebrush removal. 3. Systematically travel vehicle observation routes and record numbers and distribution of mule deer observed on various vegetation types and physiographic sites. 4. Establish permanent plots on which deer pellet group and cow chip counts will be made. 5. Establish and read forage utilization, production, and condition trend sample units for important forage species on various vegetational communities on and adjacent to treatment and control pastures.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0750, ORGANIC PHOSPHATE SYSTEMIC INSECTICIDES AND EMBRYONIC SURVIVAL AND DEVELOPMENT IN THE BOVINE

R.A. BELLOWS, U.S. Dept. of Agriculture, Animal Science Research Div., *Miles City, Montana* 59301 (033003912 1327)

OBJECTIVE: Determine whether either of two systemic organic phosphate insecticides administered to beef cows at two levels have deleterious effects on embryo development.

APPROACH: Virgin beef heifers with no history of recent organic phosphate treatment were maintained in drylot at nutritional levels recommended for optimum reproduction. After 60 days they were bred and assigned to treatments of two levels (recommended and minimum toxic) of Rueline or Co-Ral administered from 10 to 125 days of pregnancy. At calving time calves were examined for normality. Abnormal calves or calves dying early in life were studied by detailed post mortem examination. After the results are summarized a second experimental phase will be designed if necessary to elucidate the mode of action of the pesticides.

PROGRESS: Treatment of beef heifers with systemic, organo- phosphate insecticides (Ruelene or Co-Ral) during early stages of pregnancy failed to indicate deleterious effects on embryo development. No effect was noted on conception rate, number of services per conception or embryo survival. Data are presently being summarized in preparation for publication

SUPPORTED BY U.S. Dept. of Agriculture

4.0751, ORGANIC PHOSPHATE SYSTEMIC INSECTICIDES AND EMBRYONIC SURVIVAL AND DEVELOPMENT IN THE BOVINE

R.A. BELLOWS, U.S. Dept. of Agriculture, Range Livestock Station, *Miles City, Montana* 59301 (033003932 1327)

OBJECTIVE: Completed.

APPROACH: Comp leted.

PROGRESS: Treatment of beef heifers with systemic, organo- phosphate insecticides (Ruelene or Co-Ral) during early stages of pregnancy through m-Linear research at Miles City, Montana failed to indicate deleterious effects on embryo development. No effect was noted on conception rate, number of services per conception or embryo survival.

SUPPORTED BY U.S. Dept. of Agriculture

4.0752, THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA

A.R. GAUFIN, Univ. of Montana, Graduate School, *Missoula, Montana* 59801

Samples of water, mud, plankton, higher aquatic plants, fish, bird eggs, and fat from birds as pheasant, and deer will be analyzed with a gas chromatograph for residual pesticides. The procedures to be used for the chromatographic analysis will necessarily have to be varied with the type of sample, but analyses performed on deer fat samples during the last year are indicative of methods which will be used. The analyses were performed using a model 27-700 chromatograph manufactured by the Jarrell-Ash Co. The chromatograph is equipped with an electron capture detector employing tritium coated foil as an electron source. The 46' x 1/4' pyrex column was packed with 1.5% Se- 30 on Chromasorb G SMCS, A/W, 70/80 mesh. The carrier gas, nitrogen, was maintained at 28 lbs. per sq. inch. The column temperature was 185 degrees C.; the detector temperature was 190 degrees C.; the injector temperature was 185 degrees C.

The extraction procedure was the same for each sample. Fifteen grams of the wet tissue were dessicated for 36 hours at 60

degrees C., then transferred to a mortar and pestle and homogenized. A 1.10 gram sample of the homogenized material was extracted in a 10 milliliter tissue grinder four times, using 5 milliliters of nano grade hexane for each extraction. The 20 milliliters of extract were filtered, the filtrate evaporated to 5 milliliters and transferred to a tightly capped serum vial for analysis. For the analysis 15 to 30 microlite aliquots were injected into the chromatograph.

The number of samples which will be analyzed will be dependent on the personnel and time available, but enough samples will be tested to be significant. The samples will be taken from various areas in the Flathead Lake-Ninepipe Reservoir drainage system and pesticide levels will be correlated with such data as sources of contamination, plankton productivity, nesting populations of ospreys, fish distribution and kills. Inasmuch as a project is being conducted at the Biological Station dealing with plankton productivity and water quality in the lake, and the Fish and Game Department is conducting a study of fish populations in the lake this proposed project will be coordinated with these other studies.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0753, CO-RAL, RUELINE AND EMBRYONIC SURVIVAL AND DEVELOPMENT IN THE BOVINE
R.D. HUMPHREY, Fort Robinson Beef Cattle Sta., *Fort Robinson, Nebraska* 69339 (03300392213?8)

OBJECTIVE: Completed.

APPROACH: Completed.

PROGRESS: Related work at Crawford, Nebraska suggested treatment on day 40 of gestation had a teratogenic effect on the embryo. The effect resulted in a missing or constricted segment of the colon of the newborn calf. However, subsequent studies involving 99 cows treated during the suggested 'critical period' including days 35 to 46 of gestation failed to confirm the initial finding.

SUPPORTED BY U.S. Dept. of Agriculture

4.0754, THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH
N. STUCKY, State Game & Parks Commission, *Lincoln, Nebraska* 68509

Objectives: 1. To complete and publish the manuscript begun in Segment 15. 2. To complete statistical analysis of data collected from six drainages in Nebraska and prepare for publication those aspects of the study which warrant reporting in technical journals.

Procedures: 1. Complete and publish the manuscript begun in Segment 15. This will be a descriptive paper expressing the results obtained from analyzing channel catfish fat and blood samples for DDT and dieldrin residues. Samples were collected from 18 major drainages in Nebraska. The manuscript will be submitted for publication in 'Pesticides Monitoring Journal.' 2. Compile data obtained from six major drainages and analyze statistically the relationship between pesticide residue detected in fish and various physical parameters. The established parameters are: rainfall, land use, drainage basin size, and calculated amount of pesticides applied during the period from 1960 to 1964. Preparation of a manuscript for publication is conditional pending the outcome of the statistical analyses.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0755, PESTICIDE DATA - PHEASANT
C.W. WOLFE, State Game & Parks Commission, *Lincoln, Nebraska* 68509

Objectives: To complete chemical analysis of pheasant eggs, and statistical programming and analysis of pesticide data collected in conjunction with previous job segments.

Procedures: Pheasant eggs collected on the Harvard and Clay Center Study Areas will be analyzed by electron-capture chromatography. This data and other pesticide data will be combined for statistical analysis. Programming and analysis will be conducted in conjuncton with the Statistical Laboratory, University of Nebraska. Emphasis will be placed on: 1. Residue levels in eggs, and 2. Effects of pesticides on reproduction. Results will be submitted for publication in a technical journal.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0756, EFFECTS OF ETHYL PARATHION ON PHEASANTS
C.W. WOLFE, State Game & Parks Commission, *Lincoln, Nebraska* 68509

Objectives: To determine the effect of ethyl parathion on the ring-necked pheasant.

Procedures: 1. Work will be directed toward completion of tabulation and analysis of blood and brain cholinesterase levels. 2. A complete review of effects of stress on cholinesterase levels will be made. 3. Data will be incorporated into two technical publications; one will be prepared for entomological interests, the other for wildlife interests.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0757, FIELD AND LABORATORY INVESTIGATIONS OF INSECTICIDES
A.F. HAGEN, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-17-016)

OBJECTIVE: Evaluate and test new insecticides, formulating application rates and methods for control of injurious insects and to investigate possible cases of resistance to insecticides.

APPROACH: Suspected cases of insecticidal resistance in the field will be investigated by removing and treating cultures under controlled conditions in the laboratory.

PROGRESS: Toxicity of ethyl parathion to juvenile pheasants was studied. No direct mortality of pheasants was observed. Insect populations were reduced. Sevin continued to give good control of western bear cutworm. Biological factors (parasites, predators and diseases) also aid in population reduction. Malathion applied to a wide area apparently has no long range effects on insects other than rootworms. Overall rootworm populations were reduced 50% in treated area. Adult populations were reduced 90%. TIBA alone and in combination with the systemic insecticides Di-Syston and metasystox-R increased soybean yields significantly. Yields from insecticide treatments alone were not significantly different from the check. Twenty-two insecticide treatments were tested against the pale western cutworm in wheat (13 chemicals at various rates and formulations). All were better than the check. Five gave excellent control; the rest were mediocre. All chemicals tested should leave no residue at harvest. Four chemicals were tested for residue on alfalfa. One chemical was tested for residue in the soil and one was tested for residue as a seed treatment of field beans. The results of these tests are not known at this time.

SUPPORTED BY U.S. Dept. of Agriculture

4.0758, METABOLIC INTERRELATIONSHIPS AFFECTING NUTRIENT ENERGY REQUIREMENTS OF HUMANS
C. KIES, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-91-007)

OBJECTIVE: Determine interrelationships among the essential amino acids which affect ideal amino acid proportionality patterns for humans; determine qualitative, quantitative dietary fat-protein interrelationships as factors affecting human blood lipid patterns; investigate nutrient interrelationships affecting the adequacy of non- animal and unconventional proteins to meet protein needs of humans; and, study the possible influences of naturally occurring and incidental anti-nutrients on vitamin requirements, such as herbicide residues on pantothenic acid requirements.

APPROACH: The characteristic quantitative pattern of dietary amino acids consistant with optimum protein nutrition in adult humans will be determined. The influence of qualitative and quantitative alterations in nitrogen intake on the blood lipid fractions and the fatty acid components of these fractions will be studied. The effects of altering nitrogenous components of the diet and caloric intake on the utilization of non-conventional proteins

as well as the effect of herbicide residues on the metabolism of pantothenic acid will be determined.

PROGRESS: Determine the first limiting amino acid in rye flour for maintenance of protein nutritive in human adults was the objective of the first study. Mean nitrogen balance of 10 adult men fed 4.0 g N rye flour diets supplemented with L-methionine, L-tryptophan, L-lysine, a combination of all three amino acids, or no supplement were -1.28, - 1.21, -1.08, -0.58 and -0.58 g N/day, respectively, indicating lysine as being the first limiting amino acid in rye. The objective of a second study was to study lysine-tryptophan interrelationships affecting protein requirements of adult men. Using a semi-synthetic, controlled diet, 9 men were fed low, medium and high levels of tryptophan and of lysine in all possible combinations (low L low T, medium L low T, etc.). The feeding phase of this study has been completed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0759, STUDY OF INJURIOUS INSECTS ON FORAGE CROPS

W.H. ARNETT, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00138)

OBJECTIVE: Study biology and behavior of insect pests affecting forage crops and develop the best control means utilizing chemical, cultural and biological methods. Relate pest populations with damage produced to forage crops and collect residue data on chemicals used for forage insect control.

APPROACH: Greenhouse, laboratory and field studies will be designed and conducted to obtain information and biology and behavior of both pest and beneficial insects on forage crops. Chemicals and cultural practices will be evaluated as to their impact on both pest and beneficial insects and pest population levels will be correlated with both qualitative and quantitative aspects of damages. Samples will be collect in order to determine persistence and magnitude of insecticide chemicals in forage crops.

PROGRESS: Applications of various insecticides as early spring treatments against the adult alfalfa weevil indicated that only RCS-2123 gave a high degree of control. Comparative applications of Furadan, carbaryl and methyl parathion indicated that Furadan gave as good or slightly better control of alfalfa weevil than either of the presently recommended materials. Populations of pea aphids remained well below economic levels following use of Furadan but increased to economic levels following carbaryl treatments. Timing treatments comparing Furadan, 8 and 16 oz. per acre with the same rates of methyl parathion indicated that both rates of Furadan gave effective larvae control up to 28 days whereas with methyl parathion control was obtained for 10-14 days. Similar weevil larvae control was obtained when two formulations of Furadan (75WP and 4 lb. F) were compared. Comparisons of Furadan and Guthion indicated that similar dosages rated gave equivalent degree of weevil larvae control over a 10-14 day period. Experiment materials tested on small plots which gave excellent weevil larvae control included: SD 1698, 8 oz. per acre; SD17250, 8 oz.; VC506, 16 oz.; Bayer 68138, 8 oz.; Bayer 93820, 12 oz.; Ortho 11775, 16 oz.; Ortho 11776, 16 oz.; UC 34096, 32 oz. Data on the effect of pesticides on beneficial (predators) insects were obtained from all field plots.

SUPPORTED BY U.S. Dept. of Agriculture

4.0760, BEE INVESTIGATIONS

B.B. PEPPER, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00406)

OBJECTIVE: Varietal preference of solitary, bumblebees and honey bees when working blueberry bloom. Attractiveness of cranberry bloom to pollinating insects as affected by climatic factors and plant competition. Management of bees to obtain known crosses or selfpollination in holly, asparagus and blueberries.

APPROACH: Field observations to determine attractiveness of bloom to various pollinating insects. Blossom and fruit counts to determine degree of pollination in plantings. Cage tests with honey bee pollinators. Seed counts, measurement of berry size and weight of self and cross pollinated bloom.

PROGRESS: As a result of grower concern, bee activity on holly was observed to compare dimethoate-treated with untreated or lindane-treated trees. Although bloom was heavy and sticky with nectar, dimethoate- treated trees had almost no bees working while activity appeared normal where other insecticides or no sprays were used. Controlled experiments on bee repellency by dimethoate on holly are being planned for 1970. Brood food was collected from colonies in the New Jersey regions of high and low European foulbrood incidence. Brood food pH ranged from 4.1 to 5.2 with no apparent correlation with regions. Brood rearing ceased in caged colonies so no brood food could be collected from them. Royal jelly and brood food samples were frozen for bacteriological examination. An automatic pollen trap was perfected for recording the time of day pollen pellets are collected by bees. It consists of a sticky revolving cylinder which holds pollen loads scraped from the legs of bees entering the hive through a grid above the cylinder. Pollen collections were made by both automatic and manual traps during cranberry bloom to study the time of day bees concentrate on cranberry bloom and to discover variations among hives in the percentages of cranberry pollen collected.

SUPPORTED BY New Jersey State Government - Trenton

4.0761, WEED CONTROL IN ORNAMENTAL NURSERY STOCK

W.V. WELKER, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00150)

OBJECTIVE: Evaluate herbicides for the control of weeds in nursery stock, various methods of application of herbicides to nursery stock raised in containers, and investigate the long term effects of repeat applications of herbicides upon growth and quality of nursery stock.

APPROACH: Studies will be conducted in the greenhouse and field. Acceptable statistical designs shall be used in all cases. All data will be subjected to statistical analyses and interpretation. Data will be collected on the effect of the herbicides on growth and vigor of the crop and selectivity of the weeds. The effects of repeat application of the same herbicide on the same plot shall be measured over a number of years. Greenhouse screening of new chemicals for use on nursery stock shall be conducted periodically as promising new chemicals are made available.

PROGRESS: A greenhouse screening program to evaluate tolerance of Pyracantha and Juniper to various herbicides was initiated in the summer of 1969. Seventeen herbicides at various rates were tested. The herbicides were applied to the soil to one group and the foliage of another while the soil was covered. These are still being evaluated. Injury symptoms are being noted and photographed. In a field study including Japanese holly and Taxus, the same herbicides were applied for the third year. All treatments have been applied in the fall each year. Satisfactory weed control has been obtained with dichlobenil, simazine, terbacil, and linuron through the first of July. Sinbar gave satisfactory weed control through the entire season. Slight injury symptoms were noted for the first time on those plants receiving the terbacil treatment. No other injury was noted.

SUPPORTED BY New Jersey State Government - Trenton

4.0762, INCREASED BODY METABOLISM AND EXCRETION RATE OF PESTICIDE FROM DAIRY COWS

D.D. MILLER, New Mexico State University, Agricultural Experiment Sta., *Las Cruces, New Mexico* 88070 (NM00151)

OBJECTIVE: Determine the effect of various levels of body metabolism on the rate of excretion of pesticide through the milk by contaminated cows.

APPROACH: Sixteen bred heifers will be contaminated with DDT so that after calving they will secrete between 5 and 10 ppm in their milk. Four will be fed a normal ration; four a normal ration plus thyroprotein; four a two-thirds normal ration; and four a two-thirds normal ration plus thyroprotein. The milk will be tested weekly until it is free of pesticide. Change in body weight and total milk production of all animals will be recorded.

PROGRESS: Studies were continued on DDT contaminated cows secreting milk containing between 7 and 12 ppm of pesticide on a milk fat basis. Previously it had been shown that cows receiving a low- energy diet for 42 days would have the time required for the pesticide level in their milk to reach 1.25 ppm shortened by approximately 75 days. Work this past year has

shown that if the cows can be obtained in the expulsion of DDT. If this ketotic condition is implemented during the first 3 months of the cow's lactation, no appreciable reduction in the cow's total milk production will occur. Even though this is an appreciable reduction in time of removal of DDT, it still requires approximately 115 days to reduce the pesticide level from ca. 10 ppm to 1.25 ppm on a milk fat basis.

SUPPORTED BY U.S. Dept. of Agriculture

4.0763, TOXICITY AND CARCINOGENICITY OF DIPHENYLAMINE TO MICE

L. GOLBERG, Union College & University, School of Medicine, *Albany, New York* 12208 (HC-72(C))

OBJECTIVE: Determine the toxicity of diphenylamine administered orally to mice during a life span of 80 weeks.

APPROACH: A total of 600 male and 600 female weanling albino mice will be fed diets containing diphenylamine at three concentrations along with a control group which shall be fed a diphenylamine-free diet. Records of health and condition of the mice will be kept throughout the test. Analyses of various blood samples and examination of the major organs of autopsied animals during the course of the feeding tests and at their conclusion will furnish data to be included in a final evaluation and recommendation concerning toxicity of diphenylamine for its use as a scald inhibitor on apples.

PROGRESS: Feeding tests for determining toxicity of diphenylamine to mice were completed in June 1970. Final reports on all sacrificed animals and a summary of the findings will be forthcoming within a few months. The clinical state of the mice remained good throughout the tests with low mortality and well maintained body weights. The 20 mice sacrificed from each of the 4 feeding levels at the end of one year of the experiment showed no gross pathological changes in any of the mice attributable to the administration of diphenylamine. The detailed histopathological examinations on at least 16 different tissue areas showed slight variations between mice fed on different levels of diphenylamine. The significance, if any, of these differences must await a final evaluation of all data obtained. A suggestion for recommended level of diphenylamine on apples that would be considered safe is expected.

SUPPORTED BY U.S. Dept. of Agriculture

4.0764, SELECTIVE TOXICITY - AN APPROACH TO ENVIRONMENTAL HEALTH

T. GESSNER, State University of New York, School of Pharmacy, *Buffalo, New York* 14214

This will be a study of the comparative detoxication of various organic sulfur compounds, aimed at yielding information on the similarities and differences between mammalian and insect detoxication mechanisms. Compounds will be synthesized, where necessary with radioactive isotopes, and their metabolic fate determined in both mammals and insects of several species. The possible role of the above compounds as inhibitors of detoxicative processes will be studied by noting their effect on the biotransformation of several aromatic compounds whose normal metabolic fate is well documented. Efforts will be made to determine the sites of detoxication in insects. The knowledge resulting from this study should aid in the development of selective chemical pest control, and hence help in reducing the environmental health hazard resulting from the economically essential widespread use of pesticides.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0765, CONTROL OF APPLE INSECT PESTS WITH REDUCED SPRAY SCHEDULES

R.W. DEAN, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00549)

OBJECTIVE: Determine if the generalized orchard spray program now in use is necessary under present conditions of low pest populations existing in commercial orchards, or if it can be reduced or modified so as to lower production costs, lessen health hazards from exposure to insecticides and their residues, and reduce the rate of accumulation of persistent chemicals in the soil, all without permitting increases in pest damage.

APPROACH: Commercial orchard blocks, in which insect pests are now under good control, will be sprayed according to schedules which omit applications at less critical periods, or which depend upon coverage resulting from spray drift from adjoining treated rows. The most effective insecticides will be employed and applied by means of air- blast equipment, similar to that used in commercial operations. Insect damage will be assessed each season to detect any upward trends in injury levels.

PROGRESS: Reduced insecticide programs were continued in 2 test orchards outlined previously and initiated in 1 new orchard. After 4 years of testing on the Eldredge Farm, Claverack, N. Y., the average of clean fruit has increased. The basic insecticide in this block is Sevin. There was, however, a slight increase in apple maggot and plum curculio injury. The test in Crist Brothers Orchard, Walden, N. Y. utilized Gardona as the basic insecticide. There was an indication of a slight weakness of the chemical for European apply sawfly control, but control of the other apple insect pests has been good. No fruit injury, such as occurred in 1968, was noted this year with Gardona due possibly to better spray conditions and a lower rate of application than last year. A new block was initiated this year at the farm of Sidney Mead, Red Hook, N. Y. Imidan was the basic insecticide and control was excellent for all apple insects. From the results of these tests, it is indicated that in commercial plantings, where insect population pressures are low, adequate control can be obtained by alternate side spraying or skipping every other cover spray. The data suggests, however, that alternate sides of the row spraying may be the preferred method.

SUPPORTED BY New York State Government - Albany

4.0766, TOXICOLOGY AND METABOLISM OF UNINTENTIONAL FOOD ADDITIVES

G.S. STOEWSAND, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00629)

OBJECTIVE: Study the toxicity and metabolism of insecticides in animals with relation to specific nutritional and dietary effects and interactions.

APPROACH: Growing rats, consuming diets containing various amounts of protein, will be fed dieldrin or other insecticides that exhibit marked toxicity for mammals. If any interaction is indicated between the diet and the toxicity of the specific insecticide, further studies into the metabolism of the insecticide in the animals under various dietary regimens will be undertaken.

PROGRESS: A new organophosphate pesticide, 'Torak' is being studied regarding toxicity and metabolism in rats. This compound is 3-5 times more toxic in young female rats than males but no clear cut relationship is observed with quantity of dietary protein. 60% of this compound is eliminated via urine metabolites in 24 hours, and 40% is excreted in feces in 72 hours. Nitrate toxicity studies have shown that female Japanese Quail develop methemoglobin more readily than males. Feeding ascorbic acid has no effect in preventing nitrate-induced methemoglobin in this species. Additional studies with nitrate toxicosis and dietary ascorbic acid relationships in guinea pigs is under investigation.

SUPPORTED BY New York State Government - Albany

4.0767, EFFECTS OF CHEMICAL POLLUTANTS ON AVIAN REPRODUCTION

T.J. CADE, State University of New York, School of Agriculture, *Ithaca, New York* 14850

Our objective is to study the chronic, subiethal effects of organochlorine and other chemical residues on the reproduction of birds and to relate these effects to changes in population dynamics, especially in raptors. Specific aims are: in vitro studies of chemicals - especially PCB and toxaphene - that induce hepatic enzymes, which hydroxylate steroid hormones, and to correlate these effects with reproductive abnormalities; inhibition by chemical residues of carbonic anhydrase in the avian shell gland and correlation with eggshell thinning; inhibition of ATPase and glucose-6-Ca ion Na ion in the avian oviduct; studies on synergism between DDE and PCB in effects on eggshells of captive and wild Kestrels (Falco sparverius); monitoring selected

species of raptors in the field for eggshell changes, residue levels in eggs and tissues, changes in reproductive performance, and changes in numbers of breeding pairs. We are interested in these problems in relation to existing environmental levels of chemical pollution, and the two aspects of long- term chemical pollution that most concern us are synergism and the minimum chronic level of residues that initiated dysgenic reproductive effects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0768, FORAGE INSECT INVESTIGATIONS

G.G. GYRISCO, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00625)

OBJECTIVE: Study the biology, ecology, behavior and control of the insects of forage crops including alfalfa, clovers, birdsfoot trefoil, and corn; stressing the insects of alfalfa and in soil; with especial reference to the alfalfa weevil, alfalfa snout beetle, leafhoppers, plant bugs, spittlebugs, cutworms, European chafer, and rootworms.

APPROACH: Evaluate the effects of the insects on the yield and quality of forage crops, study their biology and behavior so as to control them better with parasites, cultural methods, resistant varieties, or insecticides, alone or in combination; thus to provide safe economical methods of pest control keeping the toxicant at a minimum with complete safety to dairy cattle, livestock, and in milk.

PROGRESS: Using sticky-type traps of 6 designs and 6 colors, alfalfa weevil flight and summer diapause was studied in open alfalfa fields and on alfalfa in large field cages. Alfalfa weevils flew with prevailing winds during their summer migration. Compass direction and distance from woods did not influence pre-flight orientation or flight direction. There may be an optimum range of wind speed necessary for maximum success in flight dispersal. No significant information in color preference was gained but weevils migrating in summer out of alfalfa to diapause sites in woods are not in a state of appetite behavior and really could not be expected to react to color as might be the case in fall and spring. Further work in these seasons is necessary. During August 5 fields in each of 6 counties were surveyed for the northern corn rootworm. A total of 600 plants were randomly examined in each field for visible damage and for adults, while the soil beneath 10 plants was hand-sorted for immature stages. Counts were generally low (less than 10/200 plants) and damage attributed to the insect was seen in only one field, not previously rotated.

SUPPORTED BY New York State Government - Albany

4.0769, EFFECT OF PROCESSING PROCEDURE ON MILK PESTICIDE RESIDUES WITH EMPHASIS ON RESIDUE REMOVAL

R.A. LEDFORD, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00171)

OBJECTIVE: Isolate representative microorganisms of the diverse flora associate with different varieties of cheese and to determine if their growth produces any degradation of chlorinated pesticides.

APPROACH: Different appropriate cheese types will be made with active isolates to ascertain pesticide degradation under commercial conditions.

PROGRESS: Cheese isolates of Brevibacterium linens and Geotrichum candidum were found to dechlorinate p-p DDT. Further, the growth of G. candidum appears to degrade DDE to unknown products. The identity of the breakdown products is under study. In cheese studies, where DDT was added to the milk and measurements of the residual DDT were made during the ripening process, casein was found to inhibit the pesticide degradation. The mechanism of this inhibition is being studied with particular emphasis on identifying conditions under which maximum pesticide degradation is achieved in fermented foods.

SUPPORTED BY U.S. Dept. of Agriculture

4.0770, RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES

D.J. LISK, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00637)

OBJECTIVE: Determine the content of pesticide chemicals, particularly at harvest, in or on raw agricultural commodities resulting from practical and experimental pesticide applications for control of pests above or below ground.

APPROACH: Plant growth regulators also will be considered. Analyses of milk, meat, poultry, and eggs for possible residues following experimental feeding of pesticide treated forage or grain crops also will be made. It is hoped that by proper combination of pesticide and method of application, that adequate pest control may be accomplished without exceeding legally established tolerance limits.

PROGRESS: During 1969, 1700 residue analyses were made including 19 agricultural chemicals and 17 commodities. Sensitive analytical methods were developed for an onion top killer, neodecanoic acid in onions, hexachlorophene fungicide in vegetables and a plant growth regulator, Ethrel. A new insecticide trapping system was developed for preparative gas chromatography. A method was adapted for analysis of mercury in soil and a silver-containing algacide in pond water. The metabolism of seven new agricultural chemicals (the insecticides Gardona and Hercules 14503 and the herbicides Amiben, Bromacil, Fenac, Herbisan and Planavin) were studied in dairy cows. Analysis of milk, urine and feces was conducted for these compounds and possible metabolites. The possibility of their decomposition in rumen fluid and liver microsomes was investigated to learn possible sites of metabolism. Most of this work has been submitted for publication. Research on analysis and metabolism of pesticides is essential for obtaining federal approval for pesticide use by the public.

SUPPORTED BY New York State Government - Albany

4.0771, STUDY OF HONEY BEES AND OTHER POLLINATING INSECTS AND PESTICIDE CHEMICAL MATERIALS

R.A. MORSE, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00143)

OBJECTIVE: Study the role of honey bees as pollinators, to acquire a knowledge of colony reproduction, to better understand evolution in bees, and to ascertain better ways of marketing honey.

APPROACH: Honey bees and wild bees are being collected, curated and determined to better understand the role of these insects in crop pollination. Reproduction in honey bees is being studied with observation hives and under controlled laboratory conditions; synthetic pheromones are being used to study their role in reproduction. In cooperation with the N.Y.S. conservation department, there is a continuing exploration of the effect of pesticides on bees. Honey and honey marketing are under investigation in cooperation with the Department of Food Science and the Finger Lakes Honey Producers Cooperative.

PROGRESS: A survey of the pesticides which kill honey bees in New York State showed that Sevin was present in 12 of the 13 samples of dead bees submitted for analysis. Observations of queen and drone honey bees taking mating flight in cages and confined areas, continued without any further knowledge being obtained and with our being no closer to the desired goal of having mating in confinement, than a year earlier. As a result of visits to two honey wine factories in Poland and observation of fermentations in that country, several new formulae for honey wine are being tested. Observations on the biology of swarming in honey bees have been completed and a thesis and final paper are expected shortly.

SUPPORTED BY U.S. Dept. of Agriculture

4.0772, MECHANISMS OF INSECTICIDAL ACTION

R.D. OBRIEN, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00119)

4. PESTICIDES

OBJECTIVE: Understand the precise mechanism by which insecticides, particularly chlorinated hydrocarbons, produce their toxic effects in mammals and insects.

APPROACH: The research for anti-enzyme activity in chlorinated hydrocarbons has been most unsuccessful, and the bulk of evidence suggests that these are agents which interfere with the organizational array in conducting membranes, rather than on enzymes. It is proposed to study the role of complex formation in the action of chlorinated hydrocarbons. Two initial procedures will be followed. One is to construct artificial membranes from materials which will provide a matrix into which one can insert membraneous material derived from mammalian and insect nerve tissue. The ion permeability and the electrical properties of these reconstructed membranes will be examined, particularly with a view to finding what properties are bestowed upon the system by the naturally derived component. Appropriate agents (including insecticides, transmitter substances, and selected drugs) will then be applied to the systems, and changes in the above properties, caused by complex formation between agent and natural membrane constituent, will be looked for.

PROGRESS: This study deals with the effect of insecticide upon materials (both synthetic and natural) incorporated into synthetic phospholipid bilayers, and the consequent effect upon the electrical and ion-permeability properties of those membranes. We have now mastered the technique of preparing such membranes from lecithin. Unfortunately, the failure rate is high and the lecithin has to be extensively purified following its preparation from eggs, every few weeks. Membranes may also be prepared from fully synthetic phospholipids, but they do not demonstrate the important properties which follow. With lecithin membranes (prepared in decane), we have been able to duplicate the observation of Mueller et al that the addition of 10 M valinomycin increases the conductance by 50-fold or more, an effect related to potassium flux. We have now reported that DDT at 3 x 10 M reverses this induced conductance. The effect of DDT is not given by dieldrin or lindane.

SUPPORTED BY U.S. Dept. of Agriculture

4.0773, TOXICOLOGICAL STUDIES OF DIELDRIN AND STEROIDS IN DOGS

W.J. VISEK, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00569)

OBJECTIVE: Study toxicological manifestations, reproductive performance and possible teratological effects in dogs following feeding of chlorinated hydrocarbon; study the effect of a chlorinated hydrcarbon on dogs fed simultaneously with hormonal substances; determine if the feeding of a commonly used chlorinated hydrocarbon and hormonal substances alter the ability of the liver microsomal enzymes to detoxify foreign compounds in dogs.

APPROACH: Beagle dogs will serve as experimental animals for studies of breeding and reproduction. Biochemical and enzymatic measurements will be carried out on all animals to determine ability to detoxify these and other agents when given intravenously. All animals will be necropsied and tissues will be analyzed for insecticide and evidence of damage due to the experimental treatments.

PROGRESS: The past calendar year represented the 4th year of this five year study upon the toxicological effects of dieldrin and steroids in dogs. Spermatozoa from males at bimonthly intervals have continued to show no changes attributable to treatment although there has been a sharp decline in prostatic secretion in 6 chloro-17 acetoxy-progesterone (CAP) fed dogs. Sixteen additional dogs were prepared with cystoprepuostomies to provide for collection of uncontaminated prostatic secretion. In such dogs CAP at 0.05 mg/kg/day reduced prostatic secretion 95% whereas with dieldrin 0.015 mg/kg/day plus CAP secretion decreased only 50% showing that the effects of exogenous female hormone on the dog prostate are decreased with dieldrin fed simultaneously. An interaction between 10 ppm dieldrin and CAP has also been shown in organ culture with dog and rat prostate. Testosterone reduces the toxic effects of high concentrations of dieldrin (10 ppm) on the dog prostate in organ culture. During the past year 36 male and 50 female dogs were necropsied for enzyme, histological and chemical analyses on 16 tissues per dog. These studies have shown no detrimental effects on reproduction when dieldrin is fed alone for 3 years at concentrations which are close to ambient levels. These studies have led to the development of a highly reliable biological system for detecting possible hormonal effects of chemicals in mammals.

SUPPORTED BY New York State Government - Albany

4.0774, TOXICOLOGICAL STUDIES OF DIELDRIN AND STEROIDS IN DOGS

W.J. VISEK, State University of New York, School of Agriculture, *Ithaca, New York* 14850

This is the fifth year of a 5 year study upon the effects of prolonged feeding of an insecticide, dieldrin, in combination with hormones, 6-chloro-17-acetoxy progesterone (CAP) and methyl testosterone (MT) in purebred male and female Beagle dogs. The daily intakes in mg/kg body weight/day are 0.0015 and 0.015 for dieldrin, 0.05 for CAP and 0.15 for MT. Reproductive performance of adult dogs and their offspring has been studied. Spermatogenesis and testicular histology are under investigation. The effect of dieldrin with and without CAP and MT on prostatic secretion in mongrel dogs with cystoprepuostomies is being studied in vivo and in organ culture. In vivo blood, clearances for zoxazolamine have been determined at intervals and liver drug metabolizing enzymes have been studied in 68 animals after the treatment has been administered for more than one year. The females will be sacrificed this year and the males of the study have been necropsied. All assigned animals and a number of abnormal offspring have been or will be necropsied for gross and histological pathology and for analyses of insecticides.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0775, EFFECTS OF DDT AND DIELDRIN ON REPRODUCTIVE PERFORMANCE AND GROWTH OF MINK

H.F. TRAVIS, U.S. Dept. of Agriculture, Animal Science Research Div., *Ithaca, New York* 14850 (033400521333)

OBJECTIVE: Determine effects of DDT and analogs, and dieldrin on health, reproduction and growth of mink.

APPROACH: 128 female and 64 male mink will be fed on eight diets (16 females and 8 males per group) during one growth and reproduction cycle to determine the effects of 1, 2 and 20 parts per million of oral ortho-para DDT (O, P' DDT) and 1 and 5 parts per million of oral dieldrin. Lake Michigan coho salmon, and the DDT, metabolites and dieldrin found in coho salmon will also be fed. Weights will be taken monthly and reproductive performance will be recorded. Samples of feed and tissues will be analyzed for pesticide content.

PROGRESS: Decreases in reproduction in mink fed fish obtained from the Great Lakes has been attributed to possible pesticide contamination. That p,p'-DDT was the causative agent was ruled out by a 3 year study on successive generations of mink where daily ingestion of up to 100 ppm did not influence reproduction. However, some commercial DDT contains 20% of the o,p'-isomer of DDT and this was shown to the uterotrophic in rats and mink at Ithaca. Its effect on reproduction when included at 1, 2 and 20 ppm of the daily ration of mink was investigated. No effect of the pesticide on fertility or fecundity were noted. Nowever, 10 of 10 animals fed 50% Coho salmon in their diets failed to whelp. Analysis of the fish showed the presence of 2.87 ppm p,p'-DDT, 0.82 ppm p,p-DDD and 6.40 ppm DDE. When these metabolites were included in the normal ranch ration 10 females produced only 6 kits compared to 44 for 10 controls. Dieldrin at 1 ppm had no effect on fertility or fecundity while a slight decrease in fecundity was noted at 5 ppm. All animals had been on these respective diets for 120 days prior to mating. In addition, 4 of the 10 mink receiving Coho salmon died and another 3 were necropsied in an emaciated condition. These mink were hypersensitive and slightly ataxic when killed. No significant gross or microscopic findings were obtained. Most outstanding changes were in the periportal areas of the liver where inflammatory reactions were noted. The significance of these observations is not clear.

SUPPORTED BY U.S. Dept. of Agriculture

4.0776, NEUTRALIZATION OF ROTENONE WITH ACTIVATED CHARCOAL

H.A. LOEB, State Conservation Department, *Livingston Manor, New York* 12578

Objective: To develop a method of neutralizing rotenone products in streams with powdered, activated carbon.

Procedure: Neutralization of rotenone in streams is desirable for delineation of test sections. Activated carbon would be preferable for neutralization because it is non-toxic.

A range of concentrations of activated carbon will be tested against 1 and 5 ppm of Noxfish for one hour. Effective concentrations will be tested for shorter periods in an attempt to determine the lowest concentration which neutralizes Noxfish (reduce to less than 0.03 ppm) in a practical time of 15 minutes or less.

Five and 20 gallon aquaria will be used in 65 degree F. water baths. Minimum number of fish for final bioassays will be 11. Water will have a range in pH of 6.5 to 7.5.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0777, EGG COMPOSITION, MALATHION RESIDUES, AND MEAT QUALITY OF MALATHION TREATED HENS

K. MORGAREIDGE, Food & Drug Res. Labs. Inc., *Maspeth, New York* 11378 (HN1-23(C))

OBJECTIVE: Determine effect of malathion treatment by measuring residue in tissues of laying hens. Correlate date with nutrient content of eggs and quality of raw and cooked tissues from non-frozen or 6 month freezer-stored carcasses.

APPROACH: Use normal laying hens of known breed. Malathion treatments, 100 and 1000 ppm, avoid toxicity to hens, assures insecticide residues within tolerance limits. Collect eggs from control and treatment pens before dosing. Sample hens and eggs during treatment. Assay for residues of malathion and metabolites in raw and cooked muscles, liver, abdominal fat, egg yolks and egg whites. Obtain data on eating quality, cooking losses, yields, of meat, cooked and stored. Analyze whites and yolks of eggs before and after treatment for proximate composition and amino acid profiles; yolks for cholesterol, vitamin A, carotenoids, and fatty acid profile: glycerol fraction and phospholipid fraction.

PROGRESS: Laying young hens were placed on an 8-week feeding period to test levels of 100 ppm and 1000 ppm malathion in the diet on the nutritive value of the eggs and on the eating quality of the cooked meat. Neither level produced any toxic effect. Taste panel evaluations gave no indication of an effect on flavor of the cooked meat. Residues of malathion were found in less than 0.5 ppm only in chicken fat, egg whites and egg yolks. Chemical analyses of egg whites and egg yolks showed no effect on nutrients including proximate composition, fatty acid distribution, amino acids, and carotene.

SUPPORTED BY U.S. Dept. of Agriculture

4.0778, TISSUE STRUCTURE AND GROWTH OF RATS FED LARD CONTAINING INSECTICIDES

H KAUNITZ, Columbia University, School of Medicine, *New York, New York* 10032 (HN2-49(CA))

OBJECTIVE: Determine the influence of feeding lard from hogs that had been fed diets containing DDT, malathion and methoxychlor.

APPROACH: Feed rats from weaning diets identical in all respects except for the lard from hogs fed diets containing different kinds and levels of insecticides. Sacrifice groups of rats at 7 months and one year of age. Determine rate of growth and examine microscopically tissues removed at death.

PROGRESS: Thirty-three and 56-week feeding studies indicated little adverse effect when diets contained heptachlor or DDT except with relatively high levels of heptachlor or DDT. Weanling male rats were fed lards derived from hogs fed or sprayed with the insecticides under investigation. The diets were marginal with respect to iodine needs and contained 20 micrograms of iodine. Body weights and food intakes were measured regularly. Hearts, aortas, lungs, livers, adrenals, kidneys, stomachs, testes, thyroids, pituitaries, and brains were weighed and examined histologically. There were no differences among the groups except for the thyroids. The lards from hogs fed or sprayed with malathion contained insignificant amounts of malathion and thyroids were comparable to those in control rats. Thyroids showed signs of iodine deficiency that were significantly more pronounced in those rats fed lards containing high levels of DDT or heptachlor than in the control animals or in those containing levels of DDT or heptachlor within the range currently considered acceptable.

SUPPORTED BY U.S. Dept. of Agriculture

4.0779, BEHAVIOR OF DILUTE SOLUTIONS OF MERCURIC SALTS

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From a toxicological point of view, the measurement of small quantities of mercury is a very important procedure. In the development of a method to do so, the surprising discovery through the use of Hg203 was the rather rapid escape of radioactivity from very dilute solutions. It is obvious that meaningful measurements cannot be obtained unless there is assurance that no losses had occurred in the samples.

It had been previously reported that certain bacteria normally present could reduce mercury to the elemental state which could then volatilize. Preliminary work indicated that even without the bacteria, dilute solutions would lose mercury. An understanding of the mechanism by which the loss occurs would indicate the proper action necessary to prevent it.

It is proposed to study the movement through the use of Hg203 in a closed system in order to find the conditions favoring the movement.

RESULTS: A thermodynamic consideration of the different oxidation states of mercury indicates that the most probable path is a reduction of the mercuric ion to the mercurous form. The mercurous form can then disproportionate to form one mercuric ion and one elemental mercury atom for each Hg2 super 2 plus ion. This mechanism would be favored in the more dilute solutions.

SUPPORTED BY U.S. Atomic Energy Commission

4.0780, COLLABORATIVE RESEARCH IN ENZYME INDUCTION BY CHLORINATED HYDROCARBONS IN BIRDS - ITS ECOLOGICAL SIGNIFICANCE

C.F. WURSTER, State University of New York, Graduate School, *Stony Brook, New York* 11790

Chlorinated hydrocarbons of agricultural and industrial origin have become widespread pollutants in the global ecosystem. Recently they have been shown to be inducers of hepatic enzymes that degrade steroids, including the sex hormones. This effect may be of great ecological significance. Livers from populations of selected species of birds will be assayed for enzymes induced by chlorinated hydrocarbons. Enzyme activity will be related to the concentrations of individual and of total chlorinated hydrocarbons in the liver and to the total chlorinates hydrocarbon and lipid content of the birds. Estimates of the number of different enzymes induced will be made. Experiments with caged birds will attempt to determine the metabolic relationships between the thin egg-shells observed in populations heavily contaminated by chlorinated hydrocarbons and the induced enzymes. The formation of medullary bone, which is a mobilizable source of calcium during egg-laying, is controlled by the steroid sex hormones, naturally in female birds and artificially in male birds. Experiments with domestic pigeons and American kestrels will determine the relationship between the measured enzyme activity and the amount of medullary bone formed. The possibility that the thin eggshells are caused by vitamin D deficiencies resulting from degradation of this steroid by the induced enzymes will be investigated. Since Vitamin A mobilization is also effected by estrogen levels in birds, eggs of contaminated birds might be deficient in Vitamin A. Vitamin A will therefore be determined in some eggs. Measurements of shell weight and thickness of sea bird eggs collected recently will be made and compared.

4. PESTICIDES

SUPPORTED BY U.S. National Science Foundation

4.0781, METABOLISM AND PHYSIOLOGICAL ASPECTS OF INGESTED HYDROCARBONS
P.W. ALBRO, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The investigation is in progress of the relationship(s) of accumulation of dietary paraffins in animal tissues to such suspected pathologic effects as lipidoses, co-carcinogenesis, and interference with reticular endothelial functions as well as the role of pesticides, synergists and drugs in regard to metabolic pathways of individual hydrocarbons from defined diets.

Piperonyl butoxide has been found not to inhibit the conversion of administered hexadecane to bile acids after oral administration of the synergist.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0782, EFFECT OF METHYLENEDIOXYPHENYL SYNERGISTS AND RELATED COMPOUNDS ON MICROSOMAL DRUG METABOLIZING ENZYMES
M. BICK, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The investigation of the possible inductive or inhibiting effect of methylenedioxyphenyl pesticidal synergists such as piperonyl butoxide on microsomal drug metabolizing enzymes (e.g., aminopyrene, ethylmorphine and nitroanisole demethylases) in various tissues (lung, kidney, brain and small intestine) is in progress.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0783, THE INFLUENCE OF ENVIRONMENTAL AGENTS ON THE GENESIS OF RIBOSOMES IN MAMMALIAN CELLS
P.E. BRUBAKER, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

Due to differences in stability and physiological activity of ribosomes in dividing and non-dividing cells, studies have been initiated to: 1) determine the conservation of parental ribosomes in daughter cells and their capacity to support protein synthesis; 2) determine the rate of ribosome subunits biogenesis in daughter cells and their role in protein synthesis; 3) determine the degree these processes are altered in cells exposed to various environmental agents. Ribosome, ribosomal subunit and polysome levels change significantly as cell progress through the cell cycle. These profiles are markedly altered on cells treated with various chlorinated hydrocarbons. Alterations are being made to correlate the physiological effects of the pesticidal compounds with structure.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0784, THE EVALUATION OF CARBAMATE-INDUCED ANTICHOLINESTERASE EFFECTS IN THE FETUS
N. CHERNOFF, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

Effects of pesticides that inhibit acetylcholinesterase are being studied relative to the levels of this enzyme in developing mammalian fetuses.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0785, THE TERATOGENIC EVALUATION OF THE HERBICIDE 2,4,5-T AND DIOXIN
K.D. COURTNEY, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

Herbicides of the phenoxyacetic acid class and dioxins are being evaluated for their teratogenic and perinatal toxic effects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0786, METABOLISM AND DISTRIBUTION OF 2,4,5-T AND ITS ANALOGS IN PREGNANT AND NONPREGNANT RATS, MICE, AND GUINEA PIGS
K.D. COURTNEY, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

Metabolism and distribution of 2,4,5-T and its and analogs are being investigated in pregnant and nonpregnant rats in an effort to explore potential correlations between these parameters and teratogenic effects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0787, PRENATAL AND NEONATAL EFFECTS OF PARAQUAT
B.C. ELIASON, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The weight gain and survival of neonatal rats are impaired by an i.v. dose of Paraquat given to the mother 1-2 days prior to birth. The mode of action and other effects are being investigated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0788, NORMAL AND MODIFIED PLACENTAL TRANSFER AND TISSUE DISTRIBUTION OF ENVIRONMENTAL AGENTS
B.C. ELIASON, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

With various environmental chemicals as models, mechanisms of placental transfer are being studied. Chemicals studied thus far, include dieldrin, paraquat and diquat.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0789, EVALUATION OF THE ANIMAL AND HUMAN COMPLAINTS FOLLOWING THE SPRAYING OF SILVEX, 2,4,5-T AND 2,4-D IN GLOBE, ARIZONA
B.C. ELIASON, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

As the medical member of a governmental panel, a trip was made to Globe, Arizona to study the claimed herbicide damage to animals and humans. A complete report is being prepared.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0790, METABOLISM OF PESTICIDAL SYNERGISTS
L. FISHBEIN, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The retention, localization and elimination of methylenedioxyphenyl pesticidal synergists following i.v., oral, and intratracheal administration to the rat is being further elaborated using C14-labeled methylenedioxy ring and alpha-methylene-C14-piperonyl butoxide. Special focus is centered on the elaboration of the commonality of urinary and fecal and biliary metabolites following administration via the above three routes.

Unequivocal identification of the nature of the metabolites of pesticidal synergistic agents, their tissue distribution and rates of elimination following various routes of administration would be of value toward the better understanding of the mechanisms controlling enzymic detoxification of this important class of environmental agent.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0791, THE EFFECT OF ENVIRONMENTAL CHEMICALS ON H1 VIRAL-INDUCED FETAL RESORPTIONS IN PREGNANT HAMSTERS
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The purpose of this research is to determine whether pesticides, heavy metals, or other drugs alter H1 viral-induced fetal resorption rates (FRR) in hamsters. Following last year's report

that sodium arsenite, mercuric chloride, cadmium sulfate, and certain vegetable oils (olive, corn, and cotton seed) enhanced the H1 viral-induced FRR's and also that pp' DDT influenced to a greater extent the FRR's than op' DDT or technical DTT, continued studies in this regard are being pursued. Experiments are now being conducted to learn the possible significance of interferon in these enhancements of fetal resorptions by the various drugs listed. The herbicide 2,4,5T has also been tested to determine its 50 per cent FRR when administered on days 8,9, and 10 of pregnancy, and to learn whether it has an influence on H1 viral-induced FRR. There are no indications that 2,4,5T does induce teratologies, and there is no indication of an enhancement of H1 viral-induced disease; if anything, when drug and virus are used concurrently, there appears to be a slight reduction in fetal resorptions.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0792, A CHEMICAL & MORPHOLOGICAL STUDY OF THE NEUROPATHY INDUCED BY ANTICHOLINESTERASE PESTICIDE

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The neural lesion produced by administration of selected 'demyelinating' pesticides to adult and neonatal experimental animals is being studied at the optical, ultrastructural, and chemical levels in an attempt to identify the primary site of attack and the mechanism of myelin destruction. Emphasis will be on documentation of the early changes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0793, THE STEREOCHEMISTRY OF THE POLYCYCLODIENE PESTICIDES

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The chlorinated polycyclodiene pesticides are among the most stable and persistent insecticides that contaminate our environment. The continued use of these pesticides coupled with their ubiquitous ecological distribution necessitates the elucidation of their metabolic pathways in mammalian systems. To more rapidly and accurately achieve this end, an investigation of the detailed structural stereochemical nature of this important class of environmental agent is currently in progress utilizing proton magnetic resonance spectroscopy.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0794, TOXICITY OF 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

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Objectives: Identify the sequence of toxicologic processes which develop following exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin.

Methods Employed: Initial work with the rat consists of a screen, incorporating many clinical procedures, to ascertain which organs are affected and the earliest time interval at which abnormalities are detected.

Later studies will focus on characterizing the sequence and magnitude of those metabolic dyscrasias that are involved in the toxic process. Hematologic, clinical chemistry, enzyme chemistry plus histologic procedures are routinely employed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0795, PESTICIDES AND PESTICIDAL SYNERGISTS STUDIES IN PREGNANT HAMSTERS

A. OTTOLENGHI, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

Evaluation of toxic effects of chlorinated hydrocarbon pesticides (Aldrin, Dieldrin, Endrin) and a Methylenedioxyphenyl pesticidal synergist (Piperonyl Butoxide) alone and combined on pregnant hamsters. Count of resorbed, dead, living fetuses and development of malformations is obtained by sacrificing the animals two days prior to expected term.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0796, GENERAL TESTING OF ENVIRONMENTAL CHEMICALS FOR EFFECTS ON GROWTH AND DEVELOPMENT

H.S. POSNER, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

Environmental agents are being administered to pregnant animals at a variety of doses and times of gestation in order to screen for evidence of teratogenic or alternate lasting effect. Both prenatal and postnatal determinations are being made.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0797, QUALITY IN PORK AS INFLUENCED BY CERTAIN PHYSICAL AND CHEMICAL CHARACTERISTICS

T.N. BLUMER, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC02019)

OBJECTIVE: Evaluate quality in pork by certain physical, chemical and/or physiological methods. Relate the results of quality evaluation to acceptability by sensory panel testing.

APPROACH: Physical measurements of pork carcasses to include carcass length, fat back thickness, loin eye area and lean cut yield will be determined and correlated with the average width of the split vertebra to include the dorsal vertebral processes. Marbling content will be determined visually and related to chemical fat and moisture content as well as sensory panel scores. Free moisture determinations will be made and correlated with muscle pH, weeping score, chemical fat, shear value, sensory panel scores and the in vivo measurement of muscle tissue partial pressure of oxygen. The free fatty acid content and the glucose and amino acid content of pork loin chops will be correlated with taste panel flavor scores. The effect of fat on flavor of pork loin chops will be determined using rehydrated, freeze dried pork chops freed of fat by solvent extraction. Variations in marbling content of pork carcasses of different breeds will be determined. In addition, the rate of marbling deposition commensurate with the growth of the pig will be evaluated.

PROGRESS: P,P'-DDT was fed to pigs during the normal fattening period at levels of 0, 20, 40, 80 ppm with the following objectives: 1) to determine pork tissues which contain residues of p,p'-DDT, 2) to quantitatively determine p,p'-DDT residues in all tissues sampled, 3) to determine if p,p'-DDT is metabolized by the pig and if so, to qualitatively and quantitatively determine residues of metabolites and 4) to determine the most appropriate sampling site(s) for routine tolerance checks on the best sampling site for metabolic studies. During the 10 week feeding period dietary p,p'-DDT was rapidly absorbed into the blood stream and accumulated in the subcutaneous fat after only 24 hours. A wide variety of fat, muscle, organ and gland tissues sampled at the end of the feeding period contained p,p'-DDT, p,p'-DDE and p,p'-DDD. In addition to the DDT compounds mentioned above, some tissues were found to contain other metabolites (liver and kidney). Samples from hogs of known breeding were evaluated for water-binding capacity.

SUPPORTED BY U.S. Dept. of Agriculture

4.0798, INFLUENCE OF NUTRITION ON INSECTICIDE RESIDUES IN CHICKENS

W.E. DONALDSON, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03171)

OBJECTIVE: Determine the effects of various dietary modifications on the accumulation and disposition of insecticide residues in the tissues of chickens.

APPROACH: Starvation has been shown to increase the rate of DDT depletion from chick tissues by reduction of adipose stores with which the DDT is associated. The technique used in previous experiments has been to alternately starve contaminated chicks for 2 days and re-feed for 1 day. This technique will be used in subsequent experiments in conjunction with various drug additions to the diet. The purpose of drug additions will be to stimulate the body's general detoxication mechanisms. It has been suggested that non-specific stimulation of detoxication speeds the elimination of chlorinated hydrocarbon compounds from the body. Initial experiments will utilize iodinated casein and thiou-

racil to assess their effects on DDT depletion rates from the tissues of contaminated broiler chicks.

PROGRESS: Experiments during the past year have concentrated on the distribution of DDT and dieldrin in embryos and extra-embryonic mass in chicken eggs. Both pesticides are distributed in all embryonic tissues in relation to the amount of fat in the tissues. Uptake from yolk injections is rapid and considerable (up to 60% of injected dose in embryo at hatching). These studies give a base for studying metabolic effects of the pesticides on embryos and egg composition effects (embryo nutrition) on pesticide uptake. in other experiments, the effects of barbituric acid derivatives and sulfa drugs on rate of depletion of DDT from chick tissues is being studied. At this time, we are awaiting residue analysis data from the Pesticide Residue Lab.

SUPPORTED BY U.S. Dept. of Agriculture

4.0799, MECHANISMS OF ADAPTATION OF ORGANISMS TO PESTICIDES

F.E. GUTHRIE, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03191)

OBJECTIVE: Determination of physiological mechanisms enabling organisms to adapt to exogenous chemicals and relation to pre- and postadaptive genetics.

APPROACH: Adaptation to toxic plants - examine the gross tissue distribution, binding of C toxicants (nicotine initially) to extra target storage sites (as proteins and fats), and comparative nerve membrane properites which permit entry or exclude toxicants. Adaptations of vertebrates - Initial work will involve selection of strains of mice resistant to DDT, DDVP, dieldrin, and Sevin. These mice will be used to determine the biochemical mechanisms selected by the breeding study. The primary systems to be examined are: detoxication, change in target enzyme, and storage (fat or protein binding).

PROGRESS: Four colonies of mice have been stressed at the LD-50 level for 12 or more generations and reproductive and physiological parameters of stress investigated. Despite these rather rigorous conditions, the stressed colonies do not appear to be significantly different from the control colonies with respect to overall reproductive capacity nor in such physiological phenomena as ability to degrade organophosphate insecticides, hydrolyze acetylcholine, and oxidize aniline. The response by the dieldrin colony indicated a rather small debilitating effect but the response was rather subtle. These results are of particular importance because they indicate that animals can adapt rather well to contaminants in the environment, and it is particularly comforting to note that no genetic effects have become evident over a large number of generations.

SUPPORTED BY U.S. Dept. of Agriculture

4.0800, POST HARVEST MOLDS AND DECAYS OF TOBACCO

G.B. LUCAS, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC02042)

OBJECTIVE: Determine: methods of handling tobacco to prevent damage by microorganisms; effects of pesticides, herbicides, sucker- control chemicals on microflora; if microorganisms play role in chemical changes during storage, ageing; if fungi, bacteria on tobacco harmful to smoker.

APPROACH: Make microfloral assay of tobacco treated with chemicals, pesticides, herbicides; examine smoke condensate of treated cigarettes for toxins to warm blooded animals; grow tobacco fungi in culture, assay for toxins, identify; grow pesticide free tobacco in phytotron, compare treated.

PROGRESS: Ten fungi, Aspergillus niger, A. flavus, A. ochraceus, A. ruber, A. repens, A. amstelodami, Alternaria tenuis, Penicillium brevicompactum, Cladosporium herbarum and Chaetomium dolicotrichum, isolated from moldy tobacco did not grow in N(2) or O(2). In N(2)-O(2) mixtures the greatest change in growth occurred between 1.0 and 5% O(2). In CO(2)-O(2) mixtures radial growth of all species increased with each quantitative decrease of CO(2). All species except A. niger grew faster in air than in 10% CO(2). By inoculating cigarettes with a known quantity of fungus spores, the growth rate of the fungus can be regulated, thus permitting the cigarettes to be smoked after progressive amounts of infestation. Effect of smoke and smoke condensates of cigarettes made from moldy and mold-free tobacco on the respiratory surfaces of hamster tracheae were initiated; data not not analyzed. Morphology of 4 thermophilic fungi, Talaromyces, Aspergillus, Malbranchia and Mucor was described.

SUPPORTED BY U.S. Dept. of Agriculture

4.0801, DETERMINE THE EFFECTS OF 4-AMINOPYRIDINE (DRC-1327, AVITROL 200) ON PEN-REARED PHEASANTS

S.H. RICHARDS, State Game & Fish Department, *Bismarck, North Dakota* 58501

Objectives: 1. To determine the effect of DRC-1327 on young pheasants whose parents had been subjected to the poison. 2. To determine the effect of DRC-1327 on pheasant chicks ages 2-6 weeks.

Procedure: Observe all hatched pheasant chicks whose parents were tested with DRC-1327 for abnormal behavior, physical abnoralities or pathology. Allow these pheasants chicks to reach adulthood and determine if they are capable of reproducing.

Repeat force feeding of 1-6 week old chicks to enlarge sample tested.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0802, EXCRETION OF CHEMOTHERAPEUTIC AGENTS

I.A. SCHIPPER, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-H-16-001)

OBJECTIVE: Determine the rates and routes of elimination of the various chemotherapeutic agents. Determine the spectrum of activity of the various chemotherapeutic agents for organisms.

APPROACH: The usual procedures for administration of chemotherapeutic agents will be utilized. Rates and routes of elimination will be determined and provide the basis for further investigations of applicability of various dosages and combinations under field conditions.

PROGRESS: Sulfachlorpyridazine administered orally at 1 grain per pound body weight provided detectable blood levels for 60 hrs. post- administration (PA). Highest blood concentrations were obtained at 4-8 hrs. with maximum levels of 2.2 mg. Milk levels were detectable only in one animal up to 8 PA hrs. When administered at 2 gm/lb body weight, blood levels of a maximum of 5.2 mg were obtained. In general, all levels were higher for comparable PA periods than 1 grain/lb body weight administration, but detectable levels extended through 48 hrs. only. Milk levels at 2 grains/lb body weight were detectable in 2 cows only at less than 1 mg and for a maximum of 24 hrs. Sulfabromomethazine administered at 1 grain/lb body weight orally provided detectable blood levels up to 120 PA hrs. Maximum levels were obtained between 8-24 PA hrs. Maximum concentration recorded was 5.2 mg at 24 hrs. Milk levels were most eratic always below 1 mg. and in several instances, detectable up to 72 hrs. PA. When administered at 2 grains/lb body weight orally, detectable blood levels were maintained up to 120 PA hrs. The greatest concentration, 7 - 9.4 mg. was detectable at 24-48 hrs. PA. Milk levels of more than 1 mg. (1.6 mg.) was detected in only 2 instances. Detectable levels in milk was maintained up to 72 PA hrs. Microbiological examination of quarter samples of milk before and after sulfonamide therapy indicated no bacteriological genus or species changes associated with sulfonamide therapy.

SUPPORTED BY U.S. Dept. of Agriculture

4.0803, DIELDRIN TOXICITY IN THE CHICKEN

J.L. SELL, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-S-07-011)

OBJECTIVE: Determine the toxicity of dieldrin, previously accumulated in adipose tissue, during severe dietary restriction.

APPROACH: Hens in individual cages will be divided into four equal groups and fed. a) Control ration ad libitum b) Control ration restricted to intake of dieldrin-fed hens c) Control ration

plus 10 ppm dieldrin restricted to lowest intake of dieldrin-fed hens d) Control ration plus 20 ppm dieldrin (this group will dictate restriction of groups b and c). Biopsies of abdominal fat at 4-week intervals for measurement of dieldrin storage. At end of twelfth week, feed will be removed and subsequent indications of dieldrin toxicity observed. Blood will be taken periodically during diet restriction to follow dieldrin mobilization. At termination the dieldrin content of the carcass will be determined. Subsequent research will depend on the findings.

PROGRESS: In the first of a series of experiments, 48 hens were fed rations containing 0, 20, 40 and 80 ppm dieldrin for a period of 8 weeks. Feed consumption was reduced by the addition of 40 or 80 ppm dieldrin and poisoning occurred in some hens fed dieldrin at the 20 ppm level. A like number of hens were fed rations containing 0, 10 and 20 ppm dieldrin in a second experiment. Feed consumption was equalized across treatments and at the end of 12 weeks, feed was removed. Survival following feed removal was 33, 28 and 19 days, respectively. A third experiment involving 60 hens fed dieldrin at levels of 0, 1, 5, 10 and 20 ppm is in progress and should conclude this series.

SUPPORTED BY North Dakota State Government

4.0804, METABOLIC FATE OF AGRICULTURAL CHEMICALS IN POULTRY

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OBJECTIVE: Study the metabolism of carbamate pesticides in poultry by determination of the metabolic fate of the parent compound; investigation of tissue(s) and subcellular site(s) responsible for the metabolism; isolation and identification of metabolites; and investigation of the enzymatic reactions involved in the metabolism of these compounds.

APPROACH: Initial studies will be conducted on the metabolism of Sevin (1 naphthyl N methyl-carbamate). This compound is an effective insecticide and a representative carbamate pesticide. All studies will be conducted with carbon-labeled Sevin. In vitro studies will be conducted to determine which tissue(s) and subcellular site(s) is responsible for the metabolism of Sevin in the chicken. Studies will be conducted to isolate and identify the parent compound and/or metabolic products produced in the intact animal and in in vitro studies. It is felt that the three different experimental approaches (i.e., radioisotopic tracer studies with intact birds, in vitro studies with specific tissues and subcellular fractions, and isolation and characterization of metabolites) will complement each other, and, when used in combination, will give a more complete understanding of metabolism of these compounds.

PROGRESS: P-Chlorophenyl N-methylcarbamate (I) is a potentially useful synergistic agent for carbamate pesticides. Its metabolic fate has been determined in the chicken. When a single oral dose of the C ring-labeled compound was given, no C was recovered in the expiratory CO_2, but 94 to 97% of the C activity was recovered in the urine. When chickens were dosed with the carbonyl labeled compound, 68 to 83% of the C was recovered in the expiratory CO_2 within 48 hours. Only trace amounts of carbon-14 were detected in the tissues of the chickens when sacrificed 48 hours after dosing with the ring-labeled compound. Confirmation of structure was made by synthesis. Sixty-seven percent of the urinary metabolites was identified as p-chlorophenyl sulfate (II) and 29% was identified as p-chlorophenyl glucuronide (III). The major ether extractable metabolite in the urine (4%) was tentatively identified as p-chlorophenol (IV) on the basis of its chromatographic behavior.

SUPPORTED BY U.S. Dept. of Agriculture

4.0805, CENTER FOR THE STUDY OF THE HUMAN ENVIRONMENT

R.R. SUSKIND, Univ. of Cincinnati, School of Medicine, *Cincinnati, Ohio* 45221

The Center for the Study of the Human Environment is a research and educational resource devoted to the study of environmetal problems which affect man's health and to research training in pertinent scientific disciplines. The present subject areas on which coordinated research efforts are focused include (1) trace metal metabolism (2) toxicologic problems of heavy metals (3) carcinogenesis and teratogenesis (4) pulmonary problems of environmental origin (5) pesticides (6) organic solvents (7) plastics and (8) analytical and environmental methodology. The environmental origins of these problems are related to air and water quality, solid waste management, industrial and agricultural activity, and consumer products including food, drugs, household and other manufactured materials. The training program is intimately related to the research efforts and includes masters and doctoral programs in disciplines encompassed within the arena of environmental health.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0806, FURADAN INSECTICIDE RESIDUE STUDY WITH DAIRY CATTLE AND CHICKENS

R.E. COOK, Ohio State University, Agricultural Experiment Sta., *Columbus, Ohio* 43210 (OHOSS-164)

Objective: Determine whether residues from Furadan accumulate in meat, milk and eggs.

Approach: Preliminary tests have indicated that 2, 3-dihydro-2, 2- dimethyl-7-benzo furanyl methyl-carbonate (Furadan by Niagara Chemical Division) is a promising chemical for the control of alfalfa weevil. This investigation is designed to determine whether the residues of this chemical appear in meat, milk and eggs of cattle and chickens fed alfalfa treated with this chemical. Application of the pesticide will be carried out on alfalfa 14 and 28 days prior to cutting. Hay harvested from these plots (3 levels) will be fed to cows for 30 days. Residues in the milk and meat will be determined. Dried alfalfa meal prepared from these plots will be placed in the rations of laying hens and growing broilers. Residue levels will then be determined in the eggs and meat over 10 and 8 week periods, respectively.

Progress: Carbofuran, a promising chemical for the control of alfalfa weevil, was applied to alfalfa that was harvested and used as 55 to 64% of the feed of dairy cattle and as a dried meal for chickens to determine whether this carbamate or its residues would appear in the meat, milk or eggs. With alfalfa hays containing 3 levels of residue fed to dairy cows, detectable residues were found in the milk at all levels of feeding. The only carbamate residue detected was 3-hydroxy carbofuran. No detectable levels were found in liver, kidney, muscle or fat tissue samples from the cows during the 30-day feed period. Residues disappeared from the milk within forty-eight hours following withdrawal of the treated hay. No detectable residues were found in the meat or eggs when a ration containing treated dried alfalfa meal was fed to laying hens and growing broilers during a ten and an eight-week feeding period, respectively.

SUPPORTED BY Ohio State Government

4.0807, THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS

R.A. TUBB, Ohio State University, Graduate School, *Columbus, Ohio* 43210

Dieldrin is the most commonly found insecticide in the major river basins of the United States (Breidenbach, 1967). Over 1.5 million acres in Ohio are treated annually with aldrin which is rapidly oxidized to dieldrin. Natural populations of fishes and fish eggs have been surveyed for dieldrin residues. Currently eggs from Stizostedion vitreum, Ictalurus punctatus and Polydictus olivaris are being subjected to concentrations of 0.05 ppb to 125 ppb dieldrin.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0808, THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA

R.A. TUBB, Ohio State University, Graduate School, *Columbus, Ohio* 43210

Amblema plicata occurs throughout the Ohio River drainage and is becoming increasingly important for export in the cultured pearl industry. Since this mollusk remains stationary for long periods of time, it can act as a pesticide monitor in streams. Recent studies have shown that naiads concentrate chlorinated

hydrocarbons. This study is an attempt to find the levels of dieldrin in natural populations and experimentally determine the uptake and excretion rates of the pesticide. The project was started in June, 1968 and will be completed in 1969.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0809, BIOLOGY, ECOLOGY, AND CONTROL OF INSECT PESTS
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OBJECTIVE: Devise and develop means for controlling insect and mite pests which reduce the value of ornamental plants. Gain knowledge of the life history, behavior, and ecology of species of insects and mites which are injurious to ornamental plants.

APPROACH: Control programs will be devised. Life histories of various pest species and other insects associated with them (particularly parasites and predators) will be studied.

PROGRESS: Evaluation of methods and materials for control of pests of nursery stock and shade trees was emphasized. Specifically, work continued on the development of techniques for mass laboratory rearing of the black vine weevil, one of the ten most serious nursery pests in Ohio. Development of these techniques is prerequisite to controlled testing of experimental insecticides on this insect. A basic, chemically defined synthetic diet has been developed and is being adjusted. Various natural host plants and diet additives therefrom are being investigated. Current interest is in developing alternatives to field control with chlorinated hydrocarbons. Limited chemical control studies on spruce needle miner were undertaken using standard field screening techniques. An evaluation of materials for the control of maple bladder gall mite showed that carbaryl gave better control when applied in the spring than any other candidate material. Thiodan, and C-2307 gave better control than malathion, the previously recommended control. Acaricides effective in spider mite control such as Carzol, Temik, Morestan and Kelthane did not reduce the number of maple bladder gall mite and may have actually stimulated its increase by reducing predaceous mites. An evaluation of materials for control of the mimosa webworm showed that carbaryl, dimethoate and oxydemetonmethyl gave satisfactory reductions in larval populations.

SUPPORTED BY Ohio State Government

4.0810, STUDY OF THE PRODUCTION AND DISTRIBUTION OF THE CHOLINESTERASE ENZYME IN ORGANOPHOSPHOROUS POISONING
G. CLARK, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma* (000621)

It has been postulated, but never proved, that the development of tolerance to anticholinesterase pesticides is partly due to an increased rate of synthesis of the cholinesterase enzyme. There is also the possibility that the enzyme is not uniformly inhibited in all parts of the nervous system or in single neurons due to local variations of the blood-brain barrier or the histological characteristics of single cells. These factors will be studied in poisoned animals by sensitive, specific, histochemical techniques.

Work to date indicates several areas where additional work is needed to obtain answers to the question of how tolerance to an anticholinesterase pesticide develops. The presence of enzyme in the neurons of the hypoglossal nucleus indicates that synthesis of the enzyme occurs despite the presence of the poison. In the poison animals all cells of the hypoglossal nuclei were equally stained while only some of the axons of these cells were stained. This apparently indicates a failure of transport of newly synthesized acetylcholinesterase in the hypoglossal axons. With the same method, cells from control animals failed to stain.

1. Transport of Acetylcholinesterase in Nerve Fibers. The method of Weiss will be used to block transport of the enzyme down the nerve fiber. 2. Permeability of Neuronal Cell Membranes in Rats Poisoned with Disulfoton. 3. Comparison of Acetylcholinesterase in Neuropile of the 12th Nucleus.

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4.0811, DETECTION OF PESTICIDE EXPOSURE - EVALUATION OF BLOOD CHOLINESTERASE VALUES
C.R. CRANE, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma* (000617)

During FY-68, several commonly-used methods of assaying blood cholinesterase levels were evaluated and compared for validity and interconversion of results. We also propose to study the effect of some new organophosphorus insecticides on the cholinesterase enzyme system, and to examine in more detail some of the interrelationships among the cholinesterases found in blood and brain, their various substrates, the compounds which reverse cholinesterase inhibition, and other enzymes which modify components of the total system. This information which is not available at this time should allow us to recommend a specific procedure for collection,handling, shipping and analyzing blood samples for cholinesterase activity. The study will also contribute to a better understanding of the relationship between human exposure to pesticides, the diagnostic tests used to evaluate exposure and the drugs used to treat pesticide poisoning.

Using the pH-Stat method of analysis, a detailed study will be made of the effect of the following on blood cholinesterase measurements: a) type of anticoagulant used, b) storage time, c) storage temperature, d) buffer capacity and ionic strength of assay medium, e) type of substrate used, f) presence of different types of anticholinesterase compounds,and g) presence of different types of CHE reactivating compounds. If time permits, we also plan to look at the effect of anti- CHE pesticides on related blood enzymes.

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4.0812, BLOOD CHOLINESTERASE IN AERIAL APPLICATOR CREWS
C.R. CRANE, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma*

The change in cholinesterase concentration in the blood of an aerial applicator is presently the best indicator of the magnitude of his exposure to 'organophospate pesticide' during the spray season. Primarily because of CAMI's past efforts in recommending to aerial applicators a periodic cholinesterase test, and because of our research work in methodologies and sample handling, we have had many requests to perform this test for aerial applicators in the Southwest. During the past twelve months, the additional educational efforts being made by the Accident Prevention Specialists in the Region's GADO's have dramatically increased the number of these requests. In the situation where this test was unavailable to the applicators locally, we have felt a moral obligation to furnish the service, if possible. In addition to being a beneficial service to them, it has furnished us with research material for an epidemiological evaluation of the degree of pesticide exposure experienced by this segment of the flying population.

Blood cholinesterase assays will be routinely performed on samples transported to CAMI or on blood samples drawn from individuals appearing at CAMI in person. At the request of GADO personnel in our area, we will travel to a location where 15 or more aerial applicators have been assembled, we will present educational material for safe handling of pesticides and draw blood samples for analysis in our laboratory.

In the past 12 months, March 1969- February 1970, our laboratory analyzed approximately 200 blood samples from aerial applicators. Most of this activity was at the request of GADO Inspectors and was authorized through AC-110. It included samples from aerial applicator groups at Lubbock, Plainview, Pecos and El Paso, Texas, and from the Annual Aerial Applicator Meetings in Fort Worth, Texas, and Hot Springs, Arkansas, as well as from individuals who appeared in person at CAMI.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

4.0813, NEUROPHARMACOLOGY OF CONVULSANT PESTICIDES - INTERACTIONS OF ENDRIN AND ANTICONVULSANT DRUGS IN THE CEREBRAL CORTEX OF ANESTHETIZED ANIMALS

A.M. REVZIN, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma* (000611)

Endrin and other cholorinated hydrocarbon pesticides (CHPs) are convulsant neurotoxins. They can induce, in an exposed man, hyperirritability, tremor, perceptual and behavioral disorders or seizures, depending on the dose. There is also evidence suggesting that exposure to these compounds may contribute to the development of epilepsy or related neurological disorders. Consequently, exposure to endrin or other CHPs is able to cause incapacitation of agricultural pilots and other critical personnel. These experiments are designed to provide information on the interaction of endrin with various of the clinically used, or suggested, anticonvulsant drugs. Such information will be immediately relevant to the selection of antidotes for endrin poisoning and to an understanding of the mechanisms of action of endrin in the brain. The studies will also provide information basic to the design of experiments using therapeutic procedures in the proposed studies on chronic poisoning (AM-F-69-PHB-11).

A number of studies have shown that the neurochemistry and neuropharmacology of cerebral cortex are similar in all mammals and birds. Therefore, squirrel monkeys, cats, pigeons and owls may be used in this study, since each offers unique advantages in isolating specific cortical functions for experimental analysis.

Previous work has shown that endrin selectively poisons visual relay nuclei and that endrin, lindane and DDT have separate, though overlapping, patterns of action and, presumably, receptor sites.

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4.0814, NEUROPHARMACOLOGY OF CONVULSANT PESTICIDES - ANALYSIS OF EEG CHANGES INDUCED BY CHRONIC ENDRIN ADMINISTRATION

A.M. REVZIN, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma* (000615)

Chronic exposure to endrin, and, probably, most other chlorinated hydrocarbon pesticides (CHPs) leads to electroencephalographic (EEG) changes which occur as a linear function of dose and thus seem to be a sensitive index of the extent of poisoning. There is, consequently, a possibility that the CHP-induced EEG changes could be used in the diagnosis of poisoning. If so, control of exposure, and therapy of and recovery from CHP poisoning could be put on a more rational basis than is currently the case. These experiments are designed to analyze EEG pattern changes induced by chronic endrin exposure to determine whether any such changes are sufficiently distinctive to serve as diagnostic criteria for poisoning.

Previous work from this laboratory has demonstrated that endrin causes generalized EEG changes with little or no effect on Evoked Potentials (EPs) save possibly for some effect on visual cortex.

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4.0815, PESTICIDE INDUCED MODIFICATION OF BEHAVIORAL AND BIOELECTRIC RESPONSES TO EXTERNAL STIMULI

A.M. REVZIN, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma*

Case reports and other available information indicate that there are long-term behavioural sequelae to exposure to organophosphorus (OP) pesticides. These effects could pose a greater hazard to aerial applicator personnel than the more obvious acute effects of OP poisoning, particularly since these long-term effects seem unrelated to blood cholinesterase levels or other diagnostic indices. Therefore, we will study the acute and long-term, behavioural and electroencephalographic (EEG), effects of OP poisoning. These experiments can confirm and specify the nature of the behaviour changes due to OP poisoning and can develop EEG criteria for diagnostic purposes. The techniques used in this study are also applicable to the study of other psychoactive agents.

OP pesticide effects on primate behaviour will be measured using conventional, well-standardized operant behaviour control techniques. Complex sequential visual discrimination and perception tasks must be performed by the animal to obtain rewards (e.g. food). The effects of OP poinsoning on performance of these tasks will be analyzed to isolate those aspects of behaviour specifically affected by the OP (e.g. visual pattern discrimination, attention mechanisms, etc.). Animals will be followed for periods of many months to permit study of long-term OP effects. Four 'behaviour control' chambers are available, so that four animals may be studied simultaneously. The control of the chambers, data acquisition and data analysis will be performed by the LINC-8 computer recently acquired. Indeed, it is only the use of this computer which makes this complex experiment practical. When definitive results are available the procedures used in these experiments will be combined with the electroencephalographic and related techniques developed and used in PHB-11. Correlations between behaviour and brain electrical activity will be sought to indicate specific diagnostic approaches to OP poisoning.

Last year was spent learning computer technology, programming the computer, and designing and acquiring behaviour chambers and interfaces.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

4.0816, NEUROPHARMACOLOGY OF CONVULSANT PESTICIDES - ANALYSIS OF EEG CHANGES INDUCED BY CHRONIC ENDRIN ADMINISTRATION

A.M. REVZIN, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma*

Sensitive, precise and object clinical diagnosis of poisoning (e.g. by organochlorine pesticides) or similarly accurate evaluations of the effects of psychoactive medicaments are not now possible. However, chronic exposure to the chlorinated hydrocarbon pesticide (CHP) endrin, and most other CHP's leads to generalized electroencephalographic changes whose magnitude seems to be a nearly linear function of dose -- up to convulsive levels. These experiments are designed to measure and evaluate changes in brain bioelectric activity induced by chronic exposure to a toxic CHP (endrin), and to determine whether the change are sufficiently distinctive to serve as a basis for the diagnosis of poisoning. Bipolar macroelectrodes will be implanted in a variety of cortical areas and subcortical nuclei in squirrel monkeys. The leads from these electrodes will be bought out to connectors permanently attached to the animal's skull, so that recording may be made at any time, up to 3 years after recovery from surgery, by plugging a cable from the recording system into the connector on the animals . This general arrangement permits using an animal as its own control and permits the use of mildly restrained but unanesthetized animals, both critical factors to the success of this type of neuropharmacological study . Although EEG changes are of primary interest in this study, several types of visual evoked potentials (V.E.P.s) will also be analyzed since prior studies here have suggested that these might be selectively affected by endrin.

Previous work from this task has demonstrated that chronic endrin poisoning caused dose-related changes in EEG's in monkeys, but with little associated change in evoked responses. The importance of stress- induced at mobilization with attendant release of toxic levels of endrin occuring months after termination of endrin administration was also emphasized and the phenomenon confirmed. (Text abridged).

4. PESTICIDES

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

4.0817, TOLERANCE TO CHOLINESTERASE INHIBITORS - EFFECTS OF ANTIDOTES ON TOLERANCE AND RECOVERY

W.B. STAVINOHA, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma* (000612)

When aerial applicator pilots and ground crew are exposed to organophosphorus pesticides for long periods of time, tolerance develops, and most of the chemicals deleterious effects seem to disappear. The medical implications of the adaptation phenomenon, however, are not clear. The effect could be insidious in that certain neurological and neuromuscular functions could remain impaired, despite the appearance of normality. Recent studies have shown that subtle changes do occur in homeostatic mechanisms. This study should contribute to a better understanding of the requirements for protection from exposure and the medical management of chronic poisoning.

Studies on the physiological and biochemical effects, in 42 insecticide antidotes, atropine and pralidoxime, will be done: 1) influenceupon development of tolerance to the insecticides, 2) influence upon recovery after termination of exposure, and 3) changes that occur in the cholinergic system under the combined influence of poison and antidote. Rats will be given atropine or pralidoxime before, during, or after exposure to disulfoton and the effects upon previously established parameters will be evaluated. Measurements will be: 1) cholinesterase activity,2) acetylcholine concentration, 3) acetylcholine release, 4) neuromuscular activity, 5) muscle tone, and 6) control of body temperature. Adequate statistical evaluation will be done.

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4.0818, METABOLISM OF HEXACHLOROPHENE, A POTENTIAL INTOXICANT

D.R. BUHLER, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Studies on the absorption, excretion and metabolism of 14C-methylene labeled hexachlorophene will be carried out in the rat and dog. The routes of excretion, the extent of metabolism and the distribution of drug and metabolites in tissues will be determined following oral and intraperitoneal administration of labeled hexachlorophene. Principal urinary and fecal metabolites will be isolated, purified and identified using thin layer and gas chromatography, IR, NMR and UV analysis and mass spectrometry. The possible induction or repression of microsomal drug metabolizing enzymes by hexachlorophene will also be investigated in rats after chronic feeding or periodic injection with the chlorinated bisphenol. Both the rate of hexachlorophene metabolism and the activities of selected microsomal mixed function oxidases will be determined in animals induced by treatment with hexachlorophene.

An understanding of the manner in which hexachlorophene is transported and metabolized in animals will help assess the toxic potential to man of this widely used chemical.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0819, METABOLISM OF HERBICIDES AND TRANSFORMATION PRODUCTS

S.C. FANG, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00519)

OBJECTIVE: Investigate the rate of metabolic breakdown and accumulation of ingested herbicides by rats in relation to the age, sex and nutritional status of the animal; investigate the rate of metabolic breakdown and accumulation in rats of transformation products of herbicides isolated from plants; investigate the rate of metabolic breakdown of the compounds in question in relation to the amount of ingestion; investigate the effect of these chemicals on biochemical reactions of the organs where the chemical accumulates.

APPROACH: A single dosage of either toxic or non-toxic level of herbicides C on their transformation products (2,4-D, ATA, Monuron or Tillam) will be administered to rats by means of stomach tubes. The animals will then be housed in a metabolic cage and the respiratory CO(2) and excreta collected periodically and analyzed for C .

PROGRESS: C-Phenylmercuric acetate (PMA), labeled at phenyl or acetate moiety, was synthesized, and this herbicide was fed to rats in order to study its fate, and also the rate of elimination. The result revealed the cleavage of acetate, which was mainly eliminated as respiratory CO(2), while the phenyl group was completely excreted via the urine and feces. Total recovery study showed a difference in time for the elimination for different moieties of PMA molecules, e.g. 90- 95% of acetate carbons were eliminated in 24 hr., same amount of phenyl carbons required 5 days, and elimination of 70 to 80% of PMA mercury needed 7 days. Analysis of urine samples from rats given different labeled PMA showed the presence of small amount of unchanged PMA and several labeled metabolites either derived singly from acetate, phenyl, and mercury, or in combination, indicating the complexity of PMA metabolism in the rat. Second phase of work involved the in vitro study of absorption and transport of various labeled herbicide and some plant transformation products through the intestine membrane. The experiment was designed to explore the possibility of a relationship between the permeabilities and molecular size and functional group of various herbicides, and between the permeability and the rate of elimination. Incomplete results showed a greater transport for a smaller molecule amitrole than a larger molecule such as 2,4-D. One amitrole metabolite also showed to be less permeable than the amitrole itself.

SUPPORTED BY Oregon State Government

4.0820, ORGANIC MERCURIAL FUNGICIDES AND METABOLISM

S.C. FANG, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00654)

OBJECTIVE: Synthesize radioactive organic mercurials needed for this propose research such as phenyl-Hg -acetate, methyl-Hg - hydroxide, phenyl-C -Hg-acetate, phenyl-Hg-acetate-C . Investigate the fate and persistence of these labeled fungicides both in plants and in laboratory animals. Special attention will be made to the organic moiety as well as to the mercury atom. Determine the permeability, the rate of elimination, tissue distribution and cellular incorporation of applied labeled inorganic and organic mercury compounds in order to seek differences which may exist and could attribute to the differentiated toxicity of these compounds. Investigate the effect of these compounds on biochemical reactions of plant and animal tissues in which the mercury compounds are accumulated. Relate mercury binding in the particulate or soluble protein and its influences on some enzymic activities.

APPROACH: Both C-labeled and Hg-labeled mercurials will be used to study the elimination pattern, rate of clearance, tissue accumulation, intracellular distribution and the fate of these compounds in the rat in order to assemble scientific data regarding the toxicological and biochemical problems and to search a clear understanding of their toxic action.

PROGRESS: The metabolic conversion of lactate-1- C was examined in the kidneys of male rats in vitro by a radiorespirometric method. The CO(2) production patterns were monitored continuously by a flow detectro and a Vibrating Reed Electrometer. Kidney slices from rats receiving daily oral dose of 3 mg phenyl-mercuric acetate (PMA) or inorganic mercury (Hg) for 5-10 days gave, not only a reduction of total CO(2) production, but, a shift of CO(2) pattern. Generally, 90% of lactate-1- C was converted to CO(2) during a 24-hour period by kidney slices from control rats of which 75% was found in the first peak and 15% in the second peak. Both mercurial treatments resulted in a reduction of the first peak and 15% in the second peak. Both mercurial treatments resulted in a reduction of the first peak and an enhancement of the second peak. This change was more pronounced with PMA. Extraction of kidney slices with alcohol at various intervals and chromatographs of the extracts revealed the presence of 4 labeled metabolites.

SUPPORTED BY Oregon State Government

4.0821, METABOLISM OF HERBICIDES AND TRANSFORMATION PRODUCTS
S.C. FANG, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

1) To identify the principal metabolites of monuron, propham and chloropropham in the rat and hamster. 2) To examine the subcellular sites for propham and chloropropham in the rat liver and kidney and to study their effect on some enzyme activities. 3) To study the metabolism of propham in isolated chloroplasts and other plant cells, and isolation of their transformation products.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0822, ENVIRONMENTAL TOXICOLOGY OF PESTICIDES
V.H. FREED, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The objectives of this proposed program are: 1. To conduct program integrated research on the toxicology of pesticide chemicals and other organic chemicals that may enter man's environment. 2. Investigate the toxicological effects of these chemicals at the several levels of biological organization. 3. To investigate the interaction of other environmental stressors on the toxicological effect of these chemicals. 4. To investigate the chemodynamics of environmental chemicals, particularly with respect to partitioning into exposed organisms across the organism's environment interface.

The research strategy involves identification of areas of lack of knowledge on the toxicology of a given compound, establishment of goals and objectives, and then programming the research to achieve these objectives. The data will be analyzed and synthesized applying kinetic analyses models, as well as other types of data analyses. A common pool of animals will be used in the experiments with an overall treatment or experiment with a primary chemical. Biological, biochemical analytical, and pharmacodynamic data will be obtained on aliquots from this common pool. Where stressors are to be studied these will be imposed as additional experimental variables on the common pool of animals.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0823, NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS
R.L. GOULDING, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00515)

OBJECTIVE: Research new approaches to the use of pesticides for control of arthropod pests or parasites. Current emphasis to be on pesticide-polymer resin formulations. Evaluate existing or experimental procedures or products for efficacy and host toxicity.

APPROACH: Develop basic concepts of retention and desorption kinetics of existing pesticide-polymer formulations. Utilize these relationships as models to study other pesticides and other polymer systems in terms of retention times and desorption rates. Test promising new formulations or existing formulations for pest-parasite efficacy and host toxicity in cats, dogs and other domestic animals. Examine host-parasite metabolism of toxicants. Conduct field trials with more promising products.

PROGRESS: Concluded study on efficacy of aerosol sprays of Sendran and Sevin in control of fleas on dogs. Initiated and concluded study of irritant effect of Vapona-PVC resin collars on cats and dogs. Developed system for formulating pesticide in PVC plastisol. Tests for efficacy of PVC-pesticide formulations using mosquitoes, flies and fleas were developed and a program initiated. The feasibility of formulating insect attractants in PVC was studied and preliminary tests performed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0824, THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS
R.L. GOULDING, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00097)

OBJECTIVE: Conduct investigations on arthropods affecting man and animals in order to develop information on: biological principles and techniques needed to design effective pest and disease vector control programs. Toxicological effects of newly developed pesticides on important arthropod parasites and disease vectors as well as pesticide residue problems. Economic importance of the effects on man and animals of these pests and disease vectors.

APPROACH: Test efficacy of new pesticides and other pest control techniques on a limited scale in Experiment Station animals and faculties followed by trials with the more effective materials or techniques under conditions representative of Oregon livestock management systems. Assess the toxicological effects of pesticides upon both individuals and population of hosts and parasites by means of appropriate studies in biochemistry, pathology and entomology. Where possible these studies will be related to possible economic effects as well as upon the more basic effects upon host-parasite physiologies and populations effects.

PROGRESS: Observation facefly problems in Oregon indicate irregularly distributed foci of annoyance with considerable temporal variations due to weather changes. Field observations on control techniques in use by ranchers continued. Cattle louse control trials involving the pesticide Gardona were initiated. A study on comparative pharmaco-dynamics of the pesticides Proban, Tiguvon and Ruelene in rabbits and feeding mosquitoes and ticks was concluded.

SUPPORTED BY Oregon State Government

4.0825, EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS
R.A. MILLEMANN, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Studies are continuing on the establishment of a well-balanced community of organisms in laboratory models of an estuary. The chronic effects of Sevin and other pesticides on members of such communities will be studied. Studies are in progress on the effects of the insecticides Sevin and Dursban on the survival, growth, and reproduction of the Dungeness crab, the viviparous shiner perch, and the oviparous chum salmon. Biochemical studies on the modes of action of Sevin and its metabolites on estuarine organisms are continuing.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0826, EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS
R.E. MILLEMANN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00665)

OBJECTIVE: Evaluate the acute toxicity of Sevin to certain estuarine organisms.

APPROACH: Use short-term bioassays. Determine the effects of Sevin on a community of organisms in artificial mud flats. Follow the residual life and metabolism of Sevin in estuarine organisms and in their environment. Study compounds related to Sevin, as well as other pesticides.

PROGRESS: Studies on factors necessary to maintain animal communities in laboratory models on an estuary were completed. The effect of the insecticide Sevin on such communities will now be studied. Studies on the effects of Sevin on survival and growth of the Dungeness Crab were completed. A manuscript reporting the results has been accepted for publication by the Journal of The Fisheries Research Board of Canada. Studies on the effects of sublethal concentrations of the insecticide Dursban on reproduction and growth of shiner perch are being continued.

4. PESTICIDES

SUPPORTED BY Oregon State Government

4.0827, RELATIONSHIPS OF PESTICIDE APPLICATION TO PESTICIDE RESIDUES IN WILDLIFE
B.J. VERTS, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00734)

OBJECTIVE: Determine the responses made by populations of certain wildlife species to applications of representative chemicals commonly used as pesticides in Oregon, and assess physiological, behavioral, and pharmacodynamical mechanisms that may be responsible for some of these responses.

APPROACH: Changes in reproductive capacity, changes in behavior, changes in resistance to pesticides, rates of deposition of body-burdens of pesticides, rates of excretion of pesticides, and frequency of teratogenesis by pesticides, either singly or in combination, will be used to evaluate the impact that applications of certain chemicals have or have had on populations of wildlife species.

PROGRESS: An investigation of resistance to chlorinated hydrocarbon insecticides by non-target species of terrestrial vertebrates was completed. A report of findings on tolerances exhibited by two populations of ring-necked pheasants (Phasianus colchicus) to technical DDT was prepared, submitted, and accepted for publication. Median lethal concentrations (LC(50)) of p,p'-TDE and o,p'-DDT in diets of week-old pheasants were established. These LC(50)'s, combined with those established for week-old pheasants to p,p'-DDT, p,p'-DDE, and a technical formulation of DDT during 1968, were the subject of a second report submitted and accepted for publication. It was interesting to note that the LC(50) of the technical formulation of DDT was somewhat greater than that expected on the basis of the LC(50)'s of each of the analogs. An investigation of the effects on the behavior of ring-necked pheasants by sublethal doses of various insecticides was initiated. Apparatus to test and record the performance of birds is being developed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0828, THE INFLUENCE OF PESTICIDES ON MORTALITY RATES OF BIRDS
H.M. WIGHT, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00864)

OBJECTIVE: Estimate mortality rates for species of birds before the pesticide era and compare these rates with those during the era of pesticide use. Compare mortality rates of subpopulations of key species in two or more geographic areas, and attempt to correlate the mortality rates of these populations with the history of pesticide application within the areas. Compare changes in mortality rates of species of birds with similar and dissimilar food habits within areas. Determine mortality rates of species that are consumers at various trophic levels in the food chain.

APPROACH: Life tables will be constructed from the banding data and mortality estimates derived by location, and span of years.

PROGRESS: Mortality rates have been estimated for 50 species of non-game birds with the aid of the CDC3300 Computer at Oregon State University. Mortality estimates have been made for four time periods: (1) prior to 1935 (2) 1936-1945 (3) 1946-1955 (4) 1956-1964. Regional subdivisions have been also made depending upon how much banding information is available for each species. A mathematical model has developed to relate mortality rates to production required to maintain stable population. These production requirements were then compared with observed productivity. Species fully analysed to date include: (1) Osprey (2) Barn Owl (3) Cooper's Hawk (4) Red-tailed Hawk (5) Brown Pelican. Of these five species, three are declining in North America (Osprey, Cooper's Hawk and Brown Pelican), one is remaining stable (Red- tailed Hawk), and one is uncertain (Barn Owl).

SUPPORTED BY Oregon State Government

4.0829, BIOLOGY AND CONTROL OF ENTOMOLOGICAL PESTS OF TREE FRUITS IN THE MID-COLUMBIA AREA
R.W. ZWICK, Mid Columbia Agric. Expt. Sta., *Hood River, Oregon* (ORE00371)

OBJECTIVE: Investigate, determine, and recommend control measures for insect and mite pests of pome and stone fruit crops of the area. This research includes, field evaluation of registered and experimental pesticides. Studies of the abundance and bionomics of beneficial forms parasitic and predatory on phytophagous pests and means of increasing their biological control through selective use of pesticides or other means. Studies of the life history and abundance of pest studies aimed at the application of chemical, cultural, or biological control methods for reducing their depredations to low levels.

APPROACH: Pesticide recommendations for commercial orchards are periodically reviewed and revised based upon continual field evaluations of registered and experimental compounds. Biological studies of insect pests and beneficial parasites and predators through trapping and observation of field populations are studied to enable more effective timing of pesticide applications to be followed.

PROGRESS: Pome Fruits: Evaluations of pesticides for pear psylla and mite pests have continued. One experimental compound was found to be superior against overwintering red mite eggs and pear psylla as a delayed dormant. Several materials such as Imidan for codling moth and pear psylla, Omite and Morestan for mites, have been incorporated into spray program recommendations. Studies on mite management on apples have indicated the principal deficiency in Hood River is lack of sufficient prey such as rust mites for phytoseiid predators in May-June and 1 or 2 well-timed selective acaracide applications in July-August may be necessary in most orchards. Studies of mite infestation on apple have indicated significant differences on seasonal fruit growth between low and moderate to high populations and we are continuing with studies on determining economic levels. The value of proper timing for pre- bloom applications against pear psylla has been evaluated and results demonstrated to area growers. Discriminatory dosages of many registered and experimental insecticides which preserve phytoseiid predators have been determined in plot and orchard evaluations.

SUPPORTED BY Oregon State Government

4.0830, DETERMINATION OF DDT LEVELS IN WHOLE FISH OF BROOK TROUT STRAINS FED CONTROL AND DDT TREATMENT DIETS
J.E. WRIGHT, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: To determine if there are strain differences in levels of accumulation of DDT and its metabolites in mature brook trout.

Procedure: Mature brook trout males and females from sibling lots of inbred strains will be killed, after spawning, and frozen in aluminum wrap for storage at -20 degrees C. The specimens will be from sibling lots which have been maintained on (1) a control normal pellet diet and (2) this same diet to which DDT was added at 10 p.p.m. Specimens will be weighed and homogenized in chloroform-methanol (2:1) plus anhydrous sodium sulfate, the slurry filtered, and the chloroform removed in a Synder column placed in a flask on a steam bath. After addition of n- hexane, the liquid is washed three times with water to remove methanol, the washed extract filtered through anhydrous sulfate, and evaporated on a steam bath to dryness. The lipid residue will be weighed to determine percentage of fresh weight and then dissolved in petroleum ether and extracted in a separatory funnel by shaking with acetonitrile saturated with petroleum ether - four times. These extracts are evaporated to a small volume and taken up in n-hexane, then evaporated to 2 ml for injection of an aliquot into a Research Specialties Gas Chromatograph Model 600 equipped with an electron capture detector. Samples of standard solutions will be run periodically to check on recovery and for calibration. Levels of DDT and the metabolites in p.p.m. of the lipids will then be converted to an individual fresh weight basis

and statistical analyses (analysis of variance, t Test, etc.) performed to determine significance of differences between control and treatment diets and of differences among strains.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0831, TO DETERMINE LEVELS OF DDT AND METABOLITES IN SERUM, MUSCLE AND WHOLE FISH OF STRAINS OF SALMONIDS (ABBREV)

J.E. WRIGHT, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: To determine levels of accumulation of DDT and metabolites in strains of lake, rainbow and brown trout and coho salmon and to determine the correlation between whole body levels and that in serum and muscle tissue of these species and of brook trout.

Procedure: Sibling lots of rainbow trout and coho salmon strains now being maintained on control diets and on those containing 10 p.p.m. of DDT will be utilized. Sibling lots of strains of yearling brown, lake and brook trout which will be sexually mature in the fall of 1970 will be subjected to these diets. Specimens of each lot will be taken periodically during 1970 and after spawning in the fall of 1970 and DDT and metabolites will be determined in serum, epaxial muscle fillet and the remnant whole fish. (Method of DDT determination was described on Job 1, Study 1). Statistical analyses of differences in insecticide levels between diets and among strains and species will be determined. Correlation analyses will be performed among levels found in serum, muscle, and remnant whole fish at each periodic sampling.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0832, THE EFFECT OF DDT ON EGG, FRY AND FINGERLING VIABILITY IN BROOK TROUT STRAINS

J.E. WRIGHT, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: To select those brook trout strains which are most resistant to harmful effects of DDT and its metabolites accumulated in the tissues and eggs.

Procedure: Females of control and treatment lots described in Job 1, Study 1, will be spawned individually and mated to individual sibling males from control and treated lots. Samples of unfertilized eggs, as well as each spawned fish, will be analyzed for insecticide levels as described in Job 1 Study 1. Total egg number, size, fertility and viability records will be obtained for the individually spawned lots through the fry stage. Those progeny lots will be saved for breeding stock which show significantly higher viability.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0833, THE EFFECT OF DDT ON EGG, FRY AND FINGERLING VIABILITY IN LAKE, RAINBOW, AND BROWN TROUT AND COHO SALMON STRAINS

J.E. WRIGHT, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: To select those strains of lake, rainbow, and brown trout and coho salmon which are most resistant to harmful effects on reproduction of DDT and its metabolites accumulated in the fish tissue and eggs.

Procedure: Females of control and treatment lots described in Job 2, Study 1, will be spawned individually and mated to individual sibling males from control and treated lots. Samples of unfertilized eggs, as well as each spawned fish, will be analyzed for insecticide levels as described in Job 1, Study 1. Total egg number, size, fertility and viability records will be obtained for the individually spawned lots through the fry stage. Those progeny lots which show significantly higher viability will be saved for breeding stock.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0834, SELECTIVITY AND MODE OF ACTION OF HERBICIDAL CHEMICALS

R.H. HAMILTON, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01434)

Objective: Investigate the physiological effects of herbicide treatment using resistnat and susceptible plants. Study uptake, distribution, and metabolism of important herbicides in susceptible and resistant species. Look for possible sites of herbicide action.

Approach: The studies will be concerned with influence that uptake, distribution and metabolism have on the concentration of herbicide accumulating at the active site in susceptible and resistant species. The studies will involve the use of C labeled or tritium- labeled herbicides to study the above factors. The work on possible sites of action will employ both the in vitro and in vivo approaches. Thus the effect of herbicides on intact plants or plant parts as well as its effect on isolated enzyme systems will be studied.

Progress: A major effort on this project was the tolerance of corn to 2-chloro-2-triazine herbicides. A mutant Pa. line was found to be low in benzoxazine derivatives and was more sensitive to atrazine. This was correlated with lowered ability of extracts from this mutant to detoxify atrazine to hydroxyatrazine. A survey of cereals indicated however no relation between benzoxazinone content and tolerance. Leaf concentrations of atrazine were also not related to acute toxicity. Preliminary work indicated it was possible to study intracellular localization of herbicides and plant growth regulators by radioautography and this effort was expanded with the USDA Grant No. 12-14-100-8075 (34). Recently we have identified detoxification pathway for 2,4-D in plants as formation of a major glycoside of 2,5- and 2,3-dichloro-4hydroxyphenoxyacetic acid. Four publications have resulted from this project.

SUPPORTED BY U.S. Dept. of Agriculture

4.0835, EFFECT OF INSECTICIDES ON POPULATIONS OF PARASITES OF THE ALFALFA WEEVIL

A.A. HOWER, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (00ENTC08334001CA)

OBJECTIVE: Determine the impact of insecticides applied to control the alfalfa weevil on the populations of parasites introduced against the weevil.

APPROACH: Field observations and laboratory tests will be made to determine the impact of the use of insecticides on the effectiveness of adult parasites; the impact of insecticides on parasite development and survival; the efficiency and dynamics of the parasites in the absence of insecticides; the efficiency and dynamics of the parasites following insecticide application; and the compatibility or lack of compatibility of spray schedules with parasite activity.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

4.0836, PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES

A. KURTZ, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01804)

OBJECTIVE: Determine pesticide residues on plants and animals. Develop standardized sampling and analytical methods for pesticide residues. Distribution and coordination of pesticide residue information.

APPROACH: Determine residues on fruit, vegetable, forage and animal products. Chemical and biological methods of residue analysis will be used. Emphasis will be on developing methods for new chemical analyses, determining pesticide residue on untested crops, and improvement of methods not now entirely satisfactory. Research data from all NE stations will be coordinated, residue disappearance curves on all types of crops will be prepared, and other pesticide information of value to this and other regions will be distributed.

PROGRESS: A micro florisil cleanup method as described by Henry F. Enos, et al., Perrine Primate Research Branch, USPHS, Perrine, Fla., was instituted. The method involves the grinding of 500 mg samples in Dual tissue grinders, handling of small liquid volumes with disposable Pasteur pipettes, and the use of only 1.5 g florisil for the cleanup stage. A large number of animal parts and organs have been analyzed with these procedures. The technique is now being used to analyze all fat samples from cattle adipose tissue, milk butterfat, and fish oils. Apple pomace has been found

to be an effective and safe cattle feed in Pennsylvania in using current processing methods and at current DDT contamination levels. Fat samples contained no more than 3 ppm total DDT when fed pomace for six months. Lake Erie Coho salmon, caught near the Pennsylvania shoreline, were found to contain DDT within the legally prescribed limits. Maximum concentration was found to be 1.2 ppm based on whole fish filet. A collaborative butterfat analysis study for BHC was completed under the auspices of the FDA District Laboratory in Buffalo. Methods generally were found to be good and in needed areas corrective procedures are being instituted. The Pennsylvania Station is cooperating with other Pennsylvania Laboratories and the Buffalo FDA Laboratory in monitoring and attempting to solve a serious BHC milk contamination problem. Cows high in BHC are being given special rations in an effort to reduce the contamination.

SUPPORTED BY U.S. Dept. of Agriculture

4.0837, BIOCHEMISTRY AND PHYSIOLOGY OF ADIPOSE TISSUE OF MEAT ANIMALS

J.D. SINK, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01611)

OBJECTIVE: Determine the cheimcal and physical properties of adipose tissue, study the metabolic dynamics both within and between the adipose tissues, and investigate the effect of ante-mortem and post- mortem treatments on the properties and the dnyamics of adipose tissues.

APPROACH: The panniculus adiposus and the capsula adiposa of cattle, sheep and swine will be studied. The chemical and physical systems/components, their interrelationships and their stability post- mortem will be investigated using the usual analytical, biochemical and radiochemical techniques. In addition, more complex techniques, i.e. electronmicroscopy, mass spectrometry, ultracentrifugation, activation analysis, chromatography (gas-liquid and thin-layer), will be employed. Growth studies and feeding trials will be conducted to study the effect of nutrition and aging on the development of lipid synthesizing and metabolizing systems.

PROGRESS: A study was conducted in an effort to find a sensitive and rapid analytical procedure for the determination of organochlorine pesticide residues in adipose tissue. Results of using neutron activation and gamma spectroscopy techniques with the short-lived chlorine-38 isotope indicated this procedure would have potential as a rapid, reliable method of determining organochlorine hydrocarbon content of animal tissues. In another study, work continued on the isolation and identification of the sex odor components in swine. A preliminary report was issued describing a ketonic and a hydroxy steroid that may be responsible for this odor. Work was also initiated in an effort to study the morphological changes that occur in porcine adipose tissues during growth. Cell number and size as well as lipase activity was studied.

SUPPORTED BY U.S. Dept. of Agriculture

4.0838, EFFECTS OF PESTICIDES ON INSECTS, MITES, AND PREDACEOUS ARTHROPODS IN APPLE ORCHARDS

E. NIEMCZYK, Res. Inst. of Pomology, *Skiermiewice, Poland* (480E21ENT16)

OBJECTIVE: Determine role of predators in controlling outbreaks of pest species and effects of pesticides on density of predators in apple orchards. Determine which pesticides are least detrimental to predaceous arthropods.

APPROACH: Laboratory studies will include effectiveness of predators in controlling red mites and aphids, predator preference for pest species, effects of pesticides on predators, and persistence of toxicity of pesticides. The main studies will be in apple orchards on population densities of red mite, predators and other pest densities. Fungicides and insecticides will be tested in apple orchards.

PROGRESS: Populations of red spider mites reached 120 mites/leaf during the season. The most abundant predaceous insect in the orchards sampled were Anthocoris nemorum, Propylea sp., Plaziognatus arbustrorum and Stethorus punctillum. The bark bug, A. nemorum, overwintered as an adult. Field-collected females laid 47-83 eggs each over a period of 11-28 days. Nymphs required 24-34 days to complete development through the 5 nymphal stadia when reared on Aulacorthum circumflerum, Myzus persicae or Panonychus ulmi. From 56 to 72% of the larvae reached the adult stage when reared in the laboratory. Experimental evidence indicated that mites were not a primary food of A. nemorum; thus this predator may be of relatively little value in regulating mite populations under field conditions. Studies with 19 pesticides and their effect on predaceous insects and phytophagous mites were conducted. There did not appear to be any correlation between pesticide treatments and populations of predators and phytophagous mites that would clearly indicate ways of maximizing predator benefits and minimizing use of chemicals.

SUPPORTED BY U.S. Dept. of Agriculture

4.0839, CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER

H.W. BOND, Univ. of Rhode Island, School of Pharmacy, *Kingston, Rhode Island* 02881

A series of vinyl sulfones will be synthesized and screened for potential molluscicidal activity against Australorbis glabratus, an intermediate host for human schistosomiasis. The mechanism of action of active compounds in this series will be investigated through the use of in vitro systems prepared from snail tissue. Structure activity correlations will be determined through the use of in vivo and in vitro systems. 'No effect levels' of potentially useful molluscicides in terrestrial animals will be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0840, DEVELOPMENT AND APPLICATION OF QUANTITATIVE CELL CULTURE METHODS TO ENVIRONMENTAL PROBLEMS IN CHEMICAL TOXICOLOGY

B.H. PRINGLE, U.S. Environ. Protection Agcy., Northeastern Water Hyg. Lab., *Narragansett, Rhode Island* 02882

The overall objective is the development of a sensitive bioassay system for general toxicological studies involving chemical pollutants: Emphasis is on the screening of chemicals for physiological and genetic damage. Specific objectives include an evaluation of comparative toxicity, determination of the presence or absence of genetic effects, development of methodology permitting the recognition of no-threshold events, and the establishment and quantitation of dose effect relationships.

Accomplishments of 1971: Toxicity titration studies were conducted for several selected chemicals, including cadmium, zinc, copper, and NTA, using standard cell plating efficiency techniques. In addition, the kinetics of divalent cadmium toxicity was investigated and a quantitative model constructed to describe the kinetic curves. The titration and kinetic studies served to demonstrate that reproducible quantitative data could be obtained for cell killing, and that evaluations of relative chemical toxicity could be made by comparison of titration end points.

Objectives for 1972: A. An immediate objective for FY-1972 will include the completion of kinetic studies for zinc. B. Preliminary investigations of the genetic effects of chemicals will be initiated using a standard strain of chinese hamster cell (CHO-K1) cultured in vitro. Initial studies will involve the evaluation and standardization of methodology for the inducement and quantitation of damage at the cytogenetic level, and for the inducement and isolation of single-locus mutants using known mutagens. Upon standardization and/or modification of these techniques, assays with selected chemicals will be carried out. In this phase of the genetic studies, emphasis will be placed primarily on the quantitation of dose relationships between cell killing, cytogenetic damage, and production of single-locus mutations.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

4.0841, PARASITES OF POULTRY, BIOLOGY, DISTRIBUTION AND CONTROL

J.R. ADKINS, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00134)

OBJECTIVE: Make a survey on the various external parasites. Study the biology and relate to control. Investigate insecticides for control of the external parasites. Investigate systemics. Investigate the toxicity of the newer insecticides to poultry.

APPROACH: Develop rearing techniques and life history of some of the more important species.

PROGRESS: Tests with Brofene were continued against Dermanyssus gallinae (DeGeer) and Ornithonyssus sylviarum (C. & F.). The miticide Acaralate was used against these mites. Brofene at 0.5% gave excellent control for 2 weeks and 1% for 4 weeks. Acaralate did not give satisfactory control. A synthetic pyrethroid aerosol (neo-pynamin) was as effective in the elimination of house flies from a turkey house as was natural pyrethrum.

SUPPORTED BY U.S. Dept. of Agriculture

4.0842, PHYSIOLOGICAL AND BIOCHEMICAL MECHANISMS OF HERBICIDAL ACTION

N.D. CAMPER, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00799)

OBJECTIVE: Examine interactions between herbicidal chemicals and proteins; determine effects of selected herbicides on other cellular components such as isolated enzyme activities and membranes and their functions; examine interaction of selected herbicides and soil microorganisms.

APPROACH: Emphasis will be on non-ionic chemicals, i.e., phenyl ureas, acylanilides, substituted anilines, s-triazines, and substituted carbamates. Ionic chemicals to be included are the bipyrilidium compounds. Environmental factors and molecular groups of proteins and herbicides will be studied to establish the mechanism of action. Enzymatically prepared protoplasts will serve as a tool to examine effects on membranes and their functions. In vivo and in vitro aspects of soil microflora-herbicide interactions will be studied to identify overall effects and specific organisms that affect selected herbicides.

PROGRESS: A new technique, the Sephadex Dialysis Method (SDM), was established to determine sorption parameters; it gave identical results to the partitioning technique. Sorption of relatively water-insoluble chemicals can be determined by SDM at varying concentrations. Sorption of atrazine and trifluraline by SDM increased with increasing protein concentrations and varies with the type of protein examined. Ornithine transcarbamylase from pea seedlings was comparatively inhibited by several phenylcarbamates and phenylureas. Inhibition increased with increased chlorination of the phenyl ring. The enzyme is located at a control point in metabolism and may be one site of herbicide action. Surveys of soil microflora in soils treated over several years with repeated applications of 2,4-D or trifluralin revealed, as in a previous survey, a decrease in fungi and an increase in actinomycetes in the trifluralin plots and a decrease in bacteria in the 2,4-D plots. Picloram, paraquat and diquat slightly inhibited and ioxynil (25 ppm) completely inhibited growth of Erwinia caratovora in liquid culture. The bacterium appears able to utilize ioxynil as its sole carbon source. Living protoplasts have been prepared from tomatoes by digesting the tissue with pectinol. This technique will facilitate the study of membrane transport of herbicides and their effects on membrane transport of other materials.

SUPPORTED BY U.S. Dept. of Agriculture

4.0843, BIOLOGY AND CONTROL OF ARTHROPODS ON SOYBEANS

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OBJECTIVE: Identify species of insects associated with soybeans, determine their economic importance and investigate biology and seasonal history of destructive and beneficial species. Develop management systems for pest species.

APPROACH: Weekly samples of insect pests, parasites, and predators will be taken using D-Vac, beating and sweeping techniques. Feeding habits of mole crickets inhabiting soybean fields will be investigated to determine the status of this insect as pest, scavenger or predator. Ovipositional and feeding responses by Mexican bean beetles will be compared on soybeans with different physical characteristics. Seasonal development of thrips and leafhopper populations will be determined on different isolines of the Clark and Lee varieties. Efficacy of different insecticides will be compared against pest species. Consideration will be given to timing of applications and selection of chemicals that leave no harmful residues on the crop or in the soil. Special emphasis will be placed on determining the role of parasites in supression of pest populations and the effect of pesticides on field populations of the more efficient parasites.

PROGRESS: Identification & economic importance: Vacuum samples were taken throughout season from untreated and insecticide-treated soybeans. Samples were frozen and processed to determine seasonal and treatment differences in insect and spider populations. Velvetbean caterpillar damaged pods of soybeans in late Sept. Economic importance of this damage was negligible. Interaction of insecticides, pests & parasites: Increases in numbers of earworms and decreases in predators and a possible parasite, Copidosoma truncatellum, were observed in plots treated with Temik or Azodrin. This indicates that more attention should be paid to type and timing of pesticide applications. Resistance of soybeans to damage by Mexican bean beetle: A high degree of resistance was observed in a line of Japanese origin from soybean maturity Group VII. This line is being utilized in a breeding program to develop resistance to Mexican bean beetle. New varieties will be evaluated for agronomic characteristics and resistance. Performance of insecticides: 3 non-persistent insecticides (Azodrin, Lannate & Monitor) continue to exhibit wider efficacy against pest than currently recommended materials.

SUPPORTED BY U.S. Dept. of Agriculture

4.0844, PHYSIOLOGICAL AND BEHAVIORAL EFFECTS OF INSECTICIDES ON CORMORANTS

Y.A. GREICHUS, South Dakota State University, School of Arts, *Brookings, South Dakota* 57006

A multidisciplinary research program will determine the effects of DDT and its metabolites, DDD and DDE, on penned and wild cormorants. Previous studies in these laboratories have determined residue levels of organochlorine pesticides at all levels of the food chain in the immediate ecosystem from which the birds were captured. The fish-eating cormorant, at the top of this food chain, has been shown to have average levels 270 times greater than fish, which have the next highest levels.

The objectives of this research are to determine the levels and tissue distribution of organochlorine pesticides in these birds and to relate these to the pathological and clinical findings and to the individual and social behavior of these birds. These findings will also be related to the numbers and types of endo-and ectoparasites found in and on the birds being studied.

SUPPORTED BY U.S. National Science Foundation

4.0845, PESTICIDE RESIDUES AND PARASITES IN BIG GAME MAMMALS

E.J. HUGGHINS, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00444)

OBJECTIVE: Assay the pesticide residue levels, in the big game mammals. Include whitetail deer and mule deer, pronghorn antelope, a sampling of elk and bison, a sampling of bighorn sheep and mountain goats. Study helminths and ectoparasites of these same big game mammals, patricular reference to those occuring in or on domestic livestock.

APPROACH: Viscera of deer and antelope will be collected. Also, a few animals will be taken during other seasons, and a sampling of other species of big game of more limited distribution will be taken. Fat and other tissues will be analyzed for residues of chlorinated hydrocarbons by gas chromatography procedures. Areas will be checked for past history. The viscera will be examined for helminths, and where possible.

PROGRESS: Work since 1965 has indicated that whitetailed deer, mule deer, pronghorn antelope, and elk of South Dakota to have detectable residues of several pesticides but that the levels are so low as to be of little concern at present. As to parasitic worms, the deer, elk, and bison have light helminth infestations, while the antelope have relatively heavy worm bur-

dens, particularly stomach worms. A preliminary survey of the parasites of mountain goats from the Black Hills during the past year indicates a serious lungworm infestation in the herd. Preliminary life cycle studies have been initiated with terrestrial snails collected from the mountain goat range. This infestation is believed to be the most pressing problem among the big game mammals at present. Moreover, the mountain goats harbor heavy infestations of stomach worms, which are also among the most damaging of the worm parasites. This work will be pursued.

SUPPORTED BY U.S. Dept. of Agriculture

4.0846, A STUDY OF THE PESTICIDE RESIDUES AND OF PARASITES IN BIG GAME MAMMALS OF SOUTH DAKOTA

E.J. HUGGHINS, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00507)

OBJECTIVE: Study the epidemiology of the lungworm infection (Protostrongylus rushi and P. stilesi) in the mountain goats of the Black Hills. This will involve studies on the distribution, ecology, and bionomics of the terrestrial snails which serve as the intermediate host. Determine what part, if any, the bighorn sheep of the Black Hills may play in the epidemiology of lungworm. (Lungworms were found in two bighorn sheep from the Badlands of South Dakota). Analyze kidney fat from the mountain goats for pesticide residues, in order to round out the picture for big game mammals of South Dakota. Samples will be collected during the limited fall hunting season for mountain goats in the Black Hills.

APPROACH: Maintain snails in the laboratory and subject them to infection with lungworm larvae for controlled studies. Lungworm eggs and larvae can be recovered from infected lungs collected during the limited hunting season. They are extremely resistant to both freezing and dessication and apparently remain viable for long periods in the freezer or refrigerator. Lungworm larvae can be recovered also from fecal pellets of mountain goats. Search for an effective drug which can be incorporated into salt blocks and made available to the wild goats on their range. This will entail attempts to infect domestic sheep with the lungworms for drug trials, etc.

PROGRESS: Lungs and viscera of mountain goats were obtained from the fall hunts of 1968 and 1969, and a high incidence of lungworm infection was found, as well as many helminths of the gastrointestinal tract. The latter have been identified and tabulated. With regard to the life history of the lungworms (Protostrongylus), many tiny terrestrial snails were collected on the mountain goat range and several different species have been identified by a specialist at the Smithsonian Institution. Several of these species of snails have been subjected to experimental infection with lungworm larvae, with successful infection occurring in at least one species of snail. A number of experimentally infected snails were fed to two domestic lambs, but results were negative. Samples of kidney fat from 13 mountain goats were analyzed for pesticide residues. Very low levels of several chlorinated hydrocarbons were found.

SUPPORTED BY U.S. Dept. of Agriculture

4.0847, RELATIONSHIP OF INSECTICIDES TO PHEASANTS IN SOUTH DAKOTA

K.E. SEVERSON, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00438)

OBJECTIVE: Phases 1 and 2 completed. 3rd phase - to determine the effect of pesticides on juvenile pheasants. 4th phase - to determine effect of pesticides on reproductive behavior of hen pheasants.

APPROACH: 3rd phase - two section. 1. Controlled study where birds fed known amounts of aldrin (4 levels: 0.0, 0.5, 1.0, 1.5 mg/bird/wk for 7 weeks). Data gathered will be rate and date of primary feather growth, wt. gain, food consumption, residue in tissue. 2. Broods released in 1 - acre enclosures - 2 treated with 2 lbs. aldrin 1 acre, 2 controls. Data gathered on mortality, food habits and tissue residues. 4th phase - 72 hens divided into 4 treatments, 2 replications each: Tr. 1. Sight and sound stimulus from chicks and 6 mg dieldrin. Tr. 2. Sight and sound, no dieldrin; Tr. 3. only dieldrin; Tr. 4. no stimulus, no dieldrin. Chicks will be introduced to hens. Evaluate effect of dieldrin on acceptance of chicks.

PROGRESS: Whole-body analysis of aldrin and dieldrin for 47 birds from 16 to 92 days of age and 12 control birds from 19 to 68 days of age on treated plots was with gas chromatography. Wet-weight concentrations of aldrin and dieldrin combined were from .06 - .10 and averaged .07 ppm for control birds and .11 - 1.26 and .38 ppm for treated birds. No relationship was found between length of exposure and tissue concentrations. Highest concentratoms for both treated plots occurred in tissue of birds 61 days old. Analysis of 9 feather samples suggested uropygial secretions as one source of dieldrin residues in feathers. Growth of pheasants between 5-21 weeks of age was depressed by administration of aldrin dosages of 1.0 and 1.5 mg. Aldrin values in the brain and whole body of birds varied little (.02-.08 ppm) regardless of treatment while dieldrin values increased proportionately with treatment during the period of administration. Ten weeks after treatment was terminated brain and whole body levels of dieldrin from birds surviving the experiment were comparable to controls. Administration of 1.5 mg of aldrin in a single dosage caused death of 11 of 22, 5-week old pheasants within 48 hours. Aldrin plus dieldrin levels in these 11 birds were: brain, 2.29-4.25 ppm and averaged 2.27 ppm; whole body, 1.45-4.35 (Text Truncated - Exceeds Capacity)

SUPPORTED BY U.S. Dept. of Agriculture

4.0848, RESEARCH ON ARTHROPOD-BORNE DISEASES - II

J.W. WRIGHT, World Health Organization, *Geneva, Switzerland*

The programme to be undertaken in terms of this Grant may be divided into three major parts; 1. Toxicology of pesticides to man: This portion of the programme will be directed towards determining the mode of action of newly-developed insecticides in man, their routes of absorption, the development of methods for determining cholinesterase depression, the definition of diagnostic criteria, therapy and antidotes, and the development of measures that can be used for the protection of persons coming into contact with pesticides in public health programmes. 2. Insecticide resistance: The co-ordination, stimulation and servicing of research on the genetic, biochemical and physiological aspects of resistance and vector control and the performance of global surveys on the resistance to insecticides of the major arthropod species of public health importance. 3. Meetings and conferences: The sponsoring of scientific meetings to guide the Organization in the technical aspects of its programme and to bring together scientists involved in specific fields to review the present status of important problems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0849, REDUCTION OF ADVERSE EFFECTS OF PESTICIDE RESIDUES

B.J. DEMOTT, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00242)

OBJECTIVE: Study food and feed products with respect to: the location and persistence of pesticides residues in market products, the development of commercial marketing and processing techniques for the detection, removal and/or neutralization of pesticide residue effects.

APPROACH: Milks containing insecticides (DDT, lindane, methoxychlor and endrin) will be subjected to normal milk plant processes. Milk will be obtained from animals known to produce milk having a desired level of the insecticide. These milks will be subjected to heat, vacuum, steam distillation, various chemical and physical treatments in an attempt to remove and/or neutralize the residues present.

PROGRESS: Samples of milk from cows fed known amounts of furadan (Niagara 10-242) were extracted and analyzed by the method described by Bowman and Beroza (Pesticide Reviews 17:23, 1967). The excitation and emission wave lengths used by these workers were confirmed for the pesticide dissolved in acetonitrile. Fifty-two samples of milk from two cows fed up to 3 grams per day of furadan were extracted and analyzed by use of an Aminco-Bowman Spectrophotofluorometer. The concentrations of pesticide in the milk and the amounts consumed on that same day had a correlation coefficient of -0.19 for one cow and 0.01 for the other cow, indicating very little relationship between consumption and secretion of the parent compound. Complete

withdrawal of the pesticide from the feed did not cause a noticeable decline in the level of pesticide in the milk. No studies were made on metabolites of the furadan which might have been secreted in the milk.

SUPPORTED BY U.S. Dept. of Agriculture

4.0850, CHEMICAL RESIDUES IN MILK
B.J. DEMOTT, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00235)

OBJECTIVE: Determine the amount of insecticides and herbicides or their toxic metabolites which, when consumed by lactating dairy cattle, will be present in the milk. Determine how the stage of lactation and metabolic rate influence the secretion of insecticides or herbicides in milk.

APPROACH: Cows will be fed different levels of pesticides; the intake and the amount of the pesticide and its toxic metabolites secreted into the milk will be measured. Similar trials will be conducted with herbicides. Trials will be conducted on very low levels of heptachlor. Cows will be fed pesticides while dry and fattening, in early lactation and losing weight, and in late lactation and gaining weight.

PROGRESS: Efforts to improve the precision of analysis for Furadan and its metabolites in milk have continued throughout 1968. Several different extraction methods and several measurement techniques using both the halogen and nitrogen cell for the microcoulometer have been used. No measurable amounts of the Furadan parent meterial has been detected in any milk sample including milk from cows fed up to 147 ppm (feeding trial reported in 1967) Furadan in the feed for 3 week periods. Low levels of the 3-hydroxy metabolite of Furadan were detected with some extraction methods and analysis with the halogen cell in the milks from cows receiving the higher levels of furadan. However, desirable precision to clearly establish a specific level has not been obtained. In cooperative work, the Niagara Chemical Division did find levels of 0.15 ppm of the 3-hydroxy Furadan from cows receiving 2 gm of Furadan per day. These analyses were with a nitrogen cell. No residue of the parent material was detected. An additional 10 samples of milk from cows fed Furadan in the trial reported in 1967 are now being analyzed in the Niagara laboratory.

SUPPORTED BY U.S. Dept. of Agriculture

4.0851, PHOSPHOROUS INSECTICIDES EFFECT ON SULFATE FIXATION
J.T. SMITH, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00234)

OBJECTIVE: Determine effect of organo-phosphorous insecticides on the fixation of sulfate by mucopolysaccharides. Develop a screening test for the relative toxicity of different organo-phosphorous insecticides utilizing the sulfate fixation reaction.

APPROACH: Selection littermate albino rats raised to maturity, 250-300 g, on Purina lab chow will be given graduated small amounts of an organo-phosphorous insecticide. They will then be given a subcutaneous injection of Na(2)S O(4) in saline; aftet 24 hours the animals will be sacrificed and their rib cartilage removed and stored frozen. The mucopolysaccharides will be isolated from the cartilage and the specific activity of their ester sulfer determined. Different organo-phosphorous insecticides will be administered and their effect on sulfate fixation compared with their effect on cholinesterase activity.

PROGRESS: Studies using S-malathion have shown no significant difference in the absorption of malathion administered by stomach tube or fed in diet. A pilot study indicated that the rate of absorption probably causes the difference in toxicity. The specific activity of the blood of rats given S-malathion by stomach tube reaches a peak within the first hour after administration. During a 3-day study, this peak increased in intensity each day and tended to occur earlier. The specific activity of blood of rats fed S-malathion in diet indicated a steady rate of absorption. Malathion intoxication may cause a decrease in membrane mucopolysaccharides as indicated by determination of the mg hexosamine/mg N(2) in mitochondria and nuclei of controls and rats given malathion. Previous studies using S have shown a mobilization of sulfate in malathion-treated rats. These data have been confirmed by determining the mg sulfur as sulfate/mg of dried lung and brain. Many of the previous investigations using malathion have been repeated with the more toxic organophosphorus insecticide, parathion. The levels of parathion selected did not cause a decrease in sulfate fixation as did malathion nor did it cause a mobilization of sulfate into excreta.

SUPPORTED BY U.S. Dept. of Agriculture

4.0852, PRELIMINARY PESTICIDE STUDY
V.G. HENRY, State Game & Fish Commission, *Nashville, Tennessee* 37203

Objectives: To conduct preliminary investigations as to the most feasible method and procedure to obtain overall pesticide study objectives.

Procedures: 1) Review literature on pesticides--wildlife studies. 2) Consult with knowledgeable personnel concerning project plans and procedures. 3) Based on the results of the above procedures and the feasibility of the study, design the investigative study itself concerning species to be monitored, physiographic regions concerned with, number of monitoring stations, number of samples to be collected per station, methods of collection of samples, analysis of samples, and evaluation of results. 4) Prepare project Federal Aid documents.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0853, ENZYMIC MECHANISMS OF INSECTICIDE METABOLISM
R.A. NEAL, Vanderbilt University, School of Medicine, *Nashville, Tennessee* 37203

This project is concerned with studies of the mechanism of the metabolism of the phosphorothionate insecticides by various animal enzymes. These studies include (1) The use of O-18 to study the site of attack of oxidative enzymes on these compounds. (2) Spectral studies of the binding of phosphorothionates to cytochrome P-450 present in animal microsomes, and (3) Studies of the influence of electronic factors on the rate of oxidative metabolism of phosphorothionates by rabbit liver microsomes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0854, ENVIRONMENTAL MUTAGENESIS TESTING
J.G. BREWEN, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

Work is being done to develop a meaningful assay system by which potential environmental mutagens can be tested on human cells. To this end we have concentrated our efforts toward the development of a host- mediated-assay system. Human lymphocytes are placed in a diffusion chamber consisting of millipore filters and this chamber is implanted into the peritoneal cavity of any laboratory animal. The animal can then be treated with any compound through any of several means of exposure (feeding, inhalation, injection, etc.). It is also possible to treat the animal prior to implantation of the chamber. In any case, the chambers can be removed three days after implantation and cytogenetic preparations made from the cells.

Results: Excellent cytogenetic preparations hsve been obtained from this technique and known chemical mutagens have been tested. Typical chromosomal aberrations have been seen in the implanted cells when the host animal was exposed to a known mutagenic agent.

SUPPORTED BY U.S. Atomic Energy Commission

4.0855, ENVIRONMENTAL MUTAGEN INFORMATION CENTER (EMIC)
H.V. MALLING, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

The primary goal of the Environmental Mutagen Information Center (EMIC) is to accululate, digest, tabulate, store, and disseminate all pertinent information concerning new compounds in the human environment which have been reported to be mutagenic since January 1969. It has been known for many years

that ionizing irradiation can cause genetic damage, and the need for appropriate protection has been widely recognized. Information Centers were formed to facilitate communication between scientists and from scientist to the public about the safe handling of ionizing radiation. Some chemicals, however, may be more dangerous to the genetic health of human beings than radiation. This problem is now being recognized by the public and a part of the scientific community, and this led to the formation of the Environmental Mutagen Society (EMS). Information on the mutagenic action of chemicals can appear in most Life Science Journals. This literature area, which requires constant monitoring, is therefore very wide. The EMS considered therefore establishment of an Information Center in this field extremely necessary. Our Information Center is counseled by two distinct but overlapping committees. One is composed of EMS members only and the other is composed of members from our funding agencies and the EMS.

Our operation began in October of 1969 and our primary efforts to date have been placed on the building of our data banks. Although our official opening date is not until September of 1970, we are already experiencing a high influx of information requests. In addition to this, we have also published literature surveys on chemical mutagens in mammals, cyclamates, and the genetic effects of LSD and related psychotic compounds. State of the art reviews were also published on mercury in our environment and on the genetic effects of pesticides.

SUPPORTED BY U.S. Atomic Energy Commission

4.0856, PRELIMINARY MONITORING OF PESTICIDES
F.A. SMITH, State Parks & Wildlife Dept., *Austin, Texas* 78701

Objective: To determine the levels of mercury, dieldrin, and DDT and metabolites in chukars, pheasants, deer, waterfowl, and fish collected from various areas of Utah.

Procedures: 1. Collect chukars, pheasants, deer, waterfowl, and fish from various areas of the State. 2. analysis. 3. Analyze samples. 4. Determine extent of pesticide use in sample areas. 5. Evaluate and report results.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0857, NUTRITION AND PROPAGATION OF THE ATTWATER'S PRAIRIE CHICKEN
C.R. CREGER, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01693)

OBJECTIVE: Determine the nutritional requirements and reproductive potentials of Attwater's Prairie Chicken in Captivity.

APPROACH: This is the first attempt to propagate Attwater's prairie chicken (an endangered species) in captivity. Birds will be obtained from the wild and attempts at reproduction will be made by forced matings and artificial insemination. Birds obtained from such matings will be used to determine their nutritional requirements for protein, energy, vitamins, and minerals. In addition, studies concerning the effect of herbicides and pesticides on reproduction will be made.

PROGRESS: Project includes the nutrition, propagation, genetic makeup and pesticide effects of the Attwater prairie chicken. The Attwater prairie chicken is susceptible to and readily contracts blackhead disease, aspergillosis and enteritis. Other birds have also died of trichostrongyles and Tetrameres americanus. We have succeeded in formulating a breeder diet that maintains the birds in excellent physical condition. All birds analyzed to date have contained varying levels of DDT. Further work was conducted with the Coturnix coturnix in order to determine the effects of pesticides on reproductive performance. Results show that there is no upper level of DDT accumulation in body tissue even when levels of 500 ppm are fed. As the pesticide increases in the diet, hatchability, fertility and egg shell thickness decrease. Since the greatest percentage of pesticides are lipid soluble, studies have been undertaken which involve chemicals that tend to mobilize fats. In this area, both inositol and choline show the most promise in the removal of pesticides from fatty tissue. Restriction of food intake will also decrease the pesticide content of tissue mainly by causing reverse fat depots to be utilized.

SUPPORTED BY Texas State Government - Austin

4.0858, MINERAL INTERACTIONS WITH PESTICIDES
H.R. CROOKSHANK, Texas A & M University System, U.S.D.A. Animal Hus. Res. Div., *College Station, Texas* 77843 (033005121346)

OBJECTIVE: Determine the effects of pesticides upon the mineral metabolism of sheep and effects of varying the mineral levels of the diet on the absorption and retention of pesticides by sheep.

APPROACH: Changes in the mineral composition of blood serum, urine and feces collected from sheep fed diets with varying levels of minerals with and without the addition of graded levels of pesticides will be determined at periodic intervals over an 80 day test period. Pesticide and/or pesticide residue levels will be determined from aliquots of these samples.

PROGRESS: Changing the Ca:P ratio in the diet of wether lambs at College Station, Texas, from 1:1 to 3:1 did not affect the elimination of ronnel and its metabolites in the urine. While certain changes were observed in the mineral composition of the urine and blood of these animals the changes were not consistent and the number of samples were not sufficiently large for a statistical study. When the same procedure was used on the urine from ewes and rams which had been given 100 mg. ronnel per kg. body weight orally, neither ronnel nor any of its metabolites could be detected indicating a possible variation (wethers vs. ewes and rams) in metabolism and excretion. The ewes consistently had more ronnel in omental fat than the rams. Four days after administration there was considerable individual variation in the levels within sexes. However, this had disappeared by day 7. The rate of disappearance from omental fat was essentially similar for both sexes. Ronnel was not found in omental fat 21 days after administration.

SUPPORTED BY U.S. Dept. of Agriculture

4.0859, EFFECT OF CHARCOAL ON PESTICIDE RESIDUES AND ON NUTRIENT UTILIZATION IN RUMINANTS
H.R. CROOKSHANK, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (033005770146)

OBJECTIVE: Determine the effectiveness of activated charcoal for reducing pesticide residues in body tissues of ruminants and to ascertain if the oral application of activated charcoal affects the availability of nutrients, nitrogen retention, growth, and efficiency.

APPROACH: Two phases of experimentation will be conducted with sheep at College Station, Texas. One phase will involve the administration of activated charcoal as part of the diet or as a drench and the determination of changes in blood minerals, carotene, protein and amino acids, urinary minerals, growth and efficiency. The second phase will include the same charcoal treatments and measurements as in phase one plus the administration and tissue analyses of ronnel. At Beltsville, ruminal fistulated steers will be used in a digestion trial to ascertain the effect of charcoal on nutrient digestibility, nitrogen balance, and ruminal environment.

PROGRESS: Mixing of activated charcoal with a ronnel contaminated feed reduced the residue levels in the omental fat to 10% of those in sheep not receiving charcoal. Oral drenches of activated charcoal did not significantly reduce the residue levels. The rate of excretion of residues at the termination of the test was not affected by continued administration of charcoal. With the exception of the animals fed only the ronnel contaminated diet during weeks 4 through 9, the growth of all groups were parallel and reflected stress situations equally. These results offer the feeder a practical procedure whereby ronnel- contaminated feeds may be utilized at a nominal cost.

SUPPORTED BY U.S. Dept. of Agriculture

4.0860, METABOLISM OF CARBAMATE INSECTICIDES
H.W. DOROUGH, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01559)

OBJECTIVE: Determine metabolic pathway of carbamate insecticides in insects, animals and plants. Compare mechanisms of activation and detoxification. Determine fate of carbamate metabolites. Compare metabolism of carbamate insecticides in susceptible and resistant insects. Determine effect synergist, and other insecticides, have on observed pathway.

APPROACH: Radiolabeled carbamates will be synthesized and characterized in the laboratory. Insects and other animals and plants will be treated. Parent compound and its metabolites extracted. Components separated by chromatographic procedures and detected by liquid scintillation counting or by radioautography. Attempts will be made to identify metabolic products and to determine their individual toxicity.

PROGRESS: The metabolic fate of the more promising carbamate insecticides has been investigated. Compounds studied in greatest detail were (a) Carbaryl (1-Naphthyl-N-Methylcarbamate, (b) Matacil (O- Isopropoxyphenyl-N-Methylcarbamate, (c) Temik (2-Methyl-2-(methylthio) propionaldehyde-O-(methylcarbamoyl)oxime) and (d) Furadan (2,3-Dihydro- 2,2-dimethyl-7-benzofuranyl-N-Methylcarbamate. In general, these toxicants exhibited the same type of metabolic pathway in mammals, insects and plants. Chemical reactions responsible for the alteration of the carbamates were hydrolysis, oxidation or hydroxylation, and conjugation of those metabolites which contained a hydroxyl group. In addition, the sulfur atom in Temik was oxidized to form the sulfone and sulfoxide derivatives. With the exception of Temik-sulfoxide, the metabolites of all the carbamates were less toxic than the parent compound. Studies of the fate of carbaryl, Temik and Furadan in dairy animals demonstrated that low levels of residues were excreted in the milk - their magnitude dependent upon the level of insecticide consumed.

SUPPORTED BY Texas State Government - Austin

4.0861, METABOLISM OF CARBAMATE INSECTICIDES

H.W. DOROUGH, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX04008)

OBJECTIVE: Gather detailed information on the metabolism of the carbamate insecticides for use in relating the findings to human health and in developing more effective use of these toxicants.

APPROACH: A study of carbamate insecticide metabolism will be conducted with major emphasis on defining metabolic pathways and establishing their importance in relation to the safe use of carbamates, individually and as a group. Generally, promising new carbamate insecticides will be used to a greater extent. Whether the product under consideration be old or new, radioisotopes will be used as a basic tool in all studies where radiosynthesis can be accomplished. Both plants and animals will be used as test organisms in the metabolism work. All studies will involve the identification of metabolites and determination of their individual biological activity.

PROGRESS: Continued progress was made in defining the metabolic pathways of several carbamate insecticides in plant and animal systems. Temik and Furadan still appear to have excellent potential for becoming commercially available insecticides, although their use in some cases may be highly restricted.

SUPPORTED BY Texas State Government - Austin

4.0862, INSECTICIDE RESIDUES IN POULTRY AND EGGS

F.A. GARDNER, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01560)

OBJECTIVE: Determine the effects of feeding low levels of selected insecticides on the rate of appearance, intensity and persistence of insecticide residues in both poultry and egg tissues. Determine the effects of sex and age of bird on the rate of appearance, intensity and persistence of insecticide residues in poultry and egg tissues. Determine the effects of cooking on insecticide residue concentrations in poultry and eggs. Determine the effects of storage time and temperature on insecticide residues in poultry and eggs.

APPROACH: Selected insecticides will be added to standard farm rations and fed to chickens and turkeys of both sexes and different ages. Tissues of both meat and egg will be analyzed for insecticide residue. Cooking and storage effects will be determined. Residue build-up during treatment and residue disappearance post-treatment will be determined.

PROGRESS: Chicken broilers were fed rations containing 5 and 10 ppm of both DDT and/or chlordane for a two week period (8-10 weeks of age). All combinations of these insecticide levels were evaluated. Broilers were randomly selected for a one week withdrawal evaluation period in which rations containing 6.8, 20.6 or 48.0% protein were fed. Analysis of the data demonstrates only trace accumulation of residues in breast tissue and levels less than 1 ppm in thigh tissue. (Both of these tissues are relatively low in fat content). When DDT was fed at 10 ppm, accumulation rate of residues in fatty tissues was independent of sex. Depletion rates were not affected by dietary protein during the withdrawal period. However, feeding rations containing 5 ppm of DDT resulted in a more rapid accumulation of residues in the male than in the female. Depletion rates during the withdrawal period were increased when either the high or low protein rations were used in place of the regular 20.6% ration. A dye binding method for determining the protein content of egg white and/or egg yolk has been developed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0863, TOXICITY AND RESIDUES OF INSECTICIDES AND REPELLENTS IN RELATION TO INSECTS AFFECTING LIVESTOCK

O.H. GRAHAM, Texas A & M University System, U.S.D.A. Entomology Res. Div., *College Station, Texas* 77843 (00ENTH0702460100)

OBJECTIVE: Determine toxicity of insecticides and repellents to livestock and livestock insects under laboratory and field conditions and establish residue levels of parent compounds and their metabolites.

APPROACH: Treat insects individually or in small numbers in laboratory by microdrop, sprays, or by exposure to treated surfaces to establish insecticide toxicity. Cooperate with veterinarians and biochemints to evaluate effect of toxicants on animals and to establish chemically the residues in insect and animal tissues. Chromatographic techniques will be commonly used for these determinations.

PROGRESS: In toxicity tests, diazinon, ethion, dursban, and GS- 13005 effectively controlled the turkey chigger when used at a rate of 4 lbs/acre. Toxicity of dursban to turkeys and residue studies in turkey tissues are in progress. Other elements of this work area have been reported under H0701 since facilities at College Station were incomplete through most of this reporting period.

SUPPORTED BY U.S. Dept. of Agriculture

4.0864, SYSTEMIC INSECTICIDE RESEARCH ON MISCELLANEOUS INSECTS AND SPIDER MITES OF COTTON

R.L. RIDGWAY, Texas A & M University System, U.S.D.A. Entomology Res. Div., *College Station, Texas* 77843 (00ENTC0306460100)

OBJECTIVE: Develop artificial diets for rearing such insect predators as Chrysopa. Develop more effective systemic insecticides and methods of application for control of miscellaneous insects and spider mites of cotton.

APPROACH: Rear on artificial diets Chrysopa and other predators or parasites that are tolerant to systemic insecticides, evaluate candidate systemic insecticides in the laboratory, and test promising ones in the field against miscellaneous insects and spider mites. Test new concepts in applying systemic insecticides, and test slow release formulations of systemic insecticides against various insects and spider mites.

PROGRESS: A wide range of different compacted carbon-base formulations of aldicarb were less phytotoxic in laboratory tests when placed in-furrow with cottonseed than a corn-cob formulation. Considerable differences in phytotoxicity of formulations were detected. A compacted granular formulation of aldicarb made by Great Lakes Carbon Corp. reduced phytotoxicity and extended the period of insect control in field tests when compared with the standard corncob formulation. A series of

polymeric formulations of aldicarb made of urea-formaldehyde, polyamide, polyurethane, polyvinyl chloride, cellulose acetate, and polyester were prepared and evaluated in the laboratory. A cellulose acetate formulation was the most promising slow release formulation of the series.

SUPPORTED BY U.S. Dept. of Agriculture

4.0865, POPULATION DYNAMICS OF COTTON INSECTS SUBJECTED TO INSECTICIDAL TREATMENTS
J.A. WALKER, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01270)

OBJECTIVE: Establish numbers of cotton fleahoppers necessary to reduce yield and delay boll set. Develop criteria for the initiation of insecticide programs for the fleahopper. Evaluate insecticides that are used for fleahopper control with regard to their effect on beneficial arthropods in cotton. Study the effects of insecticides on beneficial arthropods when used in area-wide treatment.

APPROACH: Populations of fleahoppers will be studied in replicated plots in dry land and irrigated cotton, relationships will be established between time, length, and magnitude of infestation and yield loss and delayed boll set. The damage potential of the immature and adult stages will be determined. Observations will be made of behavioral difference that may be induced by strains of cotton known to be resistant to the insect. The effects of the different insecticides for fleahopper control as they influence the beneficial arthropod population will be examined in replicated plot experiments in cotton. Insecticides showing the most promise for fleahopper control with minimum disruption of the beneficial arthropod population will be used in large field experimentation. The overall aim of this project is to develop a minimum insecticide program for the cotton fleahopper that lowers the pest below the economic threshold, and no more.

PROGRESS: Experiments were conducted in cotton to evaluate the effect of insecticides applied for fleahopper control on beneficial arthropods. Sulphur, Sevin, Dylox, Bidrin, Strobane-DDT, and toxaphene produced sharp reductions in populations immediately after treatment. Bidrin was the most severe. 2 weeks after treatment the less harsh materials may have regained effective predatory levels. Outbreaks of Heliothis as a result of destruction of beneficial fauna would have been most favored immediately after treatment to 10 days after treatment. Studies of Heliothis larval parasitism showed low incidence 5%. Cotton was not treated until Aug. 3 (for boll weevils) and prior to this time beneficial fauna attained populations of over 20,000 per acre. Effective biological control of Heliothis resulted from the various species of beneficial arthropods.

SUPPORTED BY U.S. Dept. of Agriculture

4.0866, EFFECT OF NITRATES AND OTHER NITROGENOUS COMPOUNDS ON TOXICITY OF PESTICIDES
R.H. SINGER, U.S. Dept. of Agriculture, Vet. Tox. & Entomol. Res. Lab., *College Station, Texas* 77843 (ADPA7-45)

OBJECTIVE: Determine the extent to which nitrogenous compounds may alter the absorption, detoxification, and excretion of pesticides in animals consequently altering the toxicity of the nitrogenous compound or pesticide.

APPROACH: Various nitrogenous compounds will be administered at varying levels to animals that receive toxic and subtoxic levels of pesticides to determine any potentiation or reduction of toxicity to the animals of either the nitrogenous compounds or pesticides or both. Chemical, enzyme, and histological studies will be made on blood, urine, and tissue specimens to determine alterations in metabolic processes and detoxification mechanisms involving the nitrogenous compounds and pesticides.

PROGRESS: Toxic doses of sodium nitrite produced peak blood levels during the first hour but methemoglobin reached its peak during the 2-4 hour post-treatment period. Cardiovascular collapse proceeded unimpeded to death. Cardiovascular collapse paralleled blood nitrite levels but did not parallel methemoglobinemia. Standard therapy of methylene blue and/or ascorbic acid was ineffectual. A vasoconstrictor, such as adrenaline, administered just before methylene blue and/or ascorbic acid resulted in prompt recovery. This is a completely new and practically useful method of treatment. With identical doses of nitrite it was found that acidosis precipitated the production of hemoglobinemia. Animals on high protein or grain diets that tend to produce acidosis are more subject to methemoglobinemia from nitrite exposure than are those on diets which preserve a normal acid-base balance.

SUPPORTED BY U.S. Dept. of Agriculture

4.0867, TOXIC EFFECTS OF AGRICULTURAL CHEMICALS ON REPRODUCTION IN ANIMALS
H.E. SMALLEY, U.S. Dept. of Agriculture, Vet. Tox. & Entomol. Res. Lab., *College Station, Texas* 77843 (ADPA7-44)

OBJECTIVE: Identify agricultural chemicals which may affect reproduction in any way. Define the damage and establish limits. Investigate mechanisms of action. Ascertain actual hazard to livestock under conditions of normal use and investigate methods of reducing the hazard.

APPROACH: Screen suspect compounds in laboratory animals and extend studies into domestic animals to determine dosage, metabolism and species differences. The effects of the compounds on male and female reproductive organs and processes will be examined as well as abortifacients, mutagenesis, dominant lethality and teratogenesis. Studies of actual hazards will be done utilizing recommended methods of use. The possibility of residual compounds being available in the human diet will also be determined.

PROGRESS: Due to severe limitations of operational funds available, this project could not be sustained during this reporting period. The project has been re-written and it is anticipated future funding and cooperative efforts will provide a base for renewed effort.

SUPPORTED BY U.S. Dept. of Agriculture

4.0868, NEUROLOGICAL EFFECTS OF PESTICIDES IN DOMESTIC ANIMALS
H.E. SMALLEY, U.S. Dept. of Agriculture, Vet. Tox. & Entomol. Res. Lab., *College Station, Texas* 77843 (ADPA7-47)

OBJECTIVE: Determination of lesions and mechanisms of neurological damage to domestic animals during and after exposure to certain pesticides.

APPROACH: Production of paralysis, or other nerve damage to be done by exposing susceptible animals to various pesticides. Characterization of damage, pathogenesis, comparative toxicities, impulse excitability or inhibition, metabolic fate, antagonism and synergism, and possible protective or therapeutic mechanisms will be studied by histopathological, histochemical, biochemical, physiological, and pharmacological methods.

PROGRESS: Paraquat, an herbicide, has been repeatedly cited as the cause of fibrosing pneumonitis in the human, almost always fatal. In comparative studies great variance of effect was noted: guinea pigs, sheep and swine reacted as does the human, hamsters died of kidney damage. Turkeys tended to be refractory. Toxicity and hazard were rather definitely differentiated in studies with turkeys. Insecticides used at 4 pounds/acre seemed rather questionable in light of the most toxic being so at 2 mg/kg. Practical (duplicating needed methods) application showed no hazard to turkeys when rates were increased up to 16-fold. (Ethion, Dursban, Supracide). Such rates provided 3-10 lethal doses/bird per square foot of pasture space. When 10 ppm each of heptachlor, BHC, p,p'-DDT and 5 ppm dieldrin were added to ruminant diets, the addition of 1% activated charcoal of plant origin reduced dieldrin residues but not the others. The addition of 5% activated charcoal to a diet containing 1000 ppm of ronnel reduced tissue residues of ronnel by 95%.

SUPPORTED BY U.S. Dept. of Agriculture

4.0869, TOXICITY AND RESIDUES OF INSECTICIDES AND REPELLENTS IN LIVESTOCK AND POULTRY
R.O. DRUMMOND, U.S. Dept. of Agriculture, Livestock Insect Laboratory, *Kerrville, Texas* 78028 (00ENTH0701461100)

OBJECTIVE: Determine toxicity of insect control chemicals and other agents to livestock and poultry; establish the extent and persistence of residues in meat, milk, and eggs; develop methods that will minimize residues.

APPROACH: In cooperation with veterinarians and chemists in coordinated approaches to the problem, study toxicity in livestock and poultry, of insect and chemical control agents, determine residue levels in various tissues by bioassay and chemical techniques. Evaluation techniques entail spray, oral, pour-on, self-application, dipping, and dust treatments of livestock and poultry. Gross toxicity, physiological effect and tissue residue studies will be evaluated through visual observation of the animals, biochemical analyses of tissues and excretion, and chemical and chromatographic analyses of meat, milk, and eggs.

PROGRESS: Calves sprayed with 0.25 or 1% emulsions of CIBA C-9491 were slaughtered 1 week after spraying. Residues in the fat averaged 5.7 ppm for the animal sprayed with the higher and 0.91 ppm for the lower concentration. Residues of ronnel and its oxygen analog were determined in the fat of beef cattle sprayed twice 2 weeks apart with a 0.25% emulsion. The highest residue found was 6.80 ppm in the fat of one animal 3 days after the 2nd treatment. The highest residue 21 days posttreatment was 0.02 ppm. Residues of Dursban and its oxygen analog were determined in the body tissues of cattle following multiple dips in 0.025% emulsions.

SUPPORTED BY U.S. Dept. of Agriculture

4.0870, LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES

J.S. PALMER, U.S. Dept. of Agriculture, Toxicological Research Lab., *Kerrville, Texas* 78028 (ADPA7-19R)

OBJECTIVE: Develop the biochemical processes occurring in livestock which alter and eliminate various pesticides, and utilize the derived information in solving the problem of chemical residues in products intended for human consumption.

APPROACH: The great variations that exist in the toxicity of organic chemical compound to which livestock, chiefly cattle and sheep, may be exposed will be investigated. Physical condition and stresses having a major role in the response of animals to these compounds. An understanding of detoxication mechanisms, and the situations in which they are utilized, will facilitate the use of chemicals that are more readily eliminated, thereby reducing the hazard to animals. To delineate the different detoxifying processes, the enzymes, metabolites, and conjugation products will be determined.

PROGRESS: The metabolism and residues of radioisotope-tagged ferbam were determined for a period of 76 hours after a sheep was treated. Quench curves for each tissue, blood, urine and feces were established at various intervals of time and autoradiograms made. Another sheep was similarly exposed to confirm these results. The effect of DDT and its metabolites on adult chickens is being studied. It includes toxicity, egg production, fertility, egg shell consistency, and residues in various body tissues. The evaluation of an insecticidal formulation of crotoxyphos as a sheep dip was made. Indications are that degradation occurs on storage, resulting in an unstable and ineffective treatment. Residual and toxicological aspects of 2,4,5-T in sheep and cattle, exposed over a 9-month period, completed. Negative results on analyses of watershed samples as to evidence of possible pollution by pesticides.

SUPPORTED BY U.S. Dept. of Agriculture

4.0871, TOXICOLOGICAL EFFECTS OF VARIOUS PESTICIDES AND OTHER AGRICULTURAL CHEMICALS ON LIVESTOCK AND POULTRY

J.S. PALMER, U.S. Dept. of Agriculture, Toxicological Research Lab., *Kerrville, Texas* 78028 (ADPA7-23R)

OBJECTIVE: Develop information on the toxicological and pathological effects of insecticides, herbicides, fungicides, and other agricultural chemicals on livestock and poultry.

APPROACH: The acute and chronic toxicologic effects of each compound will be determined in all available species as to the maximum concentration or dosage that can be tolerated. Signs of poisoning will be noted while gross and microscopic changes will be recorded when fatalities result. Photography, either still or movies, will be utilized to illustrate the signs of poisoning. Studies of the residues of these compounds in various organs and secretions will be done when indicated.

PROGRESS: Study of the toxicity of 45 dominant organic herbicides to cattle, sheep, and chickens completed. Signs of poisoning and lesions at necropsy were described. The hazard to sheep consuming vegetation treated with 2 crop insecticides was evaluated. Three organophosphorous insecticides were studied as to their oral and dermal toxicity to turkeys. These compounds, effective in control of a turkey mite on ranches during the summer, were found to vary greatly as to the degree of toxicity produced at various dosages. Two formulations of crotoxyphos, applied to young pigs, resulted in dermatosis, depressed blood cholinesterase activity, or both, after repeated dermal exposures. Recommendations were to lower concentrations used and limit concomitant physical stresses. The toxicological evaluation of 5 soil nematicides in chickens, as to degree of toxicosis produced and relative feed utilization, was accomplished. Six acaracides and 4 fungicides were tested in chickens, sheep and cattle. Oral and dermal toxicity data on 61 candidate or approved insecticides were collected in various species in cooperation with Entomology Research Division.

SUPPORTED BY U.S. Dept. of Agriculture

4.0872, BIOCHEMICAL EFFECTS OF AGRICULTURAL CHEMICALS AND CONTROL SUBSTANCE TO LIVESTOCK

F.C. WRIGHT, U.S. Dept. of Agriculture, Toxicological Research Lab., *Kerrville, Texas* 78028 (ADPA7-18R2)

OBJECTIVE: Develop the histological and histochemical changes occurring in livestock.

APPROACH: Following exposure(s) to agricultural chemical compounds, chiefly pesticides, to recognize the endogenous and exogenous toxins that are developed, and to determine the extent of harmful effects produced as the result of their presence in tissue. Studies of specific serum and tissue enzyme systems and their alterations following pesticide exposure will be correlated by histology and histochemistry. The metabolism, potentiation, and synergism of a pesticide compound as affected by other pesticides, pharmaceuticals, mineral elements, etc. will be determined. Methods will be developed for this purpose, utilizing intact animals and cultures of their cells. The gross pathological lesions produced in animals and observed at necropsy with subsequent microscopic study of tissues and cells, will be related to biochemical changes.

PROGRESS: Statistical analysis of diallate-exposed sheep over a period of 4 months was completed. Death resulted after totals of 195 to 322 gm were given. The accumulative toxic effects became apparent 3 to 7 weeks before death. The parameters of feed consumed, PCV, RBC, and Hb were affected in the sheep. Cattle, sheep and turkeys were given relatively small dosages of a mercuric fungicide daily for varying periods to relate toxicosis to tissue residues. Signs of poisoning produced, at times delayed and explosive in nature, will be related to residue analysis of liver, kidney, muscle and brain samples. The persistence of ronnel residues in cattle and sheep is being studied when phenothiazine is given as a concomitant treatment. That phenothiazine may increase ronnel metabolism, thus reducing the holding period before marketing, will be determined. Cattle were poisoned with toxic dosages of coumaphos and were treated with 2-PAM chloride or atropine for comparative purposes. At relatively large doses, 2-PAM chloride was the superior agent. As an adjunct, the effects on various blood and serum enzymes were determined in response to the toxicosis and therapeutics.

SUPPORTED BY U.S. Dept. of Agriculture

4.0873, CHARACTERIZATION OF CYTOLOGICAL RESPONSES TO TOXICATIONS OF PESTICIDES IN LIVESTOCK

R.L. YOUNGER, U.S. Dept. of Agriculture, Toxicological Research Lab., *Kerrville, Texas* 78028 (ADPA7-20R)

OBJECTIVE: Determine pathologic and cytologic changes in tissues and fluids of exposed animals and poultry, correlate relationship to the toxic process and develop pathogenesis of significant lesions.

4. PESTICIDES

APPROACH: Tissues and fluids collected from subjects exposed to chemical compounds will by laboratory procedures be examined microscopically and by analytical chemistry. Conventional and special stains and tests will be used to determine pertinent histopathological changes and histochemical reactions. Studies will be on any agricultural chemical on basis of extent of use and hazard.

PROGRESS: Microscopic tissue examination of poultry, exposed to a candidate insect chemosterilant, was made for pathological lesions. Statistical analyses of egg production, feed consumption, fertility, hatchability, and organ weights are in progress as an integral part of the study. Distribution of apholate, metepa, and tepa (injected into chicken egg yolk) and their LD(50) values in chicken embryos completed. A study of the teratogenic effects of these compounds at various dosage levels was finished with descriptions of deformities produced. Only examination of CNS and peripheral nerve tissues, to delineate neurotoxic response of sheep to an anthelminthic, remain to complete another study. Procedures for culturing bovine peripheral blood were established with chromosomal dispersions. Subsequently, the effects of various dilutions of apholate on multiplication of leukocytes were determined. Explant cultures of chicken embryo cerebella prepared for exposure to organophosphorous compounds to determine the sequence of events that occur in axons.

SUPPORTED BY U.S. Dept. of Agriculture

4.0874, TOXICOLOGIC EFFECTS OF HERBICIDE-TREATED PLANTS ON LIVESTOCK

A.E. JOHNSON, U.S. Dept. of Agriculture, Poisonous Plant Research Lab., *Logan, Utah* 84321 (ADPA7-49)

OBJECTIVE: Determine herbicidal toxicity and tissue residue in cattle and sheep from ingestion of Atrazine-treated plants.

APPROACH: Forage on stubble previously sprayed with known amounts of Atrazine will be collected daily and fed to test animals for 30 days. Samples of treated and untreated forage will be collected on 0, 3, 7, 14, 21, and 30 days post-spraying for chemical analysis to establish residue levels and dissipation rate. Daily observations will be made of bowel evacuations, behavior, and body conditions. Organ dysfunction tests, hemograms, and general physical examinations will be made weekly. At termination of the feeding period, samples of liver, kidney, fat, and muscle will be obtained for tissue residue determinations and pathology.

PROGRESS: In the process of treating tall larkspur (Delphinium barbeyi) with 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) for animal experimentation, it was noted that the use of high nitrogen fertilizer (ammonium sulfate) considerably increased the efficacy of the herbicide in controlling growth of the plant. Reasons for this are not fully understood at this time. Losses of cattle from consuming this plant equal or perhaps exceed losses resulting from any other poisonous plant, and it has to date been resistant to or impractical to control by herbicide application. Any aid in eradicating this plant from problem areas is extremely important to the livestock industry of the West. No congenital deformities were produced in the lambs from ewes fed 2,4,5-T acid (2,4,5-trichlorophenoxyacetic acid) and 2,4,5-T ester (2,4,5- trichlorophenoxyacetic acid propylene glycol butyl ether ester) at 100 mg. per kg. of body weight from 14 to 36 days of gestation mixed in dried ground alfalfa and fed daily via stomach tube. Cows fed a high sodium mineral supplement were more susceptible to pulmonary emphysema following ingestion of DL tryptophane than cows receiving no supplement.

SUPPORTED BY U.S. Dept. of Agriculture

4.0875, FUNDAMENTAL BIOCHEMICAL AND BIOPHYSICAL MECHANISMS INVOLVED IN HERBICIDAL ACTION

J.L. ANDERSON, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00716)

OBJECTIVE: Develop and employ a controlled system of plant material, environmental growth conditions and chlorophenoxy herbicide application which will be used on an interstate basis for fundamental biochemical studies of herbicide action. Discover the key biochemical mechanism(s) of herbicidal action through simultaneous interstate study and comparison of herbicide effects on biochemical and metabolic processes of the same types of plants studied under the same experimental conditions.

APPROACH: Utah will cooperate closely with Oregon in a study of the cytological and anatomical changes induced by chlorophenoxy herbicides and correlate these findings with changes in specific enzymes and nucleic acids resulting from their interaction with sodium 2,4-D.

PROGRESS: Ultrastructural effects of pyruvon on bean and oat chloroplasts were observed. Chloroplasts from treated plants were totally devoid of starch, became enlarged and spherical, and disintegrated as visual symptoms developed. Propachlor was found to inhibit protein and lipid breakdown in squash cotyledons. It was further shown that propachlor inhibited a sodium p-pyrophosphate ATP exchange reaction in vitro and may have as its mode of action the inhibition of amino acid activation. DCPA was found to alter parenchyma and phloem fiber cell orientation in treated tomato hypocotyls. Oblong swellings developed just above the ground level when tomatoes were grown in treated soil. Symptom expression may be conditioned by environmental conditions under which the tomatoes were grown. Vascular disruption has been observed in 2 ppm DCPA treatments, which is well within the label limits for DCPA application. EPTC effects on oat lipids were studied histochemically. It appears that treated oats tend to accumulate lipids in the seedling coleoptiles rather than translocate and utilize them elsewhere. Leaf cuticles were affected to the extent that they adhere to each other and are torn before they will separate.

SUPPORTED BY U.S. Dept. of Agriculture

4.0876, INSECT POLLINATION INVESTIGATIONS ON LEGUMES

G.E. BOHART, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00310)

OBJECTIVE: Methods of increasing percentage of pollen-collecting honey bees on Utah alfalfa. Improve existing management procedures for Nomia melandri and Megachile rotundata. Introduce suitable species of alfalfa pollinators to Utah.

APPROACH: In cooperation with ARS, breed one or more lines of honey bees that have a greater tendency to collect alfalfa pollen. Study of organisms in Nomia melandri nesting sites inimical to larvae in cooperation with University of California. Increase 'take' of adult Nomia melandri introduced to a new nesting site. Comparisons of mortalities of eggs and larvae of Megachile rotundata in various nesting materials exposed to various conditions of temperature and humidity. Studies of foraging behavior of Megachile rotundata to determine placement pattern for field shelters. Exploring suitable areas for alfalfa pollinators of potential value to Utah.

PROGRESS: Studies were continued on the high alfalfa pollen collecting lines of honey bees. The high APC had the highest percent of alfalfa pollen collection, the hybrid had only slightly higher percent of alfalfa pollen collectors than the 'B' line and was intermediate, and the low APC line was low as usual. Studies on the propagation of the drone fly, Eristalis tenax, were conducted in the flight room and in the greenhouse to obtain flies for field releases and to develop suitable rearing methods. Studies were conducted on the mortality of adults and immatures of the alfalfa leafcutter bee exposed to plants treated with Dibrom, Dylox, and Cygon. Survival of immatures was not affected. Adults live longer in cages with untreated than with treated plants. There was more nest abandonment in Dibrom treatment than with Dylox, but bees in Dibrom cages made more new nests after treatments than they did in Dylox cages (27% vs. 3%). The number of cells/bee increased from 1.27 to 1.74 after Dibrom treatments and decreased from 1.9 to 1.04 after Dylox treatments. Cygon applied 3 weeks before exposure to bees had no apparent affect.

SUPPORTED BY Utah State Government

4.0877, PESTICIDE AND POLLUTANT TOXICITY AND INTERACTIONS IN BEES

W.A. BRINDLEY, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (00ENTC10154701CA)

OBJECTIVE: Research on the effect of insecticides and other synthetic chemicals and their interactions on bee pollinators and develop methods to increase the resistance of pollinators to insecticides.

APPROACH: A chemical method of increasing pesticide resistance in bee pollinators by enzyme induction and other means will be sought. The toxicity of insecticides to the honey bee, Apis mellifera, the alfalfa leaf-cutter bee, Megachile rotundata, the alkali bee, Nomia melanderi, and other bees collected in the field will be studied. Determine the effect of interactions between insecticides and environment pollutants upon bee pollinators by biological assay and physiological tests. Develop a non-lethal in vivo test to survey bee populations for pesticide-resistant individuals.

SUPPORTED BY U.S. Dept. of Agriculture

4.0878, BIOLOGICAL CONTROL AGENTS TO REPLACE OR SUPPLEMENT PESTICIDES TO CONTROL PHYTOPHAGOUS ARTHROPODS

D.W. DAVIS, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00679)

OBJECTIVE: Development of principles of insect pest management for regional environmental improvement. Multistate conservation and augmentation of biological control agents through environmental manipulation. Recognition and experimental interchange of entomophagous bio-types for improved biological control.

APPROACH: Replicated field plots using cultural practices and insecticides will be evaluated both for effects on the alfalfa weevil and on predators and parasites. Laboratory rearing and field releases of new alfalfa weevil parasites will be tried. Biological studies of weevil parasites and predators will be continued.

PROGRESS: The alfalfa weevil insecticide plots discussed under Project 622 were evaluated for their effects on beneficial insects, particularly the weevil parasite Bathyplectes curculionis. All insecticides, except Imidan, seriously reduced the adult parasite numbers when applied during periods of adult activity. The parasites usually returned rapidly, especially with the short-lived insecticides. Furadan, which was the most effective material against the alfalfa weevil, unfortunately was most toxic to the parasites. The destruction of adult parasites is not always reflected by the percentage of parasitism. The total numbers of weevil larvae are less, the parasite adults usually return rapidly, and the improved alfalfa growth following treatment appears to attract the parasites. As a result there was frequently an increase in percentage parasitism in treated plots over the checks. In 1967, and again in 1969, several species of new alfalfa weevil parasites were released in Utah. In spite of numerous attempts at field recovery, there is no evidence of successful establishment of these parasites in Utah.

SUPPORTED BY U.S. Dept. of Agriculture

4.0879, CONTROL OF MITES AND INSECTS ON FRUIT TREES

D.W. DAVIS, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00431)

OBJECTIVE: Study the biology and importance of selected species of mites and insects found associated with fruit trees in Utah. Study integrated control of orchard pests, with special emphasis on involving the mite predators. Evaluate available insecticides and acaricides in the control of orchard insects and mites, especially in cases where present control measures are insdequate. Investigate techniques, other than chemical, which can improve or displace the current practices.

APPROACH: Laboratory and greenhouse studies of the major predators of spider mites, initially the major attention has been devoted to Typhlodromus occidentalis. Replicated field plots for the control of orchard pests and evaluating the effects of the spray program on beneficial insects. Laboratory bioassay evaluation of pesticides.

PROGRESS: Replicated acaricidal plots were located at North Salt Lake City in McIntosh apples. Plictran followed by Omite and Carzol were the three best materials for the control of mixed populations of McDaniel and two-spotted spider mites. These three materials not only controlled the harmful mite species, but also allowed the beneficial predatory mites to survive and extend the effectiveness of the acaricides. Six orchards in northern Utah were studied for the third consecutive season in an attempt to get integrated control of orchard pests on a firm footing. In four of the orchards, the results have been very good to excellent. In one orchard the results have been marginal, and in the sixth only fair at best. The less satisfactory results seem to be associated with orchards having problems with two-spotted mites rather than McDaniel mites. Mesurol was used in one orchard as the sole insecticide. Mite and codling moth control were good, but there was a serious build-up of woolly apple aphids. The pear psylla and the oriental fruit moth were found in Utah for the first time during 1969. Considerable time was spent late in the summer evaluating these problems.

SUPPORTED BY U.S. Dept. of Agriculture

4.0880, BIOLOGY AND CONTROL OF THE ALFALFA WEEVIL

D.W. DAVIS, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00622)

OBJECTIVE: Evaluate predators and parasites of alfalfa weevil, and determine effects of insecticides on these beneficial insects. Evaluate insecticides and insecticide timings in weevil control. Study life history of alfalfa weevil in Utah. Study all species of weevils associated with alfalfa.

APPROACH: Apply replicated field plots of insecticides and evaluate effects on both weevils and the beneficial insects. Study in detail the feeding habits of selected predators and parasites of the weevil. Study the seasonal life history and behavior of the alfalfa weevil both in the laboratory and in the field.

PROGRESS: Three series of replicated field tests of insecticides were studied. They were evaluated both for alfalfa weevil control and for effects on beneficial insects, which is reported under Project 679. All of the 1969 studies were timed for larval control about 2-3 weeks before the first cutting. By far the best results were obtained with Furadan, which showed 99% weevil control at harvest. Several other materials showed between 89% and 93% control: Imidan, Baygon, ethyl parathion, methyl parathion, Geigy 13005, Sevithion, and Guthion. Most of the insecticides began to lose their effectiveness after 10-14 days, and by 21 days the weevil populations increased very rapidly. Very few insecticides can be used within less than 14 days of alfalfa harvest. This means that pesticide applications must be made during the period of 14-21 days of cutting. Studies of weevil biology and behavior were continued.

SUPPORTED BY Utah State Government

4.0881, THE TOXICOLOGICAL ACTION OF ORGANOPHOSPHATES AND CARBAMATES

D.A. GREENWOOD, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00672)

OBJECTIVE: Evaluate the use of chicken eggs and chickens in toxicity studies of pesticides, and of chicken eggs and mice in studies of air pollutants. Determine the biological effects of feeding different elevated levels of Malathion and Carbaryl for short feeding periods. Determine the biological effects of feeding elevated levels of selected carcinogenic polynuclear aromatic hydrocarbons to mice for short periods.

APPROACH: Mature White Leghorn chickens (312 laying hens, 65 roosters) will be allotted at random to 13 pens (10' x 10') and fed laying mash to which various levels of various pesticides will be added for a period of three weeks. Eggs will be collected daily and incubated to determine hatchability and teratogenic effects. At the end of the three week period the birds will be sacrificed and tissues taken for chemical and histopathological studies. 132 adult virgin female mice, 5 to 7 months of age, will be used to determine the effects of various levels of pesticides administered to them. They will be divided into 5 groups and fed various diets, with a control group serving as the 6th group. After 21 days the animals will be examined for various symptoms.

PROGRESS: Experiments were conducted to determine the biological effects (blood cholinesterase, body weight, egg production and hatchability, development of embryos, and storage of

pesticides in the tissues of sacrificed adult birds) of feeding a laying mash alone and mash to which pesticides, Malathion and Carbaryl, were added singly and in combinations at levels of 75, 150, 300, and 600 ppm to mature chickens for three weeks. Mature White Leghorn chickens, 312 laying hens and 65 roosters, were weighed and allotted at random to 13 lots (24 hens and 5 roosters per lot). Twelve of the 13 lots were fed laying mash containing pesticides at the various levels indicated. Fresh water was always available. These studies indicated that feeding elevated levels (15-600 ppm) of Malathion and Malathion plus Carbaryl to laying White Leghorn hens and roosters for three weeks decreased the blood cholinesterase and hatchability of eggs. The percentage of deformed embryos tended to increase as the concentration of the pesticides increased in the diet. Malformations of the skeletal structures, eyes, edema of neck and head were among the deformities noted.

SUPPORTED BY Utah State Government

4.0882, BRAIN LESIONS, BEHAVIOR CHANGES AND PESTICIDE RESIDUES
R.P. SHARMA, Utah State University, School of Agriculture, *Logan, Utah* 84321

Studies in this project are proposed to relate dieldrin residues in brain, behavioral changes caused by these residues, and associated biochemical lesions in the brain. To explore the possibility of such relationships, studies will first be conducted in ducks, maintained at this institute for a long time on various dietary levels of dieldrin. Alteration in normal behavior of ducks has been related with pesticide residues and controlled studies to correlate dieldrin and behavior are in progress.

Changes in behavioral pattern may have a definite biochemical or molecular basis. Certain behavioral changes have been associated with alteration in the levels of certain chemicals, specifically serotonin and catecholamines, in different parts of the central nervous system. In the present studies, the changes in these chemicals in the brain would be determined along with the pesticide residues and will be correlated with the changes in behavior. The catecholamines and serotonin in brain will be determined spectro-fluorometrically and dieldrin will be measured by electron-capture gas chromatography. The studies will then be extended to laboratory mammals. In these animals biochemical changes in the nervous system should be indicative of deleterious effects of pesticide residues. It is expected that such studies will help us conclude whether or not the pesticide residues have any influence on mental health, and if they do, how these changes are brought about at the cellular level.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0883, RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS AND THE PHYSICAL ENVIRONMENT
J.C. STREET, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00603)

OBJECTIVE: Develop a more comprehensive understanding of metabolic interaction phenomena between organochlorine pesticides and other pesticides or significant food additives. Various specific objectives within this general aim will be pursued as follows: Investigate the detailed changes in metabolism of pesticides produced in vivo by microsomal enzyme inducing agents; investigate additive and competitive relationships among organochlorine pesticides active both as microsomal enzyme inducing agents and as toxic substrates, in vivo; investigate structure-activity relationships among hepatic enzyme-inducing pesticides and also the types of detoxication enzymes affected; investigate key nutritional factors and physiological aspects related to the above interaction phenomena.

APPROACH: The indicated investigations will be conducted using laboratory animals, principally rats and guinea pigs. Chlorinated cyclodiene metabolism by animals stimulated with various inducing agents will be studied with labeled radiocarbon compounds. Additional DDT analogues and related compounds will be examined for correlation between molecular characteristics and enzyme induction. Efforts will be made to evaluate functions of ascorbic acid and vitamin A in the induction of liver microsomal enzymes by organochlorine pesticides.

PROGRESS: Study of organochlorine pesticide interactions has continued. Chlorinated biphenyls (Aroclors) were strongly active in inducing microsomal enzymes. Dieldrin metabolism and storage were markedly affected by treatment of rats with these materials. Various phenylurea herbicides were found to have low including potency with qualitatively different enzyme responses. A study of DDT metabolism in rats indicated that DDT analogues reduced DDT storage but chlorinated cyclodienes were scarely active. A general requirement for ascorbic acid to support both microsomal hydroxylation activity and its induction by dieldrin has been established. The inducing potency of DDT and dieldrin in the rat and threshold dosages required were partly dependent upon characteristics of the diet. The inbred albino laboratory rat is atypically very sensitive to the inducing action of DDT. Previous studies with large mammals (cattle, sheep and dogs) led to the same conclusion.

SUPPORTED BY U.S. Dept. of Agriculture

4.0884, THE METABOLIC FATE OF AN ORGANIC PHOSPHATE INSECTICIDE (GS-13005) WHEN FED TO DAIRY CATTLE
J.T. HUBER, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (033106970149)

OBJECTIVE: Determine the residues in milk and tissues of dairy cattle resulting from feeding on GS-13005; determine the physiological effects of feeding GS-13005 to young ruminants; study the effects of dietary variables on the rate of rumen degradation of the insecticide.

APPROACH: The rate of GS-13005 degradation and identification of metabolites will be studied in rumen contents, in fistulated steers and in vitro. Physiological reactions of calves fed GS-13005 at various levels will be studied. Occurrence of the insecticide and its metabolites in blood and tissues of these calves will be determined. Lactating cows will be fed GS-13005 at four levels to determine the rate of insecticide degradation, accumulation and excretion in the milk. The persistence of GS-13005 in field sprayed hay and silages will also be studied.

PROGRESS: Degradation of GS-13005 was shown to occur in ensilage, baled hay and by rumen microorganisms in vitro. Disappearance of GS- 13005 from the rumen in vivo far exceeded the rate of in vitro degradation indicating that from a practical standpoint, breakdown in the rumen environment is relatively unimportant. Most important is the absorption phenomenon which was verified by rates for appearance of radioactivity into the blood of cows and the relatively small output of isotope in the feces. Considering GS-13005 for weevil control, it would appear to be a safe chemical. Levels expected on a crop two weeks post-spraying would not exceed 1 ppm. Levels adminintered in this study were often 30-50 times that. Due to additional storage losses and the demonstrated ability of the bovine to metabolize relatively high levels (30 ppm or 1 mg/kg) without accumulation in tissue or excretion in milk, this chemical control would appear satisfactory for common use.

SUPPORTED BY U.S. Dept. of Agriculture

4.0885, ORGANIC PHOSPHATE RESIDUE IN DAIRY COWS
C.E. POLAN, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-030550)

OBJECTIVE: Determine the physiological effect and extent of catabolism of GS-13005 in bovine. Determine the rate of degradation of GS-13005 in feedstuffs and in the rumen environment. Measure the extent of accumulation of phosphate residues in tissue and excretion in milk if any.

APPROACH: Administer varying levels, up to a toxic level, of GS- 13005 to young bulls. Blood was sampled routinely and cholinesterase activity established. Tissues from animals that died and those slaughtered were analyzed for organophosphorus residues. Cows were administered GS-13005 by capsule and in a second study GS-13005 was applied in the field to uncut hay. Milk was sampled periodically for residues analysis. Cows at all treatment levels were slaughtered and certain tissues analyzed for phosphate residues. Intake and productive performance was measured on all animals. The rate of disappearance of GS-13005 was

determined in baled hay, ensilage, in vitro rumen incubations and from the intact rumen. Ring labeled GS-13005 was administered to two lactating cows and the metabolism of the compound and routes of excretion were studied in detail. Metabolic products were examined by extraction techniques and thin-layer chromatography.

PROGRESS: Degradation, excretion and metabolism of GS-13005 (G), were studied in two lactating cows. Cow 290 received oral doses of 1 mg/kg B.W./day of G for 30 days. On day 31 she was dosed with 1.7 mg/kg of carbonyl - C-G. Cow 282 received a similar dose of radioactive G but without prior pesticide administration. Radioactivities in CO(2), urine, feces, and milk for cow 290 and 282 were, respectively, 16, 38, 6, 1; and 51, 43, 4, and 1% of dose. Peak urinary and serum radioactivity was observed between 4 and 6 hr, then decreased to negligible levels in 36 hr. Autoradiography of TLC and GLC indicated G in milk of cow 290. Following conclusion of the above experiments Esser et al. reported a sulfoxide and sulfone to be the principal metabolic products of G in the rat. To test the occurrence of these compounds in the milk, a cow was given 1.25 mg of G/kg bdwt. daily. On day 17, she was given 1.7 mg/kg of labeled compound. Milk radioactivity as percentage of dose of 0-12 and 12-24 hrs was respectively 1.2 and 0.7%.

SUPPORTED BY Virginia State Government

4.0886, EFFECTS OF DIETARY PROTEIN ON THE METABOLISM OF HEPTACHLOR IN THE RAT

R.E. WEBB, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0616089)

OBJECTIVE: Determine the influence of the level of dietary protein on the conversion of heptachlor to heptachlor epoxide and the distribution and excretion and metabolites; effects of dietary protein quality on the metabolism, distribution, and excretion of heptachlor; and the influence of protein nutriture on pesticide-pesticide interactions.

APPROACH: Little attention has been directed toward assessing the effects of nutritional status of the animal or individual on the toxicity of pesticides. This assessment should be considered in the evaluation of safety of pesticides. Since protein malnutrition is wide- spread in certain areas of the world, the effects of dietary protein level and quality on pesticide toxicity will be studied. Heptachlor as an example of the chlorinated cyclodienes, a group known to result in residue problems, has been selected for study under imposed variations of protein nutriture.

PROGRESS: Having established the effects of dietary protein on the acute toxicity and metabolism of heptachlor and its epoxide, studies were initiated to determine the in vitro effects by measuring the liver levels of microsomal epoxidase activity in rats fed 5, 20 and 40 dietary casein. Results show that the maximum velocity of the low protein fed rats was considerably lower than for other groups. This finding supports previous suggestions of an impaired ability of the low protein rats to convert heptachlor to the toxic metabolite.

SUPPORTED BY U.S. Dept. of Agriculture

4.0887, CARCINOGENESIS BIOASSAY RESOURCE FOR FEEDING TESTS IN RODENTS

G.C. HOLSING, Hazleton Laboratories, *Falls Church, Virginia* 22046 (NIH-70-2209)

Independently and not as an agent of the Government, the Contractor shall exert its best efforts to perform carcinogenesis bioassay feeding tests in mice, rats, or other rodents of pesticides and other environmental chemicals selected by the Project Officer. In performance of this project, the Contractor will: 1. Procure chemicals, analyze for amount and types of impurities, determine stability and purify when indicated by the Project Officer. 2. Conduct subacute oral toxicity studies to determine maximum tolerated dose for use in the long-term study. 3. Perform lifetime feeding tests for carcinogenicity studies in groups of 50 mice and 50 rats of each sex at two dose levels. Appropriate positive and negative controls will be used as indicated by the Project Officer. 4. Maintain adequate check of the diet regarding stability of test compound. Observe and record weight gain and health of animals, and acceptance of food; 5. Sacrifice moribund animals and perform complete autopsy on all animals including histologic examination of all indicated target tissues as well as tumors at other sites; 6. Tabulate data on forms provided by The National Cancer Institute. Results will be evaluated for significance.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0888, TOXICOLOGY OF CANDIDATE INSECT CHEMOSTERILANTS OR ATTRACTANTS

W.A. KNAPP, Hazleton Laboratories, *Falls Church, Virginia* 22046 (00ENTM02084908CO)

OBJECTIVE: Obtain information on mammalian toxicity of compounds under investigation as insect chemosterilants, attractants, or other new types of insect control chemicals.

APPROACH: Determine acute and subacute oral toxicity to male and female rats of experimental insect control chemicals to be specified and supplied by Entomology Research Division chemists. Make 2-year toxicological evaluation of 2 experimental insect chemosterilants including minimum subacute dermal toxicity to male and female rabbits, subacute dietary administration to male and female rats, and effects on reproduction in rats.

PROGRESS: Dermal and acute toxicities of tepa and hempa were determined on rabbits and rats, respectively. Tepa in 2-generation reproduction and 90-day incubation studies caused decreased fertility and increased thyroid size and activity. Hempa caused increased respiratory disease and decreased fertility as a secondary effect. No increased incidence of neoplasia was found. Acute toxicities for 4 other compounds were also determined.

SUPPORTED BY U.S. Dept. of Agriculture

4.0889, PESTICIDE RESIDUES INGESTED BY FINISHING AND REPRODUCING BEEF CATTLE

K.P. BOVARD, U.S. Dept. of Agriculture, Beef Cattle Research Station, *Front Royal, Virginia* 22630 (033003870149)

OBJECTIVE: Determine the rate and level of accumulation of pesticide residues in pregnant beef cows, cows nursing calves and fattening steers while consuming pesticide contaminated feeds; rate of dissipation when the contaminant is removed; and transmission from cow to calf placentally or by infestion of milk.

APPROACH: In the first experimental phase, 20 yearling steers were self-fed a fattening ration for 189 days. The ration for 5 steers (lot 1) contained 0.15 p.p.m. total heptachlor residue and that for 15 steers contained 0.23. Perianal fat samples were collected from all 20 animals at the beginning and end of this period. During the second phase lot 1 continued to receive the same contaminated ration ad libitum. The remaining steers were allotted as follows: lot 2, residue- free ration, ad libitum; lot 3, residue-free ration containing protamone, ad libitum; lot 4 residue-free ration, limited to maintenance. Perianal biopsies were taken periodically for 18 months.

PROGRESS: Beef cows in confinement received recommended amounts of a ration containing 0.4 ppm heptachlor and heptachlor epoxide (HHE) during the last 3 months of gestation and for 6 months postpartum. Periodic perianal fat biopsies indicated that: (1) Cows receiving the contaminated ration accumulated HHE at 0.01 ppm per day through the fifth month postpartum levels reaching 1.5 ppm in their external fat. During the sixth month postpartum, a decrease at about the same rate was seen, calves' contamination followed that of their dams. (2) Cows receiving residue-free feed throughout the study showed no contamination, nor did their calves, and (3) Cows receiving heptachlor- contaminated feed rapidly became contaminated. Once this insecticide is absorbed, it is very slowly dissipated by contaminated cattle. No physical symptoms of toxicity were seen in cows or calves.

SUPPORTED BY U.S. Dept. of Agriculture

4.0890, METABOLISM OF PESTICIDES BY BEEF CATTLE CONSUMING FEEDSTUFFS PRODUCED IN THE APPALACHIAN AREA

B.M. PRIODE, U.S. Dept. of Agriculture, Animal Science Research Div., *Front Royal, Virginia* 22630 (033001637014 9)

4. PESTICIDES

OBJECTIVE: Study distribution of tissue residue and the chemistry of pesticides in beef cattle for the ultimate protection of the animal and the consumer.

APPROACH: Techniques used to investigate the metabolism of pesticides by beef cattle will include cannulation of the portal and ruminal veins to estimate rate of blood flow and pesticide absorption; quantitative collections of feces, urine and respiratory gases; location and concentrations of residues in fat, muscle, blood and milk; and measurements of the general physiological status of animals being exposed to pesticides now in use or about to be used. At Front Royal, Virginia, studies will be oriented toward feedstuffs used to maintain the beef brood cow during the winter.

PROGRESS: Eight lots of four pregnant beef cows, at Front Royal, Va., each received wet apple pomace silage and protein supplement in confinement from 6 months gestation through two months post partum. Two samples of apple pomace were taken from each of 14 truckloads at delivery in October. The following pesticides and mean contamination (ppm) were found: DDT, 2.27; DDE, 0.15; TDE, 0.12; Kelthane, 1.43; Acaralate, 0.50; Ethion, 0.32; tedion, 1.3; parathion, 0.26; and delnav, 0.21. Among the first seven, highly significant (P of .01) differences existed among trucks for all except kelthane and BHC. Among 33 calves born, 6 of 8 whose dams receives CSM survived; 4 or 8 whose dams received CSM and urea survived: and 3 of 17 whose dams received urea survived. The balance were stillborn, or died soon after birth. The implication of the combination of apple pomace, its pesticides, and urea is clear-cut. Further studies are planned.

SUPPORTED BY U.S. Dept. of Agriculture

4.0891, INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES

C.B. CROSTON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Cook, Washington*

Homogenates will be made of fish tissues, particularly liver and muscle, and will be assayed for adenosine triphosphatase activity. Various amounts of DDT will be added to the assay mixtures to measure the inhibitory effect. A few percentages of liquids having a wide range of solvent powers, such as dimethylformamide and dimethylsulfoxide, will be included in the assay mixtures to attempt increased dissolution of the DDT. The amounts of inhibition will be compared to distinquish different ATPases of cellular fractions, tissues and fish species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0892, PESTICIDE MONITORING

W.D. BRUNSON, State Dept. of Game, *Olympia, Washington* 98501

Project: Pesticide monitoring.

Objective: To determine the levels of pesticide residues in fish hatchery water supplies, natural waters, and fish food.

Procedures: Samples will be collected statewide and transported to the Western Fish Disease Laboratory, Bureau of Sport Fisheries and Wildlife, Seattle, for preparation, extraction, and gas chromatographic analysis of chlorinated hydrocarbon pesticide residues.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0893, EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS

W.D. BRUNSON, State Dept. of Game, *Olympia, Washington* 98501

Project: To determine the effect of pesticides on game fish populations.

Objective: To determine the timing in respect to life cycle and the method by which pesticides accumulate in immature fish and the physical charges which result from this accumulation.

Procedures: Monitoring will be accompanied by microscopic examination.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0894, ELIMINATE OR REDUCE EFFECTS OF PESTICIDE RESIDUES

W.D. BRUNSON, State Dept. of Game, *Olympia, Washington* 98501

Project: To eliminate or reduce effects of pesticide residues on game fish.

Objective: To eliminate or reduce the effects of pesticide residues on game fish in trout hatcheries.

Procedure: Activated carbon filter will be installed and special pesticide free diets (if available) will be fed selected lots of fry to determine if mortalities can be reduced by this method. Filters will be experimented with at the Game Department's Columbia Basin Hatchery which has a record of mortalities indicating that the major cause may be the presence of DDT and its metabolites. Dietary experiments will also be conducted at the Basin Hatchery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0895, CONTROL OF INSECTS AND MITES ON HOPS

W.W. CONE, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP0184?)

OBJECTIVE: Test and evaluate insecticides and acaricides for control of insects and mites on hops. Investigate the effect of toxicants on beneficial predatory organisms. Determine the inherent natural resistance of hop variety selections to two-spotted mite infestation.

APPROACH: Insecticides and acaricides will be tested for control of two-spotted spider mites and insect pests on hops. Samples of green and dried hops taken for residue analyses. Determine the abundance of beneficial predatory mites and coccinellid beetles in hop yards; and if toxicants presently in use have an effect on their abundance. Roots from clones of disease resistant hop lines will be planted and evaluated for resistance to mite attacks.

PROGRESS: Fourteen unregistered acaricides were tested in replicated plots of hops for control of two-spotted spider mites and hop aphids. Carzol, Azodrin, Plictran and Omite were effective for mite control. Malathion must be combined with each compound except Azodrin to provide aphid control. Residue analyses are being conducted for all except Plictran. TH-427, TH-367, Bayer 68138, and Geigy 13095 show promise for future testing against mites. Torak, Geigy 19851, CIBA 9491, Cba 2307, Lovozal and superior oil were ineffective for mite control. Lovozal tested as a 40% wettable powder was phytotoxic to hops. Kelthane (dicofol) used on the same hills for four years failed to control mites. Percent control was 96.4, 93.1, 73.3 and 0 for 1966 1967, 1968 and 1969, respectively. Disyston, Temik, Thimet, Bayer 68138 and Hercules 17413 were tested for systemic activity against mites and aphids. Temik was the only promising compound. Bioassay of ether or methylene chloride extracts of quiescent deutonymphs indicate 5 to 15% male reponse at dilutions of .0005 female equivalents. Site of pheromone production appears to be mid-dorsal area. Males are attracted soon after onset of quiescence and may hold until emergence (36-48 hours). Pheronome appears to have low volatility, good persistence (over 100 hours), and may serve as an arrestant instead of an attractant.

SUPPORTED BY Washington State Government - Olympia

4.0896, BIOLOGY, ECOLOGY, AND CONTROL OF INSECT AND MITE PESTS OF APPLE

S.C. HOYT, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01477)

OBJECTIVE: Study the effect of feeding by mites on fruit quality and yield. evaluate the effects of cultural practices and pesticides on pests and on predator-prey relationships: study in detail the population dynamics of mites.

APPROACH: The level of mite populations and the time they occur will be controlled on bearing apple trees. The yield and quality of fruit will then be examined. Standard mite counting

techniques will be used to evaluate the effects of pesticide programs and cultural practices on mite populations, and insect populations and the damage they cause will be evaluated by various methods. The dynamics of mite populations will be examined under controlled conditions in bioclimatic chambers.

PROGRESS: Studies conducted during 1969 indicated that Zolone, Abar, or Torak could be used for codling moth control in integrated control programs without destroying predator mite (Metaseiulus occidentalis) populations whereas Gardona could not. Several candidate acaricides were eliminated from further consideration because of excessive predator kill. Additional studies on the aerial application of Guthion showed that a high rate was compatible with integrated mite control. Studies on timing of insecticide application for thrips control were begun. Good control of thrips was obtained with petal fall applications but damage had already occurred. Pre-pink applications did not control thrips.

SUPPORTED BY Washington State Government - Olympia

4.0897, CAUSES AND PREVENTION OF BEE POISONING BY CHEMICALS IN WASHINGTON

C.A. JOHANSEN, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01419)

OBJECTIVE: Determine which agricultural chemicals are responsible for bee poisoning and develop methods for preventing such losses.

APPROACH: Field tests of new insecticides to determine their relative hazard to bees. Comparative susceptibility of Megachile rotundata and the honey bee to insecticides. Cooperative development of safe bee forage areas isolated from cultivation. Field tests of bee poisoning vs. clover seed weevil control on white Dutch clover seed crops. Investigation of sprinkler irrigation application of insecticides to reduce bee poisoning hazard. Investigation of potential hazard involved in contamination of nectar and honey from plant systemic insecticide treatments.

PROGRESS: Mixtures of 2-3 insecticides and a new 6 lb/gal Systox formulation were more hazardous to alfalfa leafcutter bees and honey bees. Leafcutters several weeks old were more susceptible than newly- emerged individuals. Superior oil did not 'safen' Parathion sprays on alfalfa to honey bees. EL-273, Dikar, Galecron D, and Torak are relatively low in hazard to bees; while U 27,415, SD 17250, C-9491, AC 17413, and BAY 93820 are moderately to very highly hazardous. None of a series of 9 soil sterilants and fungicides proved hazardous to the alkali bee. Immature larval mortality of leafcutter bees was not significantly affected by Dylox or Dibrom sprays. Cygon gave the best results of 6 materials tested against lygus bugs and aphids in pre-bloom sprays. Biothion and Zolone show promise as bloom treatments against lygus bugs. Sorba-Spray Mg lowered pH of spray waters and increased the effectiveness of Dylox against lygus bugs. Vapona fumes were retained by a variety of materials and continued to cause killing of leafcutters. Chilling requirement for efficient emergence of diapausing leafcutter larvae is 4-5 months. Cold storage will kill emergent progeny of the leafcutter bee. There was little evidence of significant differences in female leafcutter production in nest tunnel depths from 2 to 4 inches. Locality, nest material, and seed vs. non-seed area variously affected leaf cutter larval mortality. Predators and parasites of the leafcutter destroyed 7.5% of the bee progeny.

SUPPORTED BY Washington State Government - Olympia

4.0898, CORN EARWORM CONTROL

E.C. KLOSTERMEYER, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01683)

OBJECTIVE: Develop an insecticide control program or other control for corn earworms on sweet corn compatible with beekeeping operations in Washington.

APPROACH: New insecticides will be evaluated on replicated plots of sweet corn and examination will be made on the degree of injury to the ears resulting from each treatment. Carbaryl will be used as a standard. Those insecticides showing promise will be further evaluated on larger plots by aircraft. These materials will also be evaluated in respect to honey bee mortality. Samples of corn and forage will be taken for residue determination. Biological observations will also be undertaken, including lights for evaluating adult populations, surveys of overwintering pupae and possibly the use of biological control agents.

PROGRESS: Low winter survival of pupae resulted in low early summer moth populations, but populations increased so that the late sweet corn in August and September had 75 to 100 per cent infested ears. Aerial applications of methomyl (Lannate) resulted in an average of 28 per cent infested ears compared with 52 per cent for Galecron and 100 per cent in untreated plots. Neither insecticide appeared hazardous to honeybees. Four applications with a high clearance sprayer produced 7 per cent infested ears with methomyl, 33 per cent with Bay 93820, 45 per cent with Galecron, 56 per cent with C9491, 78 per cent with Torak, and 75 per cent in untreated plots. Methomyl (Lannate) appears to be a very promising replacement for carbaryl for corn earworm control.

SUPPORTED BY U.S. Dept. of Agriculture

4.0899, WEED CONTROL IN CROP LANDS OF WESTERN WASHINGTON

D.V. PEABODY, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01123)

OBJECTIVE: Develop selective weed control methods in those horticultural and agronomic crops in which production is limited by weed competition. Determine the effect of new herbicides on those weed species which most seriously limit crop production as well as on the growth, vigor and yield of the crop itself. Integrate and alter standard crop production methods with regard to chemical weed control techniques so that the costs, effort, and time invested in producing the crop are decreased. Determine the persistence of herbicidal residues on crop plants as these may affect the use of such crops for animal and human consumption.

APPROACH: Testing of selective chemical weed control methods and materials which take advantage of growth and managerial differences between crops and weeds will be continued in the following crops: green peas, spinach, beets for seed, strawberries, blueberries, ornamental bulbs, Christmas trees and forages.

PROGRESS: Igran, terbacil, Tandex and an analog of Tandex (NIA 16476) are effective and selective in green peas. NIA 16476 also proved highly effective and safe in Christmas tree plantation as well as in tulips. In sweet corn, alachlor combined with atrazine eliminated both grassy and broad-leaved weeds. Post-emergence application of bromoxynil did not injure seedling alfalfa although other forage legumes demonstrated only low tolerance to this herbicide. No truly selective herbicide was found in cucumbers, however, the use of an activated charcoal spray applied in a narrow band over the row just prior to herbicide treatment may make it possible to use very active and effective herbicides in this sensitive crop. Field tests utilizing herbicide combinations (paraquat plus atrazine) with an especially designed planter demonstrated the feasibility of non-tillage farming in several different locations and soils. Non-tillage techniques also show promise in establishing new Christmas tree plantations. Cottonwood grown under conditions of high fertility, absence of competing vegetation and close spacing, have produced dry matter yields equivalent to three cords per acre in two years. Such yields compare favorably to cottonwood grown under more conventional conditions over a much longer period of time.

SUPPORTED BY Washington State Government - Olympia

4.0900, ORGANIC MERCURY POISONING IN SWINE

R.C. PIPER, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01606)

OBJECTIVE: Characterize and correlate the toxicity, signs, lesions, histochemical demonstration and localization of mercury and organ concentrations of mercury in acute and subacute experimental organic mercury poisoning of swine; study the pathogenesis of subacute organic mercury poisoning in swine; develop differential diagnostic techniques.

APPROACH: Swine will be given organic mercurial orally. The acute initial range finding trial will be at dosages of 0.2 to 0.3 log intervals per group. Signs, clinical laboratory results, gross

and microscopic lesions, histochemical demonstration and localization of mercury and organ concentrations of mercury will be determined and correlated. The pathogenesis of subacute organic mercury poisoning will consist of swine given a constant daily oral dosage of organic mercury and euthanatized at predetermined intervals to study the progression.

PROGRESS. To establish the diagnosis of mercury poisoning a sensitive histochemical technique for Hg that gives good cellular localization would be of value. A modified sulfide silver stain for metals was employed on tissues fixed in hydrogen sulfide-saturated 70% alcohol, 70% alcohol and 10% formalin. Rats were given HgCl(2) subcutaneously in dosages ranging from 50.0 to 0.025 mg Hg/kg body weight and renal and hepatic light microscopic lesions, Hg histochemistry and quantitative Hg organ analyses were compared. Hg was demonstrated in renal tissue sections of all rats in direct proportion to dosage, quantitative organ analysis and lesions. Correlation between microscopic lesions and specific Hg localization and concentration was excellent. Hg was demonstrated and localized at dosage levels (0.025 mg/kg b.w.) much lower than those causing signs of illness and producing microscopic lesions. Hg was detectable at tissue levels below the sensitivity (1.0 ppm) of the quantitative dithizone chemical procedure used. Moderate amounts of Hg were demonstrated consistently in livers to 4.2 ppm. (3.2 mg Hg/kg b.w.) and traces to 1.0 ppm. (0.2 mg Hg/kg b.w.). The ability to use formalin as the tissue fixative rather than H(2)S-saturated alcohol with equal sensitivity and less nonspecific staining is of value.

SUPPORTED BY Washington State Government - Olympia

4.0901, EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT

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Inhibition of Na ion, K ion-activated adenosinetriphosphatase (salt pump) of kidney, brain and gills is potentially important in the susceptibility to stress, and hence infection, which has been noted in fishes chronically exposed to organochlorine pesticides.

The hypothesis will be investigated using chlordane, DDT, and endosulfan with the rainbow trout as the test species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish

4.0902, SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH

M. KATZ, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105

Because of the rapid progress of knowledge accumulated during the past year, the study is being modified significantly from the original application. There will be two major portions of the study.

1. The principal investigator and assistants plan to measure and identify the chlorinated hydrocarbons being accumulated by trout in the commercial, state and federal trout hatcheries in Eastern Washington. After these parameters are established, the egg-bearing females will be transported to a commercial hatchery in the vicinity of Seattle, and the loss of chlorinated hydrocarbons will be followed in the adult fish and the eggs that are derived from these fish.

This is an effort to determine the rate of excretion or breakdown of chlorinated hydrocarbons that is occurring under actual hatchery operating conditions. These data obtained will document the solution to an insecticide toxicity problem that has been solved empirically by the commercial trout grower. The state and federal hatcheries who have not been able to follow this procedure are suffering disastrous egg losses. The loss of the chlorinated hydrocarbons will be evaluated by chemical analysis of the tissues of the adult fish and of the developing eggs.

2. A second project is to investigate the possible use of activated charcoal in fish feeds to reduce the absorption of chlorinated hydrocarbons which are almost universally present in the prepared fish foods fed to trout. Artificial diets will be made up containing 0.1, 1.0 and 5.0 ppm of DDT and other diets will be made up of the same concentrations of DDT but containing 0.1 percent, 1 percent and 5 percent activated charcoal. These diets will be fed to fish and their growth mortality and reproductive success will be measured. If preliminary trials are successful, appropriate analyses for DDT will be made.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0903, THIN LAYER CHROMATOGRAPHIC IDENTIFICATION OF MS-222 IN FISH MUSCLE TISSUE, BLOOD, BRAIN TISSUE, AND IN WATER (ABBREV)

J.L. ALLEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Determination of MS-222 residues by the modified Bratton-Marshall method of Walker and Schoettger gives good quantitative results. However, this method does not identify MS-222 or distinguish it from other naturally occurring aromatic amines present in fish. Before clearance of the drug by the U.S. Food and Drug Administration can be obtained, a second, confirmatory method for MS-222 is required.

Thin layer chromatography could provide a fast, semi-quantitative identification of MS-222 residues. This method would identify MS-222 residues in fish blood, and in such tissues as fish muscle and brain. Thin layer chromatography can thus be used in conjunction with Bratton- Marshall method to provide a quantitative, positive identification of MS-222 residues.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0904, INVESTIGATIONS ON FATE OF CONTROL AGENTS IN FISH. WORK UNIT RESIDUES OF MS-222 IN NORTHERN PIKE, MUSKELLUNGE, WALLEYE. (ABBREV)

J.L. ALLEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

MS-222 (methanesulfonate of ethyl m-aminobenzoate) is widely used as an anesthetic for northern pike, muskellunge and walleye. It has has not been cleared for use on these species, however, by the U.S. Food and Drug Administration. The requirements for clearance includes information on residues of the drug in the tissue of these fish.

The Bratton-Marshall method was effectively modified for detection and measurement of MS-222 in fish tissue (work Unit FR-2170-742-65-2). The residues of free and acetylated MS-222 are determined in the muscle tissue of northern pike, muskellunge and walleye which have been anesthetized to a stage of medullary collapse and recovered in fresh water. Positive identification of the MS-222 residues are obtained by confirmatory analyses using thin layer chromatography.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0905, RESIDUES OF FISH CONTROL AGENTS - FLUOROMETRY, THIN LAYER AND GAS CHROMATOGRAPHY FOR ANALYSIS OF QUINALDINE RESIDUES IN FISH (ABBREV)

J.L. ALLEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Quinaldine is widely used as a fish anesthetic. It has not been cleared for this use, however, by the U. S. Food and Drug Administration. The requirements for clearance include a need for information on the residues of quinaldine in fish tissues.

Fluorometry, thin layer chromatography, and gas chromatography all appear capable of detection and measurement of quinaldine. A combination of two of these methods would provide quantitative measurement of quinaldine residues as well as identification of the residues. Procedures for extracting quinaldine from treated fish and cleaning up these extracts must be developed. Bass, catfish, and bluegill are exposed to various concentrations of the chemical and attempts are made to extract, clean up the extracts, and detect it or its metabolites in fish tissues.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0906, THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV)
R.A. SCHOETTGER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Anesthetics are used widely in the culture and management of sport and commercial species. Laboratory tests of potential anesthetics are needed to define effective and safe concentrations which may be employed to facilitate the handling or transport of fish.

The chemical is tested on selected species such as rainbow trout, brown trout, brook trout, lake trout, channel catfish, bluegill, and largemouth bass. Concentrations and exposure times for desired depths of anesthesia are determined. Recovery time is recorded for brief and extended periods of anesthesia. The tests are conducted at 7,12,17,22 and 27 degrees C. The influences of pH, water hardness, size of fish, and repeated anesthetization on the efficacy of McN-JR-7464 are measured. Anesthetized fish are recovered in fresh water and held for several weeks to observe post-treatment mortality, general condition and appetite. They are also given periodic hematological examinations. The toxicity of the compound to reproductive products of fish is determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish

4.0907, THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV)
G.E. SVENDSEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

The literature indicates that antimycin A is a strong inhibitor of electron transport in the oxidative phosphorylation system. The tissues or organs of fish which are affected by the chemical, however, have not been distinguished. Laboratory tests are needed to determine whether the effects of antimycin are general or specific to certain tissues and whether they differ according to species susceptibility or method of treatment.

Resistant and susceptible species such as bullhead and rainbow trout respectively are treated with antimycin A by IP injection or by exposing them to solutions of the toxicant. After various periods of exposure, treated and control fish are killed and various tissues, for example, gill, brain, liver, kidney and muscle are dissected. The metabolic rates of tissues, measured manometrically, are used to evaluate the effects of antimycin. The results are compared with in vitro effects of antimycin on tissue metabolism.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0908, WILDLIFE PATHOLOGY RESEARCH
J.B. HALE, State Dept. of Nat. Resources, *Madison, Wisconsin* 53701

Objective: Determine the presence, prevalence, etiology, natural history and importance of infectious diseases and other pathological conditions which occur in Wisconsin wildlife and their relationship to various environmental contaminants.

Procedures: Gather wildlife morbidity and mortality data through a statewide necropsy service; determine the prevalence and epizootiology of specific infectious diseases in Wisconsin wildlife; determine the effects of stress on hosts with sublethal levels of pesticides.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0909, TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS
R.L. BRADLEY, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01301)

OBJECTIVE: Develop packaging techniques for reducing or preventing pest damage in agricultural commodities. Study effects of pesticides on acceptability and/or nutritive value of agricultural commodities. Develop procedures for the removal, reduction or de-toxification of pesticides and conversion products in agricultural commodities.

APPROACH: Permeability of several food packaging materials to pest organisms and the growth rates of the organisms in foods packaged in various materials will be investigated. By applying results of permeability and growth rate studies packaging techniques will be used to prevent or greatly reduce pest damage in packaged foods. The influence of preparation and processing techniques on the stability of various pesticides will be studied. Processing methods to be studied will include canning, freezing, freeze drying and others.

PROGRESS: Excellent progress has been made during the past year. Groups of baby chicks fed a synthetic and natural diet containing different levels of malathion showed no anemias from an iron deficiency. Concentrations above 1,000 mg malathion/kg feed produced growth retardation; however, concentrations of malathion less than 100 mg/kg feed showed some stimulation of growth. Moreover, if the diet of these groups of chicks is alternated daily from natural feed to a contaminated feed containing as much as 5,000 mg malathion/kg, a definite stimulation of growth occurs. This may be due in part to the fact that the birds appear to reject the contaminated feed and then consume more than the normal amount of noncontaminated feed the following day. Growth retardation in these chicks may be attributed to two factors: the toxic effect of the malathion, and the rejection of feed containing these high amounts of organophosphate pesticide.

SUPPORTED BY U.S. Dept. of Agriculture

4.0910, THE EFFECT OF PROCESSING ON THE PESTICIDE CONTENT OF DAIRY PRODUCTS
R.L. BRADLEY, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01307)

OBJECTIVE: Determine what processing steps alter effect of concentrations of pesticides in milk and milk products. Determine the effect on lactic fermentations and potential growth of pathogens in Cheddar cheese made from milk contaminated with chlorinated pesticides. Determine what bacterial metabolic functions are affected by chlorinated pesticides.

APPROACH: Cheddar cheese will be manufactured using mixed and single strain starters, accepted commercial practices, and milk contaminated with trace quantities of chlorinated pesticides. Acidity, pH, and bacterial analysis will be made during manufacture and storage to determine the extent and duration of retardation of acid development and the particular organisms affected. The possibility of overgrowth by Staphylococcus aureus and other undesirable contaminants will be determined after direct inoculation of the cheese during manufacture. Populations of these undesirable organisms will be enumerated at specific intervals during storage using standard methodology. Model systems will be developed to study the mechanism by which chlorinated hydrocarbons retard acid development. Michaelis constants will be derived to determine the type of enzymatic inhibition exerted. Based on these data, processing procedures will be designed to negate the effect of trace quantities of chlorinated pesticides during manufacture of cheese.

PROGRESS: Several single strains of Strept. cremoris, Strept. lactis and a mixed strain lactic culture used to determine effect of organochlorine pesticides on fermentation of lactose to lactic acid. These were evaluated in naturally and artificially contaminated milks. Chlordane and thiodan used at concentrations of 0.01, 0.1, 0.5, 1.0, 10, 50 and 100 ppm/g fat and added in ethanol. Milks naturally contaminated with chlordane, thiodan, dicofol also evaluated. In pilot cheese-making trials, milk naturally contaminated with chlordane required a time factor of 2X to reach pH 4.5 when compared with noncontaminated milks. Milk artificially contaminated to contain 1 ppm chlordane (per gram of fat) showed little difference in acid production. 10 cultures of lactose fermenters exhibited some sensitivity to milks artificially contaminated to contain 1 ppm thiodan, while natural contamination at 0.04 ppm showed no effect. Slight inhibition observed with as little as 0.125% ethanol in control milk.

SUPPORTED BY U.S. Dept. of Agriculture

4.0911, TRUCK CROP AND POTATO INSECTS AND THEIR CONTROL
R.K. CHAPMAN, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS00418)

4. PESTICIDES

OBJECTIVE: Study the economic pests of vegetable crops in Wisconsin and devise effective, economic and feasible control measures.

APPROACH: Determination of life cycles and habits of the pest species as they relate to susceptibility to various control techniques including chemical, biological, and plant resistance methods. Emphasis is being given to the use of systemic insecticides for foliage feeding species and to particular formulations and very specific placement of insecticides for soil pests.

PROGRESS: New and different types of insecticides must be constantly screened for their effectiveness in vegetable insect control because of the development of resistance by the insects to recommended materials and the deletions for their use by federal authorities while at the same time the public demands food that is absolutely free from insect damage, frass or parts and hazardous chemical residues. For the control of imported cabbageworms and cabbage loopers which have become resistant to such chemicals as DDT, parathion, endrin and mevinphos, Monitor showed outstanding characteristics. Excellent general insect control was obtained on potatoes and beans by foliar applications of Azodrin, Monitor, Lannate, Furadan, and VSC506. Systemic materials which gave good insect control on potatoes for the whole season in addition to the presently used phorate and disulfoton included Furadan, Temik and Dasanit when they were applied in the soil at planting time. No satisfactory materials are available for recommendation for control of the cabbage maggot on cruciferous crops in Wisconsin. Unlabelled materials which gave good control when used as granules in a narrow band in or near the seed furrow include: Dasanit, Furadan, Dursban, Baygon, Bay 37289 and compound 4072. By regulating the placement of the insecticides phytotoxicity can be reduced and better use made of the natural predators of the maggot.

SUPPORTED BY Wisconsin State Government - Madison

4.0912, INSECTICIDES AND REPRODUCTION OF COTURNIX QUAIL

F.L. CHERMS, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01298)

OBJECTIVE: Determine if low levels of commonly used insecticides, such as malathion, affect fertility, and hatchability when used as feed additives. Determine effect of compounds on spermatogenesis of male testes. Determine if compounds disrupt nuclear material of germinal disk, i.e. are mutagenic.

APPROACH: Coturnix quail, a rapid growing, early maturing bird with excellent reproductive efficiency is an ideal animal to study effects of insecticides on reproduction. Information obtained with this animal might apply to both domestic and wild birds. Preliminary studies involve feeding of compounds under test to determine general effect on reproduction. In instances where detrimental effect is found, further tests will be conducted to ascertain site of action of compound, i.e. either male testes or germinal disk.

PROGRESS: Four generations of selection for resistance to 200 ppm DDT have been completed in the artificial and natural selection populations. Up to this point, there is no difference in the length of time needed to reach 50% mortality in the selected populations as compared to a non-selected control. No differences exist between any group for fertility and hatchability. One apparent difference lies in body weight at 30 days of age where both selected populations are heavier than the control. In a separate experiment, survivors of DDT feeding to 30 days were maintained on three levels (0, 50, and 200 ppm) through a 6 weeks laying period to determine effects on shell thickness. Regardless of the bird source (artificial, natural, or control populations) there were no differences in shell thickness on any treatment.

SUPPORTED BY U.S. Dept. of Agriculture

4.0913, INSECTICIDES AND EGG-SHELL DEPOSITION

J.J. HICKEY, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01249)

OBJECTIVE: Evaluate the wildlife side-effects of insecticidal use and to work out the kinetics of DDT transfer through different ecosystems.

APPROACH: The avian effects of DDT in Dutch elm disease control have been evaluated on 7 Wisconsin study areas and the transfer of DDT through soils, earthworms and birds is now being measured. A second project is measuring residues in Lake Michigan sediments, fish, and gulls. A third is evaluating the current status of the peregrine falcon in eastern U.S.

PROGRESS:

SUPPORTED BY Wisconsin State Government - Madison

4.0914, BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES

W.L. HILSENHOFF, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01039)

OBJECTIVE: The ecology of the bottom fauna of Lake Winnebago and 14 other Wisconsin lakes, and the chemical and physical properties of these lakes are being studied to determine the factors that are responsible for nuisance population of midges. The biology of the Lake Fly, Tendipes plumosus, in Lake Winnebago is being intensively studied in the field and in the laboratory. The parasites and predators of T. plumosus are being investigated to determine their potential for biological control. Lakes treated by the Wisconsin Conservation Department with toxicants to remove undesirable fish populations are being studied to determine the effects of the toxicants on the bottom fauna and the effect of fish predation of this fauna.

SUPPORTED BY Wisconsin State Government - Madison

4.0915, ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES

F. MATSUMURA, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS00822)

Objective: Explore the possibilities of using insect pathogens or analyses ther naturally occurring compounds as insecticides. Study the mechanisms of action of various chlorinated insecticides on the nervous systems of animals. Investigate the fates of chlorinated hydrocarbon insecticides in the environment with particular emphasis on the microbial degradation of various pesticides.

Approach: The non insecticidal materials proposed for investigation are hormones, insect pheromones, chemosterilants and other naturally occurring insecticidal analogs. The major approach here is to conduct laboratory evaluation of new materials. In some cases attempts will be made to identify the toxic or active principles involved. Study the mode of action of insecticidal analogs, efforts will be made first to investigate the direct effects of biochemical means. Also efforts will be made to study the degradation enzymes which metabolize insecticidal substrates in various animals.

Progress: A number of microorganism colonies were found to be capable of degrading chlorinated hydrocarbon insecticides. About 12 colonies were particularly active degrading dieldrin. A number of hitherto unknown metabolites were chemically identified from the degradation products of dieldrin by those microorganisms. The mechanism of action of DDT was studied in the brain and the liver of the rat. DDT was found to preferentially bind in the synaptic junctions. DDT was also found to influence the function of ion transport by the liver tissue resulting in drastic alteration of the levels of other insecticides' storage. Efforts were made to study the enzymes which hydrolyze various insecticidal organophosphates and carbamates. Each insecticide tested was found to be simultaneously hydrolyzed by a number of esterases. The nature of these esterases was studied. Efforts were also made to study naturally occurring insecticides. As a result of an extensive screening, a number of fungal products were found to possess potent insecticidal properties against mosquito larvae. The trail-following pheromone of a southern subterranean termite was chemically identified. It is cis-3, cis-6, trans-8-dodecatrien-1-ol.

SUPPORTED BY U.S. Dept. of Agriculture

4.0916, MECHANISMS OF INSECTICIDE DEGRADATION

F. MATSUMURA, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

Attempts will be made to survey the patterns of enzymes degrading hazardous insecticides in insects and mammals including men. The enzymes available for insecticide degradation will be partially purified and interspecific differences will be studied. Whenever the mode of action of a particular insecticide is not known, efforts will be made to elucidate the site of insecticidal attack as well as the mode of poisoning. The resulting data will be analysed so as to estimate the actual hazard level of these insecticides in men and other animals. Several naturally occurring compounds which show specific toxicity towards a certain group of insects but not to mammals or other unique biological activities that can be utilized to control insect pests will be studied in the hope of finding the clue for their selective toxicity, as well as new approaches to efficient control measures for various insect pest species.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.P.P.

4.0917, CAUSES OF ABORTIONS IN DAIRY CATTLE WITH PARTICULAR REFERENCE TO PESTICIDES AND MOLD TOXINS

W.E. RIBELIN, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS05016-6016)

OBJECTIVE: Determine the causes of dairy cattle abortion in Wisconsin, both microbial and not, and the relative frequency of all.

APPROACH: Aborted fetuses and placentas will be examined as submitted to State Animal Health Laboratory. Studies will include gross and microscopic pathology, bacterial culture, virus isolation, pesticide determinations. Dams will be assessed for uterine bacteria, serum electrolytes, methemoglobin, antibodies. Feed will be tested for mycotoxins by feeding to pregnant rats. Herd history will be recorded. All cases will be tabulated and incidences determined. New chemical or microbial agents encountered will be given to pregnant cattle to verify abortigenic properties.

PROGRESS: 37 farms with cattle abortions studied. As usual, most could not be diagnosed by usual diagnostic means. Following new causes were detected: Streptococcal infection of fetus, Lymphatic leukemia fetus within normal mother, Aspergillus veinti toxins from moldy feed. Isolation, culture, and feeding of known estrogen-producing mold, Gibberella zeae, did not produce abortion in pregnant cow. No fetal tissues contained pesticides. No farms where market milk had been held because of pesticide contamination had abortions. Feeding of 5 pesticides to 9 pregnant cows did not produce abortion.

SUPPORTED BY U.S. Dept. of Agriculture

4.0918, EFFECT OF EXERCISE WITH HIGH CARBOHYDRATE OR HIGH FAT DIETS CONTAINING DDT

P.H. DERSE, Warf Institute Incorporated, *Madison, Wisconsin* 53706 (HN07-06-01-C)

OBJECTIVE: Biochemical and physiological response of rats to high carbohydrate or high fat diets containing low levels of DDT when sedentary or forced to exercise vigorously.

APPROACH: Feed rats from weaning until 200 days of age nutritionally adequate diets containing high levels of fat or carbohydrate. High fat diet will contain a high content of unsaturated fats. Carbohydrate diet will contain 1:1 mixture of sucrose and cornstarch. A standard casein diet will serve as control. Feed each diet with and without a low level of DDT. At 100 days divide rats on each diet into two groups, one to be kept relatively sedentary and one to be forced to exercise vigorously. Maintain weights and food intake records. Sacrifice rats at 200 days of age. Determine DDT content of brain, liver and adipose tissue. Examine selected tissues histologically. Measure fat, cholesterol, protein, DNA and RNA content of livers; determine proximate analysis of carcass and cholesterol level in blood.

PROGRESS: Laboratory work is continuing on a project which will provide information on the physiological responses of rats forced to exercise and fed diets either high in fat or carbohydrate. The feeding study is now complete but the results from the laboratory analyses are not yet available.

SUPPORTED BY U.S. Dept. of Agriculture

4.0919, CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH

D.V. SWEDBURG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Jackson, Wyoming*

This work is a continuing program for deriving toxicities of various pesticides and combinations of pesticides to cold-water fishes. Static testing conditions yield median tolerance limits (TLm) for 24-96 hour exposures and continuous-flow conditions are used for exposures as long as 30 days. The tests include standard and varied conditions of temperature and water quality. Biological effects other than mortality are evaluated when appropriate.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0920, CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH

D.V. SWEDBURG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Jackson, Wyoming*

Aroclor 1248 will be administered for 160 days to immature lake trout in dietary concentrations of 1,2, 3,6, and 12.0 mg/kg of food giving dosage rates of 36.9, 108, and 360 ug/kg of body weight per day. Aroclor residues, mortality, and pathology will be evaluated throughout treatment and for 70 days after treatment. The fish will be tested for thyroid activity, recovery time from hexabarbital anesthesia, and their ability to withstand thermal shock after the exposure.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0921, INFLUENCE OF PESTICIDAL CHLORINATED HYDROCARBONS ON ADAPTATION MECHANISM IN POULTRY

M. DELAK, Univ. of Zagreb, *Zagreb, Yugoslavia* (E30-AH-170329053701Y)

OBJECTIVE: Determine the effect of chlorinated hydrocarbons on the adaptation mechanism in poultry.

APPPOACH: The intensity of reaction of the adrenal cortex to various chlorinated hydrocarbons will be determined. The amount of residue in tissue of treated animals will also be studied. Later the reaction of the adaptation mechanism to specific amounts of pesticide, to various duration of application will be determined. Also different chlorinated hydrocarbons and combinations of them will be studied.

PROGRESS: Comparative investigations of the effects of technical grade DDT and the p,p'-DDT and o,p'-DDD isomers indicated that 30 day administrations of 100 ppm in the feed of chickens of the DDT technical and o,p'-DDD inhibited, but did not completely block, corticosterone synthesis. The rate of degradation of the hormone in the blood was also increased up to 20 days of treatment. With higher oral doses (300 & 500 ppm) of technical grade DDT and p,p'-DDT, mild depression and appetite loss was observed and adrenal function, was intensified, but o,p'-DDD continued to depress adrenal function. It is suggested that most of the adrenocorticolytic activity of technical grade DDT is due to the o,p'- DDT isomer which makes up approximately 24% of the technical product.

SUPPORTED BY U.S. Dept. of Agriculture

E. ADVERSE EFFECTS ON THE GENERAL ENVIRONMENT

Nonspecific Studies on the Animal and Plant Community and Habitat. General Ecological Effects, Material Effects.

4.0922, CHEMISTRY AND TOXICOLOGY OF INSECTICIDES

R.S. BERGER, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00192)

OBJECTIVE: Determine major chemical changes organic insecticides undergo in plants, insects, and other animals, and evaluate the role these changes play in the activation, detoxication,

selective toxicity, accumulation of residues, and resistance of insects to insecticides. Determine specific biochemical and physiological effects of different classes of insecticides and determine how these effects are influenced by the nutrition, environment, and physiological condition of the test animals.

APPROACH: Radioactive insecticide will be used, products isolated by solvent partition and chromatographic procedures and identified. Isolated enzyme systems studied and significance in activation, detoxication, selective toxicity, residues, and insecticide resistance evaluated. Influence of diet, environment, and condition of test animal on response to insecticide will be studied.

PROGRESS: Fourteen-, 16-, and 18-carbon fatty acids were increased in the body fat of Heliothis zea larvae by furnishing them in the diet at concentrations of 0.3 to 1.0 per cent. Fatty acids not synthesized by the insect, particularly the essential linolenic and linoleic acids, were increased to a greater extent than those which can be synthesized from non-fat sources. There was no apparent interconversion between different fatty acids of the same chain length in larvae when one was furnished in the diet. When larvae contained a high level of a poly- unsaturated fatty acid, the amount of the mono-unsaturated acids, especially palmitoleic, was decreased. Larvae of different fatty acid compositions as a result of rearing on fat-fortified artificial diets were treated topically with methyl parathion, endrin, and carbaryl for determination of LD-50 dosages. There were no large differences in susceptibility to these toxicants which could be attributed to the nature of fatty acids in the insect.

SUPPORTED BY U.S. Dept. of Agriculture

4.0923, ORGANIC RESIDUES AND SOIL MICROORGANISMS

E.A. CURL, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00237)

OBJECTIVE: Behavior of soil-borne pathogens as influenced by soil microorganisms, living plants, plant residues and soil amendments and develop techniques for studying soil microbial communities.

APPROACH: Principal pathogenic fungi to be used are Sclerotium rolfsii, Rhizoctonia solani, Fomes annosus, Fusarium oxysporum f. vasinfectum, Pythium ultimum, and Helminthosporium spp. Procedures will be designed to: determine direct and indirect effects of chopped plant residues and organic herbicides on growth, reproduction, and survival of specific fungi in controlled environments; influence of these materials on antagonistic microflora of soil and on the lytic and fungistatic effects of soils on spores, sclerotia and mycelia; role of C/N ratios in biological control phenomena; effects of residual factors of field-cropped soil on pathogenic fungi; influence of root rhizosphere, rhizoplant, and exudates on germination of spores and sclerotia; and develop and improve techniques for studying ecology of soil microorganisms.

PROGRESS: Research continued on: ecology of long-term fertility plots with regard to influence on fungal pathogens; influence of herbicides on sclerotium production; and enzymatic interaction of fungi in soil culture. Soil from plots of various fertility treatments continued to have little effect on sclerotium germination by Sclerotium rolfsii but affected subsequent sclerotium production. Germination of chlamydospores of Fusarium vasinfectum was lowest in Plot C (no fertilizer) and Plot 8 (PKN, no lime). Percentage of natural organic particles in assay plates varied considerably among plots and was attributed primarily to Trichoderma and 2-3 bacteria colonizing the particles. Rhizoctonia infestation corresponded to plot fertility. Production by Sclerotinia trifoliorum also was significantly affected; dry weights produced in soil treated with diuron, EPTC, and cotoran were reduced. Interaction studies with S. rolfsii and Trichoderma viride in soil showed that maximal proteolytic action of the latter coincided with increase in soil pH from 5.2 to 6.3 and above.

SUPPORTED BY U.S. Dept. of Agriculture

4.0924, RESIDUES OF SELECTED PESTICIDES

G.W. WARE, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2020-4161-016)

OBJECTIVE: Routes of pesticide residue entry into marketable commodities. Determine routes of pesticide residue entry in forage, animals and animal products. Correlate forage residues with translocation from soil, dust contamination and absorption of volatile pesticide. Trace residues in animals and seek cultural methods for reducing forage residues.

APPROACH: Concentrate on Arizona's ever-present DDT-forage problem, through radiocarbon-DDT translocation and soil half-life studies under fallow and irrigated conditions. Vapor-phase or codistillation of DDT and other compounds in the field lab will receive prime attention since Arizona's arid, irrigated conditions combined with severe air inversions may offer unique opportunities for this phenomenon to occur. A search for cultural practices to reduce initial application drift and indirect contamination from volatiles, dust and translocation will follow.

PROGRESS: Based on data from work in this laboratory over the past 30 months, the Arizona Board of Pesticide Control placed a one-year moratorium on the agricultural use of DDT, with the recommendations from cotton, beef, dairy, feed and hay commodity groups. The use-history of DDT in Arizona agriculture has been: 1965 - 554,000 lbs; 1966 - 1,072,000 lbs; 1967 - 2,519,000 lbs; 1968 - 250,000 lbs; and 1969 none. With this several old economic and related problems have been solved, with the consequences of producing several new ones. An on-column extraction-cleanup for animal fat has been developed which reduces the amount of glassware and time involved by one-half. From the DDT moratorium monitoring of DDTR in agricultural commodities beef fat residues appear to have dropped from 1.0 ppm in November, 1968, to 0.68 ppm in May, 1969. Green alfalfa residues in 3 counties dropped in May to 23% of the levels found in January. Soil levels have not changed significantly during that period in alfalfa fields or desert soils.

SUPPORTED BY U.S. Dept. of Agriculture

4.0925, PESTICIDE RESIDUES ON ARIZONA CROPS

G.W. WARE, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-0206-4162-147)

OBJECTIVE: Investigate the deposition and metabolism of pesticides by animals, plants and microorganisms. Investigate the interrelations of crops, soil, air and water as they influence pesticide deposition.

APPROACH: Metabolism and deposition studies will involve normal and radio-labeled insecticides to be detected by liquid scintillation, thin layer and gas chromatography. These include all classes of insecticides, to be investigated in the lab, greenhouse and field. Crop residues will be determined and correlated with soil and water residues to isolate the contribution of each by quantitating pesticide additions to soils directly through application, irrigation and canal systems, and indirectly from field effluents into others, and the resulting crop residues from routes other than deliberate application.

PROGRESS: A laboratory method for the separation of DDT residues from interfering toxaphene components has been developed. It consists of reacting the Florisil eluate with saturated ethanolic-NaOH for 1 hour, followed by injection into a gas chromatographic column packed with 1 inch each of $CdCl(2)$ and $Na(2)CO(3)$ at the injection end. Generally, the DDT moratorium in Arizona, begun in January 1969, has been successful during its first year despite some apparent agricultural use of DDT in the three major irrigated areas. Alfalfa residues declined notably as did feedlot beef fat. Both irrigated and desert soil residues, however, remained relatively stable showing little decline.

SUPPORTED BY Arizona State Government

4.0926, FATE OF INSECTICIDE CHEMICALS IN RELATION TO NONPERSISTENCE AND SPECIES SPECIFICITY

J.E. CASIDA, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (WO2217)

OBJECTIVE: Provide information, including explanation of biological action of compounds, their chemistry, degradation, and reactions as modified by synergists, leading to the development of selective insecticides for forest insects.

APPROACH: In vitro tests with microsomes from rat liver and insects will be made to prepare biological degradation

products for separation, purification, and identification or characterization. In vivo tests to determine toxicity, enzymic effects, and biological effects of chemicals. Persistence and stability of a proposed insecticide will be determined by application to laboratory-reared plants and to inert surfaces, using light of various spectral characteristics, followed by residue determinations at intervals.

PROGRESS: A ketone analog of allenthrin was produced with enhanced insecticidal activity against a number of insect species, including Choristoneura fumeriferana. Studies with water-soluble metabolites from eight substituted phenyl methylcarbamate and two substituted pyrazolyl dimethylcarbamate insecticide chemicals injected into bean plants were completed. Research to synthesize 'pyrethroid-like' compounds lacking cyclopropane or ester groups led to development of a number of such compounds that respond to pyrethrum synergists and block nerve excitability in the same manner exhibited by allethrin.

SUPPORTED BY U.S. Dept. of Agriculture

4.0927, BIOLOGICAL ACTIVITY OF INSECTICIDAL DERIVATIVES

J.E. CASIDA, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B0-ENT-2222)

OBJECTIVE: Provide fundamental information on the toxicology of insecticides necessary for their safe and efficient utilization.

APPROACH: The metabolic fate of the compounds will be defined in the variety of organisms which they might contact under normal use conditions. The biological activity of metabolites will be determined in order that the contribution of these metabolites to the over-all toxicological picture and the residue hazards can be evaluated. Attention will be focused not only on the principal mode of action of the pesticide but on deleterious side effects. The biochemical lesion leading to poisoning will be investigated through biochemical and physiological techniques.

PROGRESS: Rotenone and other chromanochromanones markedly enhance the rate of photoalteration of cyclodiene insecticides, such as dieldrin, allowing some control in reducing or prolonging the life of toxic residues from these persistent insecticides on plants. Rotenone photo-decomposes to yield rotenolones, rotenonone, derritol, and tubaic acid. Certain insecticide synergists inhibit microsomal mixed function oxidases of mouse liver for long periods and so synergist-treated mice are very susceptible to poisoning by barbiturate drugs and insecticides that are detoxified by this enzyme system. The low toxicity of pyrethrins to mammals as compared with insects appears to result in part from more rapid oxidation, at multiple sites on the molecule, in mammalian species. Resistant housefly strains vary in the substrate specificity of their microsomal mixed function oxidases and in the spectral properties of their cytochrome P-450. Rats and mice metabolize dessin by ester hydrolysis, reduction of nitro groups, and oxidation of the sec-butyl side chain. Radiosynthesis procedures were developed for pyrethrins I and II and several related compounds. Feasibility probes are underway on use of radioautography to localize the site of action of pyrethroids in the insect nervous system. Studies were initiated on the possible role of enzymes in degradation of captan-type fungicides, methylation of organophosphate and carbamate insecticides, and cleavage of propynyl ether and ester synergists.

SUPPORTED BY California State Government - Sacramento

4.0928, EFFECT OF SOIL FUMIGANTS AND FUNGICIDES ON FRUIT AND VEGETABLE QUALITY

G. EMERSON, Univ. of California, Agricultural Experiment Sta., *Los Angeles, California* 90024 (HN3-33(C)A)

OBJECTIVE: Determine the effects of soil fumigants and fungicides used in the production of selected fruits and vegetables on their quality and composition.

APPROACH: A root crop, a legume, a leafy vegetable, and a small fruit will be grown in soil treated with a commercial fumigant. Fruits representing pre- and post-harvest use of fungicides will be treated with a fungicide recommended for the selected fruit. Foods will be analyzed for selected nutrients. Pesticide residues will be determined. Panel evaluations of flavor, color, and texture will be made on fresh and prepared foods.

PROGRESS: One additional crop year for carrots grown on Telone- treated soil and two crop years for carrots grown on dibromochloropropene and ethylenedibromide fumigated soils were gained in this reporting year. Two additional crop years were gained for lima beans grown on ethylenedibromide treated soil. The additional crop years substantiate the earlier findings that soil fumigation with dibromochloropropene, ethylenedibromide, and 1,3-dichloropropene can result in an increase in the beta-carotene content of carrots in the range of 20% to 40%. There were no differences in quality, specifically maturity, between treated and untreated samples as judged by sensory evaluation. The loss of equipment, space, and a notebook in the laboratory fire has proven to be a greater handicap than expected. At this stage the laboratory analyses are judged to be approximately three- fourths complete.

SUPPORTED BY U.S. Dept. of Agriculture

4.0929, EFFECT OF SOIL FUMIGANTS AND FUNGICIDES ON FRUIT AND VEGETABLE QUALITY

G. EMERSON, Univ. of California, Agricultural Experiment Sta., *Los Angeles, California* 90024 (HN3-33(C))

OBJECTIVE: Determine the effects of soil fumigants and fungicides used in the production of selected fruits and vegetables on their quality and composition.

APPROACH: A root crop, a legume, a leafy vegetable, and a small fruit will be grown in soil treated with a commercial fumigant. Fruits representing pre- and post-harvest use of fungicides will be treated with fungicide recommended for the selected fruit. Foods will be analyzed for selected nutrients. Pesticide residues will be determined. Panel evaluations of flavor, color, and texture will be made on fresh and prepared foods.

PROGRESS: The production and harvest of carrots, tomatoes, lettuce, lima beans, oranges, and strawberries in two crop years has been completed. The laboratory analyses are approximately half completed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0930, BIOLOGICAL HAZARDS OF PHOTOTRANSFORMED PESTICIDES

M. TANABE, Stanford Research Institute, *Menlo Park, California* 94025

The increasing use of pesticides in our environment emphasizes the importance of knowing their fate after application. Light-induced transformations of these chemicals is an area that has received little study. Photolytic transformations of pesticides introduce unknown materials into the environment. These must be evaluated for their biological and chemical properties. We hope to elucidate the nature of these phototransformed products and study their effects in various biological systems. The physical, chemical, and biological properties of these new chemicals must be understood in order to minimize risks and control toxic hazards arising from the use of these compounds.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0931, REPELLENT ADDITIVES TO REDUCE PESTICIDE HAZARDS TO HONEY BEES

E.L. ATKINS, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (00ENTC10160519CA)

OBJECTIVE: Develop chemical repellents that would prevent bees from foraging in crops during the period of time a pesticide is applied or present.

APPROACH: Screen candidate compounds to determine comparative repellence for the honey bee. Determine whether contact or vapor chemical repellence is most effective. Test promising materials to determine the effectiveness of repellent formulations under field conditions. Determine the effects of the condition and attractiveness of the bloom of target crop and of competing adjacent crops and how they can be counteracted. Delimit the effects of temperature, relative humidity and light intensity on field performance of promising repellents. Study the possible phytoxicity of each candidate repellent.

4. PESTICIDES

SUPPORTED BY U.S. Dept. of Agriculture

4.0932, RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS AND THE PHYSICAL ENVIRONMENT
T.R. FUKUTO, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-1981-RR)

OBJECTIVE: Investigate the metabolism of new organophosphorus and carbamate insecticides in animals and plants, and determine the toxicological properties of their metabolic products.

APPROACH: New organophosphorus and carbamate insecticides under current development with unusual properties of specificity and toxicity will be selected for metabolism studies. Radiotracer preparations of the compound will be used to determine rates of absorption and translocation in plants. Metabolism in the house fly and white mouse also will be examined using radiolabeled compounds. Metabolic products will be identified using chromatographic, spectrometric and other chemical methods and by comparison with known compounds. Identified metabolic products will be examined for toxicity to insects and the white mouse, and for anticholinesterase activity.

PROGRESS: Studies are continuing on the metabolism of Stauffer R- 16,661, a new systemic insecticide. Two different batches of labeled R- 16,661 have been prepared in higher purity and metabolism studies have been carried out in the cotton plant. The most significant finding in this study was the amazing stability of R-16,661 in cotton. Analysis at different time intervals up to 51 days showed that the major portion of material isolated from the plant was unchanged R-16,661. Unequivocal proof for the structure of the material isolated as R-16,661 from cotton leaves was established by eventual isolation and purification of this material from methanol extraction of leaves by column and thin-layer chromatography and analysis of the product by NMR spectroscopy. Confirmation of the structure also was obtained by GLC. Three other metabolites also were detected by TLC with R(f) values of 0.0, 0.10, and 0.58. The materials at 0.0 and 0.10 are hydrolyzed products but the one at 0.58 is probably intact ester since it is an anticholinesterase. The metabolism of Monitor (Chevron's O-methyl S- methyl phosphoramidothioate) was examined in the house fly. Monitor proved to be exceedingly stable in the fly and the only compound which could be isolated and identified was Monitor itself. Evidently this material is not activated metabolically into other compounds. A GLC method applicable to the separation and identification of methyl parathion and paraoxon and their polar metabolites, including desmethyl and desaryl products, has been developed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0933, ORGANOMERCURIAL POISONING
N.O. NIELSON, Univ. of Saskatchewan, *Saskatoon, Saskatchewan, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

4.0934, TRACE MERCURY IN ENVIRONMENTAL MATERIALS
R.E. JERVIS, Univ. of Toronto, *Toronto, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

4.0935, PESTICIDE RESIDUES - THEIR NATURE, DISTRIBUTION AND PERSISTENCE IN PLANTS, ANIMALS AND SOILS
R.E. JOHNSEN, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00237)

OBJECTIVE: The metabolism of pesticide residues by plants and micro-organisms as factors in modifying residue levels in food chains and in the environment. The effects of soil amendments such as sewage sludge and cattle manure on pesticide metabolism in Colorado soils will be studied.

APPROACH: Soil with and without soil amendments will be uniformly treated with 10 ppm of a chlorinated hydrocarbon insecticide such as DDT and aldrin. At intervals the soil will be analyzed for residues and metabolites using standard chemical methods including gas chromatography (GLC) to determine the rate of metabolism. If rapid degradation occurs, attempts will be made to isolate and identify the responsible micro- organism(s). Analytical methodology will be developed for materials which are non-pesticidal and known to interfere with GLC such as the chlorinated naphthalenes.

PROGRESS: An estimate of the extent and rate of metabolism of DDT by microorganisms was accomplished by aerobic incubation of 200 micrograms of the o,p'-and p,p'-isomers with 4 levels of diluted raw sewage in aqueous solution. After 1 week, the replicated solutions were extracted and analyzed by gas chromatography (GLC). At the highest sewage levels, 89 and 98% of the p,p'-isomer and 86 and 100% of the o,p'-isomer were metabolized. The principle metabolites were the respective TDE isomers. No evidence of either DDE metabolite was found. The existence of other metabolites not detected was indicated by the recovery rates decreasing with increasing sewage volume. Work on metabolism studies with sewage sludge has been hampered by interfering co-extractives with electron- capturing properties which obscure insecticide regions in GLC. The peaks resemble those obtained with chlorinated biphenyl compounds and come through normal clean-up procedures. The chromatographic behavior relative to aldrin of several chlorinated biphenyls (Aroclors) was studied by GLC using 2 columns because of their interfence with pesticide analysis. Results indicate means must be employed to separate these from pesticides.

SUPPORTED BY U.S. Dept. of Agriculture

4.0936, WEED CONTROL IN FRUIT CROPS, WITH SPECIAL REFERENCE TO APPLE AND PEACH
V.J. FISHER, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00104)

OBJECTIVE: Select the best timing of herbicide applications for maximum effectiveness, convenience and economy, determine the long-range effects of herbicides on growth and yields of fruit trees and on fruit quality. Study the plant ecology of orchards in which herbicides are used and measure the effectiveness of herbicide rotations and combinations in preventing unfavorable ecological changes.

APPROACH: Both preemergence and postemergence treatments of terbacil, simazine, diuron and dichlobenil will be made. Timing studies with paraquat as a supplementary spray will continue also, with paraquat being applied before, as well as with, the residual sprays of terbacil, simazine and diuron. Check trees will receive 'chemical mowing' only, using paraquat as needed. Data will be taken on yields, observable injury, weed control and fruit quality. New studies will be initiated on the ecology of orchards subjected to various weed control practices. Calculations will be made of species diversity and importance value.

PROGRESS: Studies were completed on the efficacy of three residual-type herbicides for controlling weeds in apple orchards, and on the most effective ways of using paraquat as a supplementary weed control agent. Terbacil was far superior to diuron, which in turn was superior to simazine. All three herbicides varied in the spectrum of weed species affected. Paraquat was effective whether used alone or in combination with residual herbicides. The use of paraquat greatly decreased the need for precise timing in the use of herbicides in orchards. An ecological study of peach orchards with different vegetational characteristics was conducted using different herbicide programs. In a minimal weed control area there was a high species diversity with low importance values for each species. Changing from a minimal weed control program to an effective herbicide program resulted in a decrease in species diversity and an increase in importance value for each species. The total number of plants in the area decreased with effective control measures. In areas of effective weed control there was a low species diversity, low total plant coverage, and high importance value for each species. When effective control measures were discontinued there was an increase in species diversity, an increase in total plant coverage, and a decrease in importance value for individual species.

SUPPORTED BY U.S. Dept. of Agriculture

4.0937, EFFECT OF PESTICIDES ON KEEPING QUALITY AND NUTRITIVE VALUE OF PLANT COMMODITIES
P. ROINE, Helsingin Yli. Helsing. Univ., *Helsinki, Finland* (SP43(E8-AMS-6(A)))

OBJECTIVE: Determine how postharvest pesticide treatments applied to improve keeping quality may affect storage life, chemical composition, food quality and nutrient content of plant commodities. Also, to study fate of pesticide residues, their metabolic and other disappearance routes and develop methods to determine residues.

APPROACH: Analytical methods will be developed to detect residues of CIPC, IPC, captan, malathion, diazinon and pyrethrins-piperonyl butoxide on various fruits, vegetables, grains and nuts for studies that include amount and specific kinds of pesticide residues and degradation products and where they are located in or on the product, effect of handling practices, processing reaction with plant constituents and rate of disappearance under different conditions, and biochemical and physiological background of important changes caused by residues in chemical composition, flavor, odor, color, appearance and nutrient content.

PROGRESS: Compositional changes in carrots take place during growth and storage following treatment with CIPC, linuron, and parathion. Carotene and sugar metabolism appeared to be affected. Changes in terms of technological or nutritional value of the plant commodities is assumed to be of minor importance.

SUPPORTED BY U.S. Dept. of Agriculture

4.0938, EFFECTS OF AERIALLY DELIVERED DEFOLIANTS AND INSECTICIDES
J.H. HUNTER, U.S. Air Force, Armament Laboratory, *Eglin Air Force Base, Florida* 32542

Technical Objective: The objective of this effort is to determine the long-range effects of repetitive aerial applications of military defoliants and insecticides on the natural environment of the target and adjacent areas. This objective is concerned with possible accumulation and persistence of spray materials that may be detrimental to plant and animal communities.

SUPPORTED BY U.S. Dept. of Defense - Air Force

4.0939, BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST
K.K. STEWARD, Florida Agric. Expt. Station, *Fort Lauderdale, Florida* 33310 (0710-02-05)

OBJECTIVE: Develop more effective and economical methods of controlling aquatic vegetation in waterways, canals, lakes, ponds in ways to minimize herbicide toxicity to the environment.

APPROACH: Study the growth requirements and patterns of aquatic plants as related to nutrition, light, temperature and other aspects of environment. Study life cycles and reproduction of aquatic weeds to determine optimum chemicals and times for control applications. Study the selectivity, absorption, and translocation of herbicides in plants and their persistence in the aquatic environment.

PROGRESS: Seven amine salt formulations of 2,4-D were evaluated in static water tests on the 2,4-D resistant submersed weeds Vallisneria and Egeria. The oleyl amine was most phytotoxic and a mixture of dodecyl-tetradecyl amines was next. Complete control was obtained at 5 ppmw in 2-4 weeks. A technique of applying herbicides to specific plant zones to increase effectiveness was assessed on the floating weed water hyacinth. Eight formulations of oil soluble herbicides were mixed in kerosene and applied to the root zone by floating the oil on the water surface. None of the treatments produced a phytotoxic response greater than the standard foliar application. Two silvex and one 2,4-D ester formulations were comparable at equivalent rates. Injury from diquat and amine salt of endothall applied to intact isolated stem regions of Hydrilla, Vallisneria, and Eurasian watermilfoil was restricted to tissue actually in contact with the herbicide. No translocation to other regions was apparent. Of 22 chemicals evaluated for effects on sprouting and regrowth of vegetation propagules of Hydrilla, dichlobenil was the most active. Shoot growth was completely inhibited at a concentration of 0.05 ppmw in continuous contact for 6 weeks. Herbicides incorporated into plastic pellets for slow controlled release into water were evaluated for phytotoxicity toward Eurasian watermilfoil. In static water tests a 0.1 ppmw rate of fenac acid produced 94% control in 8 weeks.

SUPPORTED BY U.S. Dept. of Agriculture

4.0940, ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST
R.D. BLACKBURN, U.S. Dept. of Agriculture, Crops Research Division, *Fort Lauderdale, Florida* 33310 (0710-02-04)

OBJECTIVE: Develop effective and safe biocontrol methods of controlling aquatic weeds. Determine the effects of herbicides on biological control agents, fish, and other desirable organisms in the aquatic environment. Determine the changes in the aquatic environment when using biological, mechanical, and herbicidal control.

APPROACH: Study the life histories and ecology of biocontrol agents as related to the control of aquatic weeds. Conduct laboratory, growthpool, and field experiments to determine refinements in the most effective and safest techniques of utilizing biocontrol agents alone and in combination with herbicides for control of aquatic weeds. Evaluate in controlled environmental and field conditions the toxicity of herbicides to biocontrol agents, sports fish, and the aquatic environment.

PROGRESS: Hydrilla has replaced the submersed weeds southern naiad and Vallisneria in the freshwater canals and lakes of Florida. Regrowth in herbicidal treated areas is primarily from stem nodes and underground tubers. Diquat and paraquat were evaluated over a 3-year period in ponds to determine their effects on the fishery environment. The herbicide had an initial effect on the plankton but it recovered in 30 days after treatment. Diquat showed an acute toxicity to the amphipod Hyalella. Water quality was affected for a period of 10 to 14 days after treatment with both herbicides. Both herbicides could be used in the aquatic environment without long term effects. The Pomacea snail can be grown in the laboratory. Circulating water has been necessary for rapid growth. The snail feeds vigorously on aquatic weeds.

SUPPORTED BY U.S. Dept. of Agriculture

4.0941, AGRICULTURAL CHEMICAL RESIDUES IN PLANT AND ANIMAL PRODUCTS
H.A. MOYE, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32603 (FLA-FS-00952)

OBJECTIVE: Development, adaptation and standardization of chemical, instrumental and biological methods of residue analysis. Investigate the behavior of chemicals as related to residues in agricultural commodities, and determine residues and their metabolites in agricultural commodities and in their environment.

APPROACH: Development of new and improved detectors for gas chromatography giving increased sensitivity and selectivity to pesticides. Enhancement of gas chromatographic response to carbamates by chemical modification. Improved extract cleanup with elution chromatography.

PROGRESS: New analytical procedures were developed for parathion on celery (phosphorimetry) and for Sevin on spinach, chicory and escarole (derivitization-E.C.G.C.) with limits of detection at 0.08 ppm and 1.0 ppm respectively. Speed is the primary advantage of these procedures over others. A D.C. discharge emission detector was evaluated for analysis of the organophosphate pesticides. Reliability and sensitivity were found to be superior to the microwave emission detector; selectivity over hydrocarbons was less, however. A modified flame photometric detector was constructed which did not extinguish upon sample injection and gave superior sensitivity and selectivity than the commercially available model. Florisil cleanup of aldrin, heptachlor epoxide, dieldrin and endrin was studied to determine elution solvent effects on oil retention. With comparable cleanup it was found that the oil capacity was strongly dependent on the elution solvent(s) used. A study in which the humidity, temperature and photoperiod of the environment surrounding rye grass

were studied for effects on dieldrin uptake showed that only humidity was involved. Low humidities enhanced uptake. Persistence studies and necessary modifications to analytical procedures were performed for Gardona on corn silage, Hercules 14503 on oranges and lemons, Azodrin on cabbage and Sevin with pinolene on potato and bean foliage.

SUPPORTED BY U.S. Dept. of Agriculture

4.0942, PESTICIDE RESIDUES AND METABOLITES
C.H. VANMIDDELEM, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-FS-01106)

OBJECTIVE: Provide data on pesticide residues remaining on or in Florida vegetables, subtropical fruits, pasture grasses, meat and dairy products.

APPROACH: Field treatment will include recommended dosage as well as 50-100% higher rate. Field sub-samples containing pesticides will be chopped and frozen until analyzed. Co-solvent extraction by blending in isopropanol and hexane or benzene will remove pesticide for biological material. Extracts will be cleaned up by elution through chromatographic columns. Chemical procedures approved by Food and Drug Administration employed wherever possible. Approved non-specific methods of analysis to establish practical cut-off periods for crops on compounds with established tolerance. Data also used to aid industry establish tolerance for a pesticide on crops of particular interest to the State of Florida.

PROGRESS: Torak residues remaining on oranges, grapefruit and lemons were determined following 2 spray applications 3 months apart. Torak residues over 1.0 ppm were detected in the peel of the oranges and grapefruit 84 days after the second application, whereas residues were somewhat less in the lemon peels 56 days after apraying. Although Niran 6-3 residues approached 5 ppm on sweet corn forage 5 days after 14 daily applications, the concentration on the shucked edible ear was only 0.01 ppm, which is far below tolerance levels for ethyl or methyl parathion. Insignificant residues of 2,4-D were found in both sweet corn fodder and the edible ears following one application to the actively growing crop. The following persistent pesticides were applied as bait or granular applications to rye grass either as a pre-plant or post-emergence treatment: trichlorfon, chlordane, diazinon and dyfonate. Most of the pre-plant treatments resulted in below 0.05 ppm residues in the rye grass except chlordane which was found in concentrations as high as 0.28 ppm following the 3.0 pound per acre application. The only exceptions were residues of dyfonate oxygen analog which were observed to peak between the 3 and 7 days following the post-emergence application to the rye grass. Most post-emergence pesticide treatments resulted in residues ranging from 0.15 ppm to 0.50 ppm 21 days after application to the rye grass.

SUPPORTED BY Florida State Government - Tallahassee

4.0943, REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT
W.N. BRUCE, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-12-0317)

OBJECTIVE: Determine physical, biochemical, and biological factors influencing occurrence and persistence of insecticidal chemical residues in soils and agricultural commodities. Identify fundamental factors influencing magnitude of air and water pollution by insecticidal chemical residues. Develop basic studies related to the metabolism and detoxication of insecticidal chemical residues in animals, plants, soils and water. Identify effects of residues on ecosystems with emphasis on fish and wildlife. Influence of residues on soil microflora, microfauna, and non-insect fauna. Develop analytical techniques.

APPROACH: Study persistence, metabolism and detoxication of insecticide chemical residues in soils, plants, animals and water and study the effects of toxicant residues on ecosystems in soils and water.

PROGRESS: Methoxychlor, dieidrin, and furadan residues in the soil as they relate to the contamination of the aquatic environment are under investigation. Soil, pond silt, water, algae, and fish samples have been analyzed at weekly and monthly intervals following treatment of a watershed with these chemicals. Four days after a treatment with furadan at a rate of 4 lb. per acre and one day after a one inch rainfall, furadan was found in the pond water (.0167 ppm), plankton (2.957 to 4.839 ppm) and suspended silt and organic matter in one liter of water (2.465 to 3.873 micrograms). The analysis of all the fish and water samples has not been completed. Of special interest in the field experiment was the lack of reproduction in the Fairfield pond where dieldrin residues in fish ovaries and eggs were between 0.5 and 1.0 ppm. The water solubility of methoxychlor is higher than that of DDT. The reaction velocity of dehydrochlorination of methoxychlor (methoxychlor yields methoxy-DDE) is slower than that of DDT (DDT yields DDE) in water. Most of the methoxychlor, as with DDT, is adsorbed on sediment and silt in the water. However, significant amounts of methoxy-DDE were found in the water. Trace amounts of O,P - DDT are found in DDT-treated waters, but O,P - methoxychlor - DDE was not detected in methoxychlor- treated waters. Pond water and distilled water gave similar results.

SUPPORTED BY U.S. Dept. of Agriculture

4.0944, COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE
E.L. KNAKE, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-15-0364)

OBJECTIVE: Study plant response to herbicides, develop weed control systems adapted to the soils, crops and climate and specific weed problems of Illinois; develop weed control methods that will improve environmental quality for both desirable plants and humans.

APPROACH: Individual crop and weed response to herbicide placement in the soil will be studied. Since some weeds are more sensitive through shoot adsorption than root adsorption or vice versa, better control methods could result from studies on herbicide placement. New chemicals and chemical combinations will be evaluated for their performance in preplant, preemergence and postemergence weed control systems. Combinations of cropping systems, chemicals and cultivation will be used to develop control measures for nutsedge, climbing milkweed, common milkweed and wirestem muhly. Weed control methods will be developed that will minimize the potential for surface runoff of herbicides (minimum tillage) into water supplies.

PROGRESS: Greenhouse studies, to determine the extent to which morphological differences between plant species may serve as a basis for herbicide selectivity, will compare two grass species, Avena sativa with an elongating mesocotyl and Triticum vulgare without same. Field studies include the delineation of specific herbicide rates needed for control of specific weed species. Herbicide combinations with various ratios have been evaluated to improve consistency of performance and spectrum of control. Propachlor plus atrazine at 3 plus 1.6 lbs/A for surface application and butylate plus atrazine at 3 plus 1 lb/A preplant incorporated have been the two outstanding combinations for soil with 3 to 7 percent organic matter. Studies with low volume application equipment indicate feasibility for both liquid and wettable powder formulations. Calibration is more difficult than with conventional pressure systems. Evaluation of 13 granular formulations suggests considerable commercial potential for propachlor plus atrazine and alachlor plus atrazine. Use of herbicides for controlling vegetation in no-till systems indicates the feasibility of paraquat plus atrazine to kill fescue sod, but the need for translocated herbicides (2,4-D or dicamba) to control alfalfa.

SUPPORTED BY U.S. Dept. of Agriculture

4.0945, SOIL TOXICANTS, SOIL PHYTOPATHOGENS AND OTHER SOIL MICROORGANISMS
M.B. LINN, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-68-0349)

OBJECTIVE: Effect of toxicants including fungicides, nematocides and insecticides, on development of Endogone spp. Effect of toxicants on growth and/or metabolism of asymbiotic nitrogen fixing and nitrifying bacteria. Rate and extent of recolonization of the above soil microorganisms following treatment with toxicants.

APPROACH: Soil and plant roots containing Endogone spp. will be treated with several soil fungicides. Roots of appropriate host plants grown in treated and untreated soil will be examined for Endogone. Trichoderma will be introduced into soils that have been treated with pesticides. Persistence of Trichoderma will be determined. Effect of allyl alcohol on ability of Trichoderma to antagonize Rhizoctonia solani and other soil fungal pathogens will be evaluated. The effect of these pesticides on bacteria involved in nitrification and asymbiotic N- fixation.

PROGRESS: Growth of Trichoderma viride and Gliocladium fimbriatum was inhibited in culture by the fungicide Demosan at 25 ppm and by Plantvax and Vitavax at about 250 ppm. Further work with these 2 fungi was discontinued because of difficulty in crystallization of the antibiotics viridin and gliotoxin produced by the fungi. Nylon mesh discs (Nos. 263 or 275 Nitex) as transfer matrices for soil and other fungi were a marked improvement over nutrient agar plugs previously used by most investigators. The fungus on the disc can be placed in soil columns, removed afterwards and washed free from soil and fungitoxicants. A wide range of plant pathogens were successfully transferred. The growth of Gibberella zeae appeared to be stimulated by the nylon. This technique permits better separation of fungicidal and fungistatic properties of soil chemicals, and determination of actual concentrations of fungitoxicants required to inhibit fungal growth.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0946, DETERMINE METHODS OF DIFFUSION OF IDEAS AND DO FURTHER DEPTH ANALYSIS OF DIFFUSION PROCESS

J.M. BOHLEN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01320)

Progress: Studied and evaluated the adoption-diffusion process related to agricultural chemicals and the variables related to adoption- diffusion. Attention was given to the farmer adopters and dealers in the adoption-diffusion process. It is judged that the general, but at the same time limited objectives of the original project, were far exceeded as the project grew in scope and in depth during the period of the project. Of equal importance is the fact that this study provided many of the theoretical and methodological bases for more recent studies related to safe and effective pesticide use. While the vast majority of farmers possess favorable attitudes toward agricultural chemicals and their use and use of agricultural chemicals on their farms, their level of technical knowledge judged to be needed for safe and effective use is relatively low. Agricultural chemical dealer knowledge was also relatively low. Farmer's sources of information on agricultural chemicals: Awareness stage--mass media; Information stage--neighbors and friends; Evaluation stage--neighbors and friends; Trial stage--commercial. There were major differences in sources of information at each adoption stage by adopter categories--innovators to laggards. The dealer is not only a major source of information at the trial stage but apparently plays a major role in determining the chemical and brand of chemical used by the farmer.

SUPPORTED BY: Iowa State Government - Des Moines

4.0947, INSECTICIDAL CHEMICALS IN THE ENVIRONMENT

P.A. DAHM, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01686)

OBJECTIVE: Determine the fundamental physical, biochemical, and biological factors influencing occurrence, magnitude, interaction, and persistence of insecticidal chemical residues in soils and raw agricultural commodities. Develop basic studies related to the metabolism and detoxication of insecticidal chemical residues in animals, plants, soils, and water. Seek methods of removing or reducing residues of insecticidal chemicals from the environment. Develop and improve analytical techniques essential to the pursuit of this research.

APPROACH: Greatest emphasis will be placed on objective 2, by studying the metabolism of organophosphorus, carbamate, and chlorinated hydrocarbon insecticides in animals, plants, soils, and water. Differences between closely and distantly related species of animals and plants will be investigated as well as intraspecific factors such as age, physiological conditions, and environmental influences. The interaction of insecticides with other synthetic chemicals in our environment will also be explored.

PROGRESS: Two nitrogen-fixing soil microorganisms, Rhizobium japonicum and R. meliloti, were incubated with parathion in a phosphate buffer. Time course studies showed that parathion was rapidly metabolized in about 25 hours. Gas-liquid chromatography, thin-layer chromatography, and colorimetric analyses showed that reduction of parathion to aminoparathion was the major metabolic pathway. Aqueous fractions of S-parathion provided evidence that parathion was also being metabolized to 0,0-diethyl phosphorothioic acid. An oxidative enzyme system was evidently lacking since no paraoxon was found.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0948, WARNING AGENTS FOR TOXIC FUMIGANTS

E. BERGMANN, Hebrew University, *Jerusalem, Israel* (480A10ENT30(MQ))

OBJECTIVE: Develop nontoxic chemical warning agents to serve as indicators of the presence of methylbromide or other toxic fumigants.

APPROACH: Test compounds with irritant, sternutatory, or lachrymatory properties to determine whether their vapors produce an effect on man, at very low, nontoxic levels, that is strong enough to serve as a positive warning signal when they are added in small concentrations to methyl bromide. Test compounds that give promising results in the above tests to select ones that will not be absorbed and retained by foods or feed, not damage plants or seeds, and not corrode or otherwise harm structural materials, textiles, plastics, etc.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0949, PESTICIDE RESIDUES IN MARKETING CHANNELS

A.M. KADOUM, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00687)

OBJECTIVE: Reduction of pest damage or pesticide residues in agricultural commodities during transportation, processing and/or storage. Susceptibility of varieties of corn grain in storage to grain- contaminating and grain-damaging insects. Secure available corn varieties, strains and hybrids, from the corn germ plasm bank. Determine relative resistance of corn to representative pests. Determine reasons for resistance.

APPROACH: Corn varieties will be exposed to infestation. Screening will include rice weevils, confused flour beetle, lesser grain borer and Angoumois grain moth. Each variety tested for feeding, oviposition and progeny. Insects will be confined with the grain in containers to determine the type and extent of feeding damage. Radiographs will expose the activities of insects inside the kernels.

PROGRESS: Heat treatment of purified silica gel 950 (60-200 mesh) and 923 (100-200 mesh) in a muffle furnace at 130 C and 300 C for two hours was found to be the most effective for activation of silica gel for cleanup of pesticide residues from biological material with complete recovery of pesticides. A simple, aqueous acetonitrile partition cleanup method for analysis of insecticide residues has been developed. The partition characteristics of the insecticides used between hexane and two separate aqueous acetonitrile solutions (85%, 95%) were utilized. A starch-gel electrophoretic method to investigate esterase inhibition by common organic insecticides. Results indicate that aluminum lactate buffer at 0.038 M and pH 3.1 was the most satisfactory buffer system for resolving blood protein components of Tenebrio molitor larvae at a constant current of 45 ma (180 volts) for 25 hr. There was no significant difference between electrophorograms obtained from endrin-treated and control larvae.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0950, EFFECTS OF HERBICIDES AND SOIL TOXINS ON RHIZOBIUM

E.P. DUNIGAN, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01438)

4. PESTICIDES

OBJECTIVE: Determine the effects of selected herbicides and soil toxins upon the survival of Rhizobium japonicum grown in culture solutions, on agar plates and in soils. The ability of the bacteria to invade soybean roots and effectively fix atmospheric nitrogen in the presence of these materials will be evaluated.

APPROACH: Viability of Rhizobium japonicum grown in contact with selected herbicides will be determined on agar plates, in nutrient solutions and in herbicide-treated soils. Bacterial population numbers will be compared with non-herbicide-treated controls. The effects of the herbicides on the degree of nodulation of soybeans grown in selected media will be observed in the greenhouse and in field plots. Herbicidal effects on the symbiotic nitrogen fixation will be evaluated by observations of the plants for symptoms of nitrogen chlorosis, final yield data and plant-tissue analysis for total nitrogen. Newly-cleared soils within the state will be investigated in order to determine if a soil toxin is responsible for the poor and sometimes total lack of nodulation found. The soil organic matter will be selectively extracted and checked for the presence of compounds which are detrimental to the survival of the bacteria. The effects of soil amendments and soil pH on the degree of nodulation will also be determined. Tests will be made to determine if soil microorganisms are responsible for the death of Rhizobium japonicum in the problem soils.

PROGRESS: Greenhouse experiments with potted soils indicated that amiben, linuron, nitralin, trifluralin, vernolate, prometryne and GS16068 had no adverse effect on the nodulation of soybeans grown in Commerce loam soil. In Mhoon silty clay loam amiben had an adverse effect at the recommended rate as did linuron at twice the recommended rate. On Norwood silt loam, linuron, nitralin, prometryne and vernolate had an adverse effect on nodulation at recommended rates while all seven herbicides affected nodulation at twice the recommended rate. Field tests on Olivier silt loam indicated no adverse effects on the nodulation of soybeans from either pre-emergence or post-emergence herbicides applied at recommended rates. Pre-emerge herbicides included amiben, dacthal, GS16068, [illegible], linuron, nitralin, prometryne, trifluralin and vernam.

SUPPORTED BY: Louisiana State Government

4.0951. PESTICIDAL RESIDUES IN FOODS

A.F. NOVAK, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01390)

OBJECTIVE: Pesticide investigations will be made on various foods during the course of handling as they pass from the field to the table and into the nutritional pattern of the ultimate consumer, to ascertain if any health hazards exist.

APPROACH: Studies will be made on the following: Actual testing of seeds where applicable. Several stages during growth and cultivation. Comparisons will be made with the foods. Harvesting. What quantities of residues are present when the foods are removed from the soil, the vines or trees. Pre-processing storage. What quantities are degraded prior to processing. Processing foods. Foods will be analyzed during the various steps commonly employed for processing each food under investigation. Packaging. What problems and effects are encountered by employing various packaging materials and procedures. Distribution. What happens to residues during transportation, storage in warehouses, storage under various temperatures, etc. Retail outlets. Does long term handling result in residue changes or unusual modifications. Preparation of foods. Various methods of cooking, frying, mixing, etc. Consumption. What is the actual concentration, if any present at the time of consuming the food.

PROGRESS: The object of this project during the year has been to determine the amount of degradation of endrin in sweet and Irish potatoes from harvest through processing, storage, and to consumption. The possibility exists that certain types of processing will degrade insecticides and/or render their residues physiologically harmless for humans. One hundred pounds of each type of potato were procured locally and divided into four treatments: heat processed with and without water; blanched and frozen; and frozen. Prior to processing, the samples were washed, peeled, chopped, and placed in cans. One-half of each type of treatment was inoculated with endrin at a level of 1 mg /200 g. of sample. One-half of each process and inoculation treatment was irradiated with cobalt-60 at a dose of 750 Krads. All samples were tested for residual endrin at 0, 6, and 12 weeks of storage. Samples at 0 and 6 weeks retained residual amounts of endrin in all treatments. Quantitation is incomplete. The 12-weeks samples have not been analyzed as yet. A considerable amount of time was required to standardize the insecticide analyzer.

SUPPORTED BY: Louisiana State Government

4.0952. PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES

R.L. KADUCE, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00204)

OBJECTIVE: Investigate residues resulting from the use of pesticides and plant growth regulators applied to plants and animals, determine how to use these materials without undue residues in soil, water, and other parts of the environment. Standardize sampling and analytical methods for the determination of pesticide residues in or on agricultural commodities.

APPROACH: Investigate pesticide residues in and/or on apples, blueberries, potatoes, strawberries, poultry meat, and other selected vegetable and animal materials.

PROGRESS: To determine, in control of Red Leaf in blueberries, if 2,4-D would translocate from root to blueberries after burning of bushes and new plant growth interval. Replicates of five treated areas were examined. Six samples - none found; four samples - less than 0.03 ppm; 4 samples - range 0.039 to 0.104 ppm.

SUPPORTED BY: U.S. Dept. of Agriculture

4.0953. FUMIGATED WHEATS--VITAMIN CONTENT OF PRODUCTS, BAKING PERFORMANCE OF FLOURS

E.M. HEWSTON, U.S. Dept. of Agriculture, Human Nutrition Research Div., *Beltsville, Maryland* 20705 (HN1-22)

OBJECTIVE: Effects of several types of wheat fumigants on tocopherols and B-vitamins of wheats, milling fractions, doughs, and baked products, and on eating quality of baked products.

APPROACH: Fumigate and sample hard red winter wheat, treated with 3 types of fumigant at intervals during 3 years storage, for total of 12 test periods. Mill to bran, shorts, low grade and patent flours. Prepare and bake bread and roll doughs from patent flours by 2 methods. Evaluate performance of flours and doughs and quality of bread and rolls. Analyze wheats and all products for residues, proximate composition, tocopherols, B-vitamins. Compare all measurements and analyses with those of control wheats. Correlate performance of flours in commercial and home-type breads with chemical components, physical measurements, taste panel evaluations of home-type breads and rolls, and fumigant residues.

PROGRESS: Results of physical tests on the control and fumigated flour samples such as hydrogen ion concentration, amylase activity, oil- binding capacity, color, and mixograph determinations as well as other tests submitted to Biometrical Services for statistical analyses. These analyses were completed and three manuscripts were prepared. All residue work was completed. Fumigation 8 times over a 3 year period has had no effect on total solids, fat, ash, tocopherols, or total B(6) contents of the wheat berry and the milling fractions from the wheat as determined by 12 samplings. Only 5 sampling periods selected for analyses for thiamine, riboflavin, niacin and 'bound' niacin for the wheat berry, milling fractions, bread and roll doughs, and baked breads and rolls. Tocopherols were determined on only certain selected samples of bread doughs, breads, roll doughs, and rolls. Wheat tocopherols in baked rolls and breads obscured by tocopherols in the shortening, and the fat used to grease pans. Increase in fat also observed in fat analyses. Evaluation of baking results for proximate composition not yet completed. No measurable loss of tocopherols due to baking; 80% retention of vitamin B(6) in breads and rolls after baking. Indications of baking losses for other B vitamins, but analytical results not completed.

SUPPORTED BY U.S. Dept. of Agriculture

4.0954, ANALYTICAL INVESTIGATIONS OF PESTICIDES AND THEIR RESIDUES
K.R. HILL, U.S. Dept. of Agriculture, Entomology Research Division, *Beltsville, Maryland* 20705 (00ENTM0301210200)

OBJECTIVE. Determine the amount, persistence, and fate of new insecticides or other insect control chemicals in crops, animals and animal products, and soils.

APPROACH. Obtain information, by analysis, on deposition, distribution, and persistence in plants, animals, animal products, and soils of residues from application of new chemicals being considered for insect control. Determine identity, amount, and fate of their metabolites or breakdown products in plants, animals, and soil. Analyze pesticide formulations to be used in experiments on insect control.

PROGRESS. Greenhouse-grown radishes and cress were exposed to dichlorvos at 1 gram active ingredient/1000 ft. for 7 days. No residues were found in radishes while the cress contained a maximum of 0.98 ppm after 16 hr. exposure. Greenhouse tomatoes were exposed to dichlorvos from 5% impregnated 8-mesh corn cob formulation either continuously or for 16 hr. nightly. Only a trace of dichlorvos was found less than 1 hr. after removal of continuous exposure and none was found 1 hr. after removal of the 16-hr. nightly exposure. Cuts of pork from various organs of swine fed diets containing heptachlor from 0.14 to 2.8 ppm were analyzed and found to contain residues of heptachlor epoxide from 0.0 to 5 ppm. Water and sediment soil from a well in Washington County, Md., was analyzed for pesticide residues and found to contain DDT (.05 ppb water, .04 ppm soil) and elemental sulfur (1.0 ppm soil). Four samples of beeswax foundation from Spain were analyzed and found to contain 1.0-2.0 ppm of DDT. Tomatoes, cucumbers, radishes, and leaf lettuce were exposed to the vapors from 1/8 oz. or 1/4 oz. of 42% calcium cyanide in 7000 ft. greenhouses. Cyanide found on the surfaces of tomatoes and cucumbers was below the detectable limit of 0.01 ppm. Tomato pulp contained an average of 0.35 ppm at the 1/8-oz. level and 0.19 ppm at the 1/4-oz. level while cucumber pulp averaged 0.43 ppm and radish pulp 0.14 ppm over the testing period. Lettuce averaged 0.21 ppm and 0.14 ppm from the 1/8- and 1/4-oz. treatments, respectively.

SUPPORTED BY U.S. Dept. of Agriculture

4.0955, CHLORINATED INSECTICIDE RESIDUES IN ANIMAL PRODUCTS AND FEEDS
W.A. MOATS, U.S. Dept. of Agriculture, Market Quality Research Div., *Beltsville, Maryland* 20705 (FC-86)

OBJECTIVE. Develop simplified procedures for detection and quantitative estimation of chlorinated insecticide residues in animal products and livestock feeds.

APPROACH. Study such commodities as dairy products, poultry and eggs, feed grains, forages, mixed livestock feeds, and animal by-products used in feeds. Pesticide residue analysis involves extraction, cleanup (separation of residues from interfering materials in the crude extract), and analysis to identify and quantitate the amount of pesticide residues present. Extraction and cleanup procedures for each commodity will be simplified as much as possible consistent with adequate recovery of pesticides and removal of interfering materials. Make final analyses by gas and thin-layer chromatography. Determine optimum conditions for these methods.

PROGRESS. Thin-layer plates incorporating vegetable oil and silver nitrate were found to be more color stable than other types of plates in which silver nitrate was incorporated. Plates incorporating only silver nitrate are unstable and it has therefore not been feasible to prepare them commercially since they cannot be kept for any length of time. The improved stability may make manufacture of commercial prepared plates feasible. The uniformity of the plates may also make it possible to analyze spots quantitatively using a thin-layer scanner.

SUPPORTED BY U.S. Dept. of Agriculture

4.0956, METABOLIC OBSERVATIONS - NUTRITIONAL INTERACTION BETWEEN UREA AND APPLE POMACE RE REPRODUCTIVE FAILURE
T.S. RUMSEY, U.S. Dept. of Agriculture, Animal Science Research Div., *Beltsville, Maryland* 20705 (03300551213?1)

OBJECTIVE. Determine if a biological interaction occurs between urea and the pesticide residues or ether extract portion of apple pomace within pregnant beef cows that is measurable by metabolic observations.

APPROACH. Two phases of experimentation will be conducted at Beltsville. Phase one will involve feeding apple pomace and urea to pregnant beef cows and quantitating changes in blood amino acids and minerals. The second phase will involve measuring blood residues in both the pregnant cow and her fetus to determine the proportion of pesticide residues which are absorbed by the fetus.

PROGRESS. Thus far, 10 of 11 cows fed apple pomace supplemented with cottonseed meal and 8 of 11 cows fed apple pomace supplemented with urea plus corn meal have calved. All of the calves from the cottonseed meal treatment were normal. Two of the calves from the urea treatment were born weak and died within 3 days. Preliminary summarization indicates the calves in the urea treatment at birth were less vigorous, weighed less and showed a tendency for less development of the metacarpus and the bones in the cartilage matrix. Diet did not affect serum copper in the cows but liver copper of the cows of the apple pomace-urea treatment was somewhat lower.

SUPPORTED BY U.S. Dept. of Agriculture

4.0957, EFFECT OF HERBICIDES ON PROVITAMIN A VALUE OF SELECTED RAW AND COOKED VEGETABLES
J.P. SWEENEY, U.S. Dept. of Agriculture, Human Nutrition Research Div., *Beltsville, Maryland* 20705 (HN10-06-02)

OBJECTIVE. Determine provitamin A values in selected raw and cooked vegetables as affected by use of herbicides during growth of vegetables, by changes occurring during cooking, and by biological availability when food is consumed.

APPROACH. The effects of amitrol or atrazine on biologically available carotenes will be determined in carrots, spinach and squash. Provitamin A values of these raw and cooked vegetables will be determined spectrophotometrically after chromatographic isolation of all-trans carotenes and their cis-isomers with lower biological activity. Cis-isomers of carotenes would be produced by household preparation of the vegetables, and possibly by herbicides. Amounts of biologically available provitamin A will also be evaluated by biological assay with rats.

PROGRESS. Arrangements have been made with the Crops Research Division, ARS, for growing carrots, spinach and squash treated with herbicides. Work has been carried out on the determination of the effects of preparation methods on the provitamin A content of fresh, frozen and canned vegetables, and on the conversion of all-trans-alpha carotene and all-trans-beta carotene to isomers with decreased provitamin A activity. A method has been developed for the determination of stereoisomers of alpha and beta carotenes. Results indicate that preparation methods for vegetables convert up to 35 percent of all-trans carotenes to stereoisomers, causing significant decreases in provitamin A content.

SUPPORTED BY U.S. Dept. of Agriculture

4.0958, OXIDATIVE DEALKYLATION OF PESTICIDES
R.E. MENZER, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-H-090)

OBJECTIVE. Evaluate the in vivo mechanism of N-deethylation of the organophosphorus insecticide phosphamidon, and the N-demethylation of dimethoate and to characterize intermediates in those reactions. Develop a model in vitro system for the production of any oxidative methabolites detected in the in vivo work. Investigate the reactivity of the intermediates in oxidative dealkylation of these insecticides in relation to possible alkylation reactions in vivo.

4. PESTICIDES

APPROACH: The oxidative dealkylation of phosphamidon and dimethoate will be investigated using a variety of radiometric, chromatographic, and chemical degradation techniques. The insecticides, labeled in the phosphorus and N-alkyl groups, will be administered to rats, to ascertain the presence of metabolites. Characterization of the metabolites will be attempted. Liver microsomes will be prepared by differential centrifugation of liver homogenates, in an attempt to develop optimum conditions for production of metabolites.

PROGRESS: Dimethoate is converted to its oxygen analog in rats and plants. Both dimethoate and oxygen analog are subsequently oxidized to N-methylol derivatives which lose formaldehyde to give unsubstituted amide analogs. It was not possible to separate chromatographically the oxygen analog and N-methylol derivative of dimethoate, but positive identification of the latter was made by a derivative isotope-dilution procedure. Complete oxidative deethylation of phosphamidon has also been characterized. This compound undergoes reactions which successively oxidize the N-ethyl groups with subsequent loss from the compound, ultimately resulting in the phosphamidon unsubstituted amide. It has also been discovered that the vinyl chlorine of phosphamidon is replaced by a hydroxyl group by an unknown mechanism. This results in three additional neutral metabolites: vinyl hydroxyphosphamidon, des-N- ethyl vinyl hydroxyphosphamidon, and vinyl hydroxyphosphamidon amide. Identification of these new metabolites is based on chromatographic, isotope dilution, chemical, and radiometric data. No metabolism of organophosphates was found in whole cell or sonicated preparations of L- 929 of Chang liver cells. However, there are pseudocholinesterase-type enzymes present, which organophosphates inhibit at high levels.

SUPPORTED BY Maryland State Government

4.0959, PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES

F.R. SHAW, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01002 (MAS00058)

OBJECTIVE: Determine composition and persistence of pesticide residues on forage, fruits, and animal products.

APPROACH: Pesticides will be applied at different periods during the growth cycle and residues determined chemically.

PROGRESS: Research on residues of Rabon resulting from feeding of various formulations to poultry are well underway and will be continued. Comparisons of residues resulting from application of two formulations of Imidan to alfalfa have been determined. Residues of pesticides on cranberries and blueberries have been conducted at the Cranberry Station.

SUPPORTED BY U.S. Dept. of Agriculture

4.0960, PHYTOTOXICITY OF MSMA RESIDUES AND ARSENIC CONTENT OF FOODS

W.L. BARRENTINE, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (0710-11-02(CA))

OBJECTIVE: Determine the effect of simulated accumulations of arsenic from monosodium methanearsonate (MSMA) upon phytotoxicity to tolerant and susceptible crop plants; assess effect of arsenic residue upon crop quality and yield and upon arsenic content of the edible portions; determine arsenic movement in soil and influence of iron and aluminum content of soil upon arsenic activity.

APPROACH: Plots high and low in iron and aluminum will receive a single incorporated application of a range of dosages of MSMA to simulate short- and long-term accumulations of the arsenic herbicide. Cotton, soybeans, rice, potatoes, and snapbeans will be planted each year, and response will be rated visually and by measurement of yield and quality. Transport of arsenic in the soil will be determined by bioassay and other analyses. Edible portions of the crops will be analyzed for arsenic content.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

4.0961, EFFECTS OF PESTICIDES ON PROTEIN, CARBOHYDRATE, AND NUCLEIC ACID METABOLISM. INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES

B.T. JOHNSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Preliminary investigations will be initiated utilizing a selected group of yeast, bacteria and protozoa to ascertain the influence pesticides play in basic respiration and synthesis. Fundamental work will involve development of suitable radio-respirometry and disc electrophoresis technique.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0962, ANALYTICAL LABORATORY

C.W. GEHRKE, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00132)

The major objectives of the Experiment Station Chemical Laboratories are to conduct analytical chemical services and research on chemical methods for the College of Agriculture and Experiment Station. The research concerns development of new, improved, automated and instrumental methods and basic research in Agricultural Chemistry. Analyses were: Fertilizer 31,500; ASCS limestone 6150; general assays for College of Agr. 17,050; other general assays for service and research 3000. Specilized analyses: 2500 lysine and 400 methionine by automated colorimetric methods; 1500 gas chromatograms including service and method development; 200 lysin, 50 multiple amino acids, and samples for nucleic and fatty acids; 200 samples for amino acids by automated ion- exchange; 10 analytical ultracentrifuge samples; 50 lyophilizations; 50 samples for pesticide residues. Total assays 62,410. Research was continued on development and automation of methods, especially in fertilizers, pesticides, amino acids, and protein chemistry. A major accomplishment was compiling and publishing the book listed as the second item in the publication list. Dr. Gehrke served as AOAC General Referee on limestone and Assoc. Referee on sampling of fertilizers. Mr. Rexroad served as AOAC Assoc. Referee on nitrogen in fertilizers and mechanical analysis of limestone. A continuation of the major objective is planned for next year.

SUPPORTED BY Missouri State Government

4.0963, TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS

D.D. HEMPHILL, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00573)

OBJECTIVE: Study the effects of pesticides on acceptability and/or nutritive value of agricultural commodities. Develop procedures for the removal reduction or de-toxification of pesticide residues and conversion products in agricultural commodities. Develop or improve methods for the determination of pesticide residues in agricultural commodities in marketing channels.

APPROACH: As studies are completed with the chlorinated hydrocarbons (organochlorine) emphasis will be shifted to organophosphate and carbamate pesticides.

PROGRESS: Commercially grown tomatoes sprayed with malathion were used to determine the effects of certain preparative and processing treatments on pesticide residues. Ethyl acetate extraction and sweep co-distillation methods along with alkali-flame gas chromatography were used to determine residues. Water rinsing removed 28% while buffing removed 69% of the residue. Most of the malathion residue was on or absorbed in the peel. Peeling gave a 98% reduction in malathion residue. Boiling resulted in a 62% and a 10 hr. exposure to UV light gave 81% reduction. Diazinon, Malathion and parathion in ethyl acetate solution were subjected to 90,000 Rad Cobalt 60 radiation. There was a 41% reduction in diazinon, 49% reduction in malathion and 59% reduction in parathion. DDT, DDD and DDE standards in hexane solution exhibited losses od 32, 36 and 59% respectively. An improved alkali flame detector system using purified rubidium sulfate and anode of new design was developed

and optimized for the quantitative determination of organophosphate pesticides. Under optimum conditions sensitivity of one picogram was achieved. The detector life with an average of 27 injections of sample extracts and standards per day was more than 90 days and cleaning of the electrode and detector cell were not necessary during this period.

SUPPORTED BY U.S. Dept. of Agriculture

4.0964, EVALUATION OF PESTICIDE RESIDUE PROBLEM IN MONTANA

J.C. BOYD, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715 (MONB00165)

OBJECTIVE: Evaluate pesticide residue problem, conduct necessary research to determine plant uptake and contamination, determine practices to prevent build up of residue in animal tissue and milk and reduce residue levels in animal tissues and milk.

APPROACH: Literature review and consultation, location of residue in soil and ground cover, determination of residues in hay and forages with various treatment histories, determine effect of flaming contaminated areas on volatilization of residue, measurement of translocation of residue and pesticide by plants, and measurement of decay curve of pesticide from animal tissue and milk.

PROGRESS: Montana experienced a pesticide problem in milk as a result of chlordane being used to control adult alfalfa weevil. Some 30 dairymen were restrained from selling milk and some 1500 cattle quarantined. All dairymen are now back on the market and all cattle have been released. Data relative to rate of decline of residue in the milk after feeding contaminated hay has been collected. Relationship of residue in milk fat as related to body fat, residue in soil and crowns of alfalfa plant to foliage of plant have been determined. Translocation of chlordane from soil to alfalfa foliage has been demonstrated. In recent months the so-called heptachlor epoxide level has been shown to contain other components, as yet unidentified. Samples of contaminated milk have been supplied to Food and Drug Research Laboratory in Washington D. C. for work in this area. The problem is largely over. Five progress reports have been written for use of staff, and extension personnel.

SUPPORTED BY Montana State Government

4.0965, BIOLOGICAL INTERACTIONS WITH SYSTEMIC FUNGICIDES

D.E. MATHRE, Montana State University, School of Letters, *Bozeman, Montana* 59715

With the people and governments of the world becoming more and more concerned about the use of pesticides and the potential contamination of our environment with pesticide residues, it becomes extremely important to know the ways in which pesticides interact with and affect biological systems. This investigation will be concerned with a study of a new group of organic fungicides, the oxathiins, that have the unique property of being systemic in higher plants.

The main objectives will be concerned with determining how these materials interact with various biological systems so that we may better assess the potential danger from residues of these materials in our environment. Experiments will be conducted to provide information in the following areas: 1) The mechanisms of uptake and movement of the oxathiins through higher plants, 2) the effects of the oxathiins on the metabolism of higher plant cells, resistant and sensitive fungi, 3) the reasons for the specificity of the oxathiins for the Basidiomycetes, 4) the ability of higher plants to metabolize or transform the oxathiins to other compounds, 5) the metabolism or transformation of the oxathiins by various microorganisms, 6) the longevity of the oxathiins in plant residues and the factors affecting their decomposition. At present there is little information available on any of the above areas.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0966, BIOLOGICAL DEGRADATION OF AGRICULTURAL PESTICIDES

C. STILL, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00508)

OBJECTIVE: Investigate the enzymic mechanisms and pathways of biological degradation of pesticides.

APPROACH: We propose to determine with the aid of zonal centrifuges the intracellular localization of enzymes which might participate in the biological degradation of pesticides. We expect to purify these enzymes so as to determine such characteristics as substrate range and specificity, rate of pesticide transformation and the chemical nature of the products formed. We propose to explore the development of continuous-flow zonal rotors for the concentration of plankton from fresh waters. If successful, this procedure would permit precise estimates on the amounts of pesticides and their transformation products accumulating in phyto- and zoo-plankton. Molecules of special interest will be those structurally related to the acylanilides.

PROGRESS: Studies on the propanil amidase of rice plants have been continued. The enzyme is associated with particles showing many characteristics of mitochondrial fragments. Propanil is an inhibitor of the Hill reaction and photosynthesis in green plants. We find that it is also a growth inhibitor in a non-green plant (dark-grown Euglena gracilis) and the slime mold Physarum polycephalum. We have not demonstrated the conversion of dichloroaniline (DCA) to tetrachloroazobenzene (TCAB) in rice plants. We have compared peroxidases from rice, barnyardgrass, and horseradish and find that the enzymes of rice and barnyardgrass, unlike horseradish, do not convert DCA to TCAB. TCAB is a highly toxic, stable metabolite of propanil and DCA in soil. We find that TCAB is without lethal effect in the slime mold, indeed some growth stimulation may occur. However, we have been unable to obtain evidence of metabolic breakdown of the parent compound.

SUPPORTED BY U.S. Dept. of Agriculture

4.0967, INSECT REPELLENT RESEARCH

UNKNOWN, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00475)

Two general approaches may be taken in repellent research--screening candidate compounds and attempting to improve known repellents which have certain inherent advantages. The latter approach was emphasized in 1968 to improve ethylhexanediol. Criteria for upgrading such a repellent are by increasing resistance to wear, improving ease of application, improving consumer acceptance by reducing heating of skin or respiratory irritation, and by increasing the number of annoying insects against which protection can be assured. During the past year 40 formulation comparisons including 219 duration tests were conducted in the laboratory, and 16 formulation comparisons including 74 duration tests were conducted in the field. Repellent testing methods and tools used in repellent studies have been critically reevaluated. A concentration testing method is being developed to complement the duration testing method by determining the threshold concentrations at which repellents are effective and thus reduce the man-hours involved in each test. In addition, two testing tools are presently under development. A cylindrical test cage is being studied to improve the handling of bioassay organism and visibility for the tester, and to reduce experimental error from accidental rub-off and uneven wear of the repellent. A 'bite-o-meter' using electronic recording may find future use for screening several compounds simultaneously, reducing human observational errors and influences, and permit testing with less costly pharmacological studies.

SUPPORTED BY New Jersey State Government - Trenton

4.0968, BIOASSAY OF SUCKER CONTROL CHEMICALS AND PESTICIDE RESIDUE ON LEAF TOBACCO

F.G. BOCK, Health Research Incorporated, *Buffalo, New York* 14203 (709-053-A103(C))

OBJECTIVE: Determine the possible threshold carcinogenic activity, if present, of sucker control chemical including penar, maleic hydrazide, methyl caprate, 1-octanol, 1-decanol, Tween-20 and Tween-80, and leaf extract from green and cured tobacco with or without field pesticide treatment.

APPROACH: Establish the dosage response relationship in tumor promoting ability of sucker control chemicals and the highest negative response level. Penar, maleic hydrazide, T-43, T-

148, Tween-20, Tween- 80, and possibly radiocarbon-labeled Tween compounds are tested separately or in combination through topical application to the shaved backs of animals. Make extracts of green and cured leaf tobacco samples produced in the field with or without pesticide treatment. Fractionate into soluble and insoluble fractions for bioassay as above. At the end of the test period, animals showing evidence of tumor formation and/or associated pathological changes will be sacrified, and autopsies, including histological examination, will be performed to determine the possible threshold level of these compounds.

SUPPORTED BY U.S. Dept. of Agriculture

4.0969, TOXICOLOGY OF FOREST INSECTS OF THE SOUTHEAST

F.L. HASTINGS, U.S. Dept. of Agriculture, S.E. Forest Experiment Station, *Durham, North Carolina* 27709 (SE2206)

OBJECTIVE: To acquire basic knowledge of the toxicology of forest insects as a basis for safer, more effective chemical control methods.

APPROACH: Systemic insecticides; uptake, translocation, deposition, toxic activity and metabolism by trees. Effectiveness of organic insecticides, under varying environmental conditions - humidity, heat, soil moisture and soil acidity - will be determined. Use of adjuvants to include wetters, spreaders, extenders, stickers and synergists. Penetrants affecting uptake of systemics; effectiveness of conventional poisons. Evaluate toxic properties of the parasporal bodies of Bacillus thuringiensis terpenes and polyphenols. Study other physiologically active chemicals and their mode of action.

SUPPORTED BY U.S. Dept. of Agriculture

4.0970, HEALTH-RELATED FLUE CURED TOBACCO RESEARCH IN NORTH CAROLINA

J.F. CHAPLIN, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (0500-03-16(CA))

OBJECTIVE: Develop chemical disease control methods leaving no metabolic products or residues harmful to the consumer.

APPROACH: Evaluate combinations of resistant varieties and new pesticide chemical formulations such as a mixture of 80% dichloropropene, 15% chloropicrin, 5% propargyl bromide; or 80% 2- methyl-2-2 (methylthio) propion and 20% aldehyde-0-(methylcarbamoly) oxine on control of brown spot, black shank, nematodes, and black root rot of flue-cured and burley tobacco. Yield and quality performance will be determined Residue determinations and bioassay studies of smoke condensate will be performed from leaf produced under successful treatments.

PROGRESS: Tests conducted in critical problem fields showed the value of high resistance in reducing losses to black shank, Granville wilt and black-root-rot in flue-cured tobacco and black-root-rot in burley tobacco. The average value of high resistant varieties in black shank test was $146 more than that of moderate, $253 above low, and $730 more than that of susceptible varieties. For bacterial wilt the performance of high resistance varieties increased in value over those that were moderate and low by $270 and $464 per acre respectively. Sps G-7 and G- 28 were the only flue-cured varieties that appeared to have resistance to black-root-rot. Ky 12 and 14, burley varieties with high levels of black-root-rot resistance, produced $420 per acre more than the low resistant Bu 21, and $1663, above the susceptible varieties. Nematicides, containing Ethylene dibromide, were the only ones from 25 nematicides tested, that provided sufficient control of all four species of root-knot nematodes (M. incognita, new race of incognita, javanica, and arenaria). Nicotine and sugar levels of tobacco treated with different chemicals were only slightly affected, however, tobacco produced on plots treated with halogenated chemicals was generally higher in total halides than the checks.

SUPPORTED BY U.S. Dept. of Agriculture

4.0971, CONTROL OF URBAN AND INDUSTRIAL PESTS

H.B. MOORE, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03252)

OBJECTIVE: Establish, by means of surveys, the distribution, abundance, and economic importance of urban and industrial pests in North Carolina. Improve the safety and effectiveness of the control of these pests through the evaluation of chemicals and application techniques, old and new.

APPROACH: The surveys will be accomplished by making systematic collections across the state and by examing the collection records in museums and the control records of pest control firms. Evaluate techniques and chemicals for control; replicated tests will be conducted in infested buildings and in the laboratory.

PROGRESS: Initiated project with Raleigh Housing Authority, Shell Chemical Co. and Surety Exterminating Co. to determine cockroach control using Vapona (Reg) mini-strips in enclosed cabinets of low-rent housing. Data analysis incomplete. (C.G. Wright) Survey on old house borer distribution in the state, and the reasons for its increase, was initiated but no data has reached the reportable stage. (H.B. Moore)

SUPPORTED BY U.S. Dept. of Agriculture

4.0972, AGRICULTURAL CHEMICAL RESIDUES IN PLANT AND ANIMAL PRODUCTS

T.J. SHEETS, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC01022)

OBJECTIVE: Development, adaptation and standardization of chemical, instrumental and biological methods of residue analysis. (Methodology) behavior of chemicals as related to residues in agricultural commodities. (Behavior) residues and their metabolites.

APPROACH: Pesticide residue analysis in support of commodity research projects. Research in the area of pesticide residue analysis. Breakdown of pesticides in environment studied.

PROGRESS: Studies on uptake of chlorinated hydrocarbons from soil by oil-seed crops were continued. Levels of dieldrin in seeds of peanut and soybean increased linearly with rate of application and varied with location. Peanuts can become contaminated to levels exceeding the FDA action level from relatively low levels of the insecticide in soil at planting. In chicks with a high body burden of DDT, administration of low levels of Protamone increased the rate of conversion of DDT to DDE. Seventy-two hours after feeding DDT to quail, adipose tissue contained greatest concentrations, but relatively high levels were found in liver and muscle tissue. DDD was present in greatest proportions in the liver. Dieldrin levels in milk fat of two dairy cows decreased from 55 to 0.4 ppm in a 5-month period. One year after the last application, residues of dichlobenil, terbacil, and DP-733 in soil were greater on incorporated plots than on plots that received surface applications. Persistence was greater with incorporation. Carbofuran was converted to 3-hydroxy carbofuran in young tobacco plants. Its concentration reached a peak in 8 days and declined. Small amounts of other metabolites were found. These results show that pyrolysis during cigarette smoking of 3-hydroxy carbofuran as well as the parent pesticide, carbofuran, should be determined.

SUPPORTED BY U.S. Dept. of Agriculture

4.0973, IMPORTANCE OF FEED AS AN UNAVOIDABLE SOURCE OF PESTICIDE CONTAMINATION IN POULTRY MEAT AND EGGS

E.C. NABER, Ohio State University, Agricultural Experiment Sta., *Columbus, Ohio* 43210 (OHOSS-160)

OBJECTIVE: Survey commonly used feedstuffs for their pesticide content in order to determine levels of contamination from dietary sources. Determine the amounts of residue in meat and eggs from feeding the levels found in natural feedstuffs.

APPROACH: Samples of corn, soybean meal, alfalfa meal, fishmeal, and fat will be obtained on the open market, or from processing plants. Five samples of each feed ingredient from each area shall be collected randomly each month for 24 months. Composite samples of each feed ingredient for each area will be analyzed monthly for DDT, DDE, DDD, aldrin, dieldrin, heptachlor, methoxychlor, toxaphene, and lindane. In addition, day-old broiler chicks in groups of at least 10 chicks each will be fed diets formulated to contain the three levels of the pesticides as indicated above. These birds will be slaughtered at 8 weeks of age and pooled samples of liver, muscle and fat taken for residue anal-

ysis. In addition, samples of eggs from other groups will be analyzed at 1, 2, 4, 6, 10, 16, 24 and 32 weeks for the above residues.

PROGRESS: Poultry feed ingredients were analyzed for their content of 10 organochlorine pesticides. 688 samples have been analyzed. Egg samples have also been analyzed. DDT and its metabolites were the most frequently found contaminants in all poultry feed ingredients. Residues of aldrin were found frequentiy in soybean and corn meal. Heptachlor expoxide and aldrin were occasionally found in alfalfa meal. Aldrin, lindane, and dieldrin occurred frequently in fish meal and fat. The range of residue concentrations in the feed ingredients was considerable. Although pesticide residues were common in all types of feed ingredients, the highest concentrations found during the past year were: heptachlor, 0.13 PPM in alfalfa meal; aldrin, 8.4 PPM in fat; DDE, 0.533 PPM in fishmeal; DDD, 0.603 PPM in corn meal; and methoxychlor, 0.149 PPM in corn meal. Lower concentrations of residues ranging down to zero were found in all five ingredients.

SUPPORTED BY Ohio State Government

4.0974, THE CYCLING OF CL-36 LABELED DDT IN NATURAL ECOSYSTEMS

T.J. PETERLE, Ohio State University, School of Arts, *Columbus, Ohio* 43212 (AT(11-1))

Prior experience in the use of isotope-labeled pesticides has demonstrated that this is a useful and economical way for determining the transfer of these organic compounds in ecosystems. This project will attempt to determine the transfer of the Cl-36 DDT through a terrestrial system. Radioassay procedures will be used to qualify the level of the insecticide and its metabolites in the various physical and biological components of the ecosystem. Since the radioassay procedures will assess only the labeled DDT applied, total body burdens will reflect only that DDT accumulated from the study area. Some artificial exposures in time and space will be made to determine rates of accumulation for the various species present on the treated area.

SUPPORTED BY U.S. Atomic Energy Commission

4.0975, PESTICIDE STRESS EFFECTS ON EXPERIMENTAL ECOSYSTEMS

G.W. BARRETT, Miami University, School of Arts, *Oxford, Ohio* 45056

The investigation will deal specifically with plant, arthropod and small mammal components within eight 1/4-acre fenced enclosures.

The design of the experiment allows for the comparison of a pesticide stress on two kinds of ecosystems of major interest to man, namely a cultivated monoculture ecosystem and a natural 'oil-field' ecosystem.

Ecologists are still seeking good criteria to measure the resilience and regulatory powers of an ecosystem when such systems are treated with stressors, such as pesticides. A study of this nature will discover and evaluate such criteria.

SUPPORTED BY U.S. National Science Foundation

4.0976, FEED AS A SOURCE OF PESTICIDE CONTAMINATION IN POULTRY MEAT AND EGGS

E.C. NABER, Ohio Agric. Res. & Dev. Center, *Wooster, Ohio* 44691 (032900170137)

OBJECTIVE: Survey five feedstuffs for pesticide content and determine levels of residues in meat and eggs from feeding levels found.

APPROACH: Samples of corn, soybean meal, alfalfa meal, fishmeal and fat will be obtained on the open market. Five samples of each of these materials shall be collected randomly each month for 24 months and composite samples of each feedstuff for each area will be tested for DDT, DDE, DDD, aldrin, dieldrin, heptachlor, methoxychlor, toxaphene and lindane. Selected levels, based on analytical results will be fed and residues determined in meat and eggs.

PROGRESS: A total of 1128 samples of feedstuffs were collected during the reporting period. Pesticide residues were determined in 688 of these samples. The feeding study of pesticide-fortified feedstuffs to laying hens was completed and residue analyses of 314 samples of eggs have been made. Samples of fat, muscle and tissue were collected. Traces of dieldrin and DDE appeared to be common contaminants in all egg samples. Most of the residues in feedstuffs were present in trace amounts and were reported in ppb. The major residues found are as follows: soybean meal -- aldrin, DDE, pp' DDT, lindane and dieldrin; corn -- aldrin, pp' DDT, lindane; alfalfa -- all pesticides tested for were present, with aldrin, DDT and its isomers, lindane and dieldrin predominant; fishmeal -- essentially the same as alfalfa; fat -- DDT and its isomers, lindane and dieldrin.

SUPPORTED BY U.S. Dept. of Agriculture

4.0977, REDUCTION OF HERBICIDE RESIDUES

A.P. APPLEBY, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00732)

OBJECTIVE: Find herbicides which are more effective at lower rates, less toxic to humans and animals, less injurious to desirable plants, and less persistent in the soil. Develop methods of increasing the effectiveness of present herbicides so that dosages required for adequate control may be reduced, thus reducing residue levels.

APPROACH: Laboratory, greenhouse, and field experiments will be conducted to accomplish the above objectives. Use of combinations to reduce total amount of herbicide per acre, use of adjuvants to increase effectiveness, study of controlled-release of short-residual materials by granular coatings, encapsulation, etc. and study timing applications for maximum control at minimum rates.

PROGRESS: Research on herbicide combinations for corn has largely been concluded. Results indicate that any of 4 herbicides effective against grass (EPTC, butylate, propachlor, or alachlor) combined with any of four herbicides effective against broadleaves (atrazine, S-6115, dinoseb, or 2,4-D) effectively and safely control a wide range of annual weeds in corn in Oregon. The use of these combinations has led to a reduction in the rates of persistent type herbicides at the same time that weed control has improved. Application of atrazine in oil for postemergence weed control in corn appears to reduce the rate requirement even further. However, the application must be made before weeds reach more than two inches in height. Extensive tests for postemergence applications of sinbar terbacil for weed control in peppermint have shown promise for reducing the rates of that material required. This may lead to consistent weed control with less chance of injury to rotation crops. Surfactants added to terbacil increased its effectiveness, but little difference could be noted between the various surfactants tested. Non-phytotoxic oils were more effective in increasing terbacil activity from either surfactants or liquid fertilizer. At least one major herbicide in each family of herbicides was found to stimulate plant growth when applied at sublethal doses. This seems to point to a general biological phenomenon since the mechanisms of action of the herbicides tested vary widely.

SUPPORTED BY U.S. Dept. of Agriculture

4.0978, TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT

V.H. FREED, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00674)

OBJECTIVE: The approach used in this study is a coordinated, interdisciplinary type of investigation. It involves entomologists, pathologists, pharmacologist, ecologists, analytical chemists, physical chemists, biochemists and mathematicians. The study attempts to assess the current behavior and persistence of pesticides in the environment, the transport across interface between the environment and organisms or uptake, the pharmacodynamics and effects of various levels of organization in the biological system. This will include effects at the molecular level through the whole animal and the effects studied consist both of metabolism by the organism and the effect of the xenobiotic on metabolism and function in the organism. An important feature of

the study is the involvement of analytical chemists in all phases of the work. A central analytical facility is available to assist in development of new methods and the quantitation of pesticide and metabolites in the studies.

APPROACH: NOT-PROVIDED

PROGRESS: Progress has been made in the following areas: Uptake of chemicals from the environment by food chain; analytical chemistry of pesticides including analyses of a number of research standards; metabolism of pesticides by intact organisms as well as isolated systems of enzymes; chemodynamics in the environment; the effect of xenobiotics on metabolism of organisms; effect of xenobiotics on behavioral responses.

SUPPORTED BY Oregon State Government

4.0979, PESTICIDE RESIDUES

V.H. FREED, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00284)

OBJECTIVE: Determine the rates of metabolism of selected pesticides in plants, animals and soil. Ascertain the nature of the metabolic transformation products of pesticides. Develop methods of analysis for pesticides and their degradation products in soil and biological tissues.

APPROACH: The procedure for accomplishing these objectives will be to treat plants, animals or soil with selected pesticides. Radiolabeled pesticides will be used when they are available to facilitate determination of metabolic pathways. After varying periods of time, the treated substrate will be analyzed to determine the amount of parent pesticide remaining. The metabolites will be isolated and their identity determined by means of adsorption- and gas chromatography and mass- and Infrared spectroscopy.

PROGRESS: The metabolism of the herbicide 2,6-dichlorobenzonitrile (dichlobenil) by soil and cranberry plants was studied, The rate of metabolism of the herbicide in soil is relatively slow, its half-life being nearly 4 months at 80 C. The energy of activation for the decomposition is about 4 Kcal/mole. Since the effective soil life of dichlobenil is considerably shorter under field conditions, it is apparent that volatility losses are appreciable. Cranberry plants readily absorb and metabolize dichlobenil. The metabolites of the herbicide are conjugated with plant constituents. Hydrolysis under alkaline or acid conditions yields two metabolites. These two metabolites were identified by mass spectral analysis and found to be 3- hydroxy-2,6-dichlorobenzonitrile and 4-hydroxy-2 6-dichlorobenzonitrile. However, no detectable residues of either of these metabolites were found in cranberries from fields treated with 6 lbs/acre of herbicide.

SUPPORTED BY U.S. Dept. of Agriculture

4.0980, CENTER FOR ENVIRONMENTAL MANAGEMENT

V.H. FREED, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The Environmental Health Sciences Center at O. S. U. has been in operation a little over two years. In this time a program of research and training on environmental problems has been initiated. Further, the center has contributed to the crystallizing and focussing of interest and work on this campus concerned with environmental problems.

The renewal proposal emphasized the role of the Center in research and training in a coordinated effort on the environmental health aspects of microchemical pollutants. Attention will be given; (1) the identification and inventorying the various environmental chemicals (2) study of the dynamics of distribution and (3) their biological effects, made of action and metabolism. The objectives of the program are: 1. To identify critical environmental health problems, conduct research on selected problems and stimulate and encourage research on others, 2. To provide training with specific environmental health orientation to students and to encourage their commitment to this important area of work, 3. To facilitate the research and training through planning, coordination and provision of research support service and facilitate the dissimination and utilization of the research findings.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.0981, INSECT AND MITE PESTS OF DECIDUOUS FRUITS AND THEIR CONTROL

D. ASQUITH, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01650)

OBJECTIVE: The evaluation of insecticides and acaricides to find new chemicals to substitute in spray schedules for chemicals to which pests have become resistant; select chemicals suitable for integrated control programs; and select chemicals which will have low potential hazard to the public. The selection of beneficial organisms for their potential adaptability to integrated fruit pest control programs.

APPROACH: Pesticides will be evaluated for effectiveness against the pest complex; phytotoxicity to fruit and fruit trees; effect on beneficial organisms; residual toxicity; hazard to public. Beneficial organisms will be studied in the laboratory and field and selections made for those to be used in integrated control programs. Some species will be subjected to residues of certain pesticides to select strains resistant to pesticides, and these used in the development of an integrated control program.

PROGRESS: Twenty insecticidal treatments were tested for effectiveness on the codling moth, the red-banded leaf roller, apple aphid, European red mite, and two-spotted spider mite. The suitability of some insecticides for inclusion in a system of integrated biological and chemical control of mites in apple orchards was evaluated. Twenty- five acaricidal treatments were tested to determine their effectiveness against the European red mite, the two-spotted spider mite, and certain predatory mites. In addition, some newer insecticides and acaricides were tested in 6X concentrate sprays for integrated chemical and biological control programs. Both Gardona and Imidan showed promise as insecticides in this type of program. Gardona, however, caused serious cracking of Stayman apples and serious russeting of other varieties. Populations of Stethorus punctum survived standard dosage 6X concentrate sprays of Omite WP 30 and Acaralate 2EC, and one-half standard dosage 6X sprays of Fundal SP. S. punctum also survived standard dosage 6X sprays of older acaricides, Kelthane and Morestan.

SUPPORTED BY U.S. Dept. of Agriculture

4.0982, WEED CONTROL IN AGRONOMIC CROPS

S.M. RALEIGH, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01346A)

Objective: Determine most satisfactory methods, materials and techniques for the control or eradication of weeds and other undesirable plant growth. Determine tolerance of various economic plants to ascertain weed and brush control chemicals. Determine the reciprocal relationships of various weed and brush control chemicals and soil microorganisms.

Approach: Promising new and the best commercial herbicides now in use are tested, when practical, for controlling weeds in small grain, forage crops, pasture and inter-tilled crops such as corn and potatoes. Applications are also made on perennial weeds before crops are planted. The chemicals are generally applied at 3 rates per acre or are log sprayed. The effect of the chemical on weed control and on the crop are recorded. The residual effect of chemical is studied in the field on succeeding crop or in the greenhouse. When pre planting treatments are applied for weed control, the interval necessary for eliminating crop injury is observed.

Progress: Monsanto 50144 has been the outstanding preemergence herbicide for annual grass control, under Pennsylvania conditions for the last three years. It is poor on some broadleaf weeds such as Mustard and Common Ragweed. It works exceptionally well in combination with atrazine which is excellent for most annual broadleaf weeds but weak on fall panicum crabgrass and sometimes giant foxtail. Atrazine at 2 lbs. plus oil with wetting agent at 2 gallons per acre or atrazine plus 8 ounces of wetting agent per acre is effective when applied to foxtail or barnyardgrass when the grass is in the 2-4 leaf stage. This treatment is not as desirable as atrazine used in preemergence.

Quackgrass is more readily controlled with atrazine applied pre plowing if the weather is cool and there is considerable rainfall, while Amitrol-T is most effective when the weather is warm and plenty of sunshine.

SUPPORTED BY U.S. Dept. of Agriculture

4.0983, PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES

T.W. KERR, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00609)

OBJECTIVE: Investigate residues resulting from the use of pesticides and plant growth regulators applied to plants and animals. Develop and standardize sampling and analytical methods for the determination of pesticide residues in or on agricultural commodities.

APPROACH: Pesticide residues will be investigated on forage, animal products, fruits and vegetables. Detailed studies of sampling procedures for the crops will be investigated.

PROGRESS: Potatoes sprayed 4 to 5 times during the 1969 season with 8-16 ounces per acre of the insecticide carbofuran showed less than 0.05 ppm residue at the lesser rate 0, 1, 3, 7, 14, 21 and 28 days after application. Sixteen ounces per acre showed from 0.05 ppm to 0.10 ppm residue 1, 3, 7 and 14 days after application but less than 0.05 ppm thereafter. Both treatments showed less than 0.05 ppm at harvest 53 days after the last application of carbofuran. Potatoes treated in 1968 with 2 and 3 pounds of the herbicide chlorbromuron per acre showed less than 0.03 ppm of residue when analyzed both as washed, frozen samples and unwashed, fresh samples in May 1969.

SUPPORTED BY U.S. Dept. of Agriculture

4.0984, ANALYTICAL SERVICES

O.E. OLSON, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00407)

OBJECTIVE: Provide analytical services to members of the Experiment Station Staff who lack adequate laboratory facilities, with particular attention to certain special types of analysis. Provide chen ical diagnostic services for Veterinary Science. Provide limited analytical service for farmers, ranchers, and other residents or agencies of the state.

APPROACH: Analyses are conducted in accordance with the objectives when there is sufficient need for them. Except in the case of farmers and ranchers, need must be established by those requesting the analyses. In the case of farmers and ranchers, analyses are made whenever, in the opinion of the laboratory the results will be worthwhile. Charges are made for work done for all but members of the Experiment Station staff.

PROGRESS: Station Biochemistry does work for residents of the state to assist them in planning their livestock feeding programs, to assist in the diagnosis of livestock diseases, and to solve other household or farm problems. In addition, many Experiment Station research workers in other departments use the analytical services on a variety of projects. Industry and governmental agencies and workers from other Experiment Stations also use these services on occasion. A summary of analyses made during 1968 is as follows: Moisture determinations 914; Ether extract determinations 389; Protein determinations 1083; Crude fiber determinations 389; Ash determinations 389; Chromic oxide determinations 284; Carotene determinations 81; Salt determinations 16; Mineral analysis on feeds 117; Blood analyses 33; Selenium determinations 193; Special water analysis 26; Nitrate determinations 203; Other poison analyses 127; Insecticide analyses 49; Egg pigmentation analyses 112; Miscellaneous 76. Total: 4481.

SUPPORTED BY South Dakota State Government

4.0985, INSECTICIDAL RESIDUES

R.J. WALSTROM, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00374)

OBJECTIVE: Determine the fundamental physical, biochemical, and biological factors influencing occurrence, magnitude, interaction, and persistence of insecticidal chemical residues in soils and raw agricultural commodities. Identify and evaluate fundamental factors influencing the magnitude and mechanism of air and water pollution by insecticidal chemical residues. Develop basic studies related to the metabolism and detoxication of insecticidal chemical residues in animals, plants, soils and water. Identify and evaluate the effects of residues of insecticidal chemicals on ecosystems with special emphasis on fish and wildlife. Explore the reciprocal influences of residues of insecticidal chemicals on soil microflora, microfauna, and non-insect fauna. Seek methods of removing or reducing residues of insecticidal chemicals from the environment. Develop and improve analytical techniques essential to the pursuit of this research.

APPROACH: Apply insecticides to alfalfa in a dosage range to include the most satisfactory control under northern great plains conditions. Cut samples of forage at intervals following treatment. Samples to be handled as fresh-cut (to simulate pasture and silage) and as field-dried (to simulate hay). Samples to be analyzed for residues on a qualitative and quantitative basis. Samples will be analyzed by the use of gas chromatography and thin-layer chromatography.

PROGRESS: Studied chlorinated hydrocarbon and organophosphorus insecticides in alfalfa and surface soils. Residues of DDT, dieldrin, methoxychlor, and toxaphene detected in treated foliage and soil 52 days after application. Residues of malathion and diazinon dissipated in less than this period after application. No residues of any of the tested insecticides detected on fresh-cut new growth sampled on June 7 the year after application. Data on rate of uptake, translocation, expiration, and metabolism of diazinon in alfalfa obtained utilizing non-radioactive, C ring labelled or C ethyl labeled diazinon. Absorption was rapid with detectable quantities of diazinon appearing in the plant within 24 hours after soil treatment. Loss of diazinon from the soil was rapid with an average of 15% remaining 15 days after application. No radioactive CO(2) detected as a metabolite of C diazinon treatments. Diazinon was expired by alfalfa plants after being absorbed into the plant.

SUPPORTED BY U.S. Dept. of Agriculture

4.0986, CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES

P.R. ATKINS, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

Project Objectives and Description of Work: Pesticide usage in many portions of the world is increasing at an accelerated rate. The production of the chemicals required to satisfy these demands often results in wastes which may be harmful to aquatic organisms, plants, animals, and man. Information concerning these waste streams, is scattered, confused, and often unavailable. The purpose of this proposed study is to investigate the quantity and quality of pesticide manufacturing waste streams and to evaluate the methods presently being employed to treat and dispose of the pollutants. The study area involved will be limited to the continental United States and Canada.

The project will include: 1. A comprehensive review of the literature dealing with historical, present and projected pesticide usage, manufacture, and waste water treatment. 2. A survey of a number of major manufacturing plants, including site visits and personal interviews where possible. The production process used, the wastes produced, and the treatment and disposal methods utilized will be investigated. 3. A completion and evaluation of the information obtained from the literature, site visits, industry reports, agency reports, research projects, and other sources. 4. The development of recommendations on the type of research needed in this area. 5. The development of a complete and comprehensive bibliography on pesticide wastes and waste treatment.

This project was to begin July 1, 1970 and terminate June 30, 1971.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0987, THE EFFECT OF PESTICIDES ON AN ECOSYSTEM

H.G. APPLEGATE, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX04001)

OBJECTIVE: At Presidio, Texas, to follow changes in pesticide concentration in soil, water, bird, reptile, and animal tissue,

human urine and vegetation for a 3 year period; determine changes in water and soil biota as functions of the physical and chemical environments; compare species and populations of native organisms living in an area heavily treated with pesticides with those from a similar area not treated with pesticides.

APPROACH: Samples of various organisms, soil, water and air will be extracted and studied for pesticides. The pesticide concentrations will be studied in three dimensional space and correlated with time and site of application.

PROGRESS: Previous work indicated that soil temperature, soil alkalinaty and ultra-violet radiation were instrumental in breaking down DDT at Presidio. Laboratory data indicate that of the three factors ultra-violet radiation is the most important and soil alkalinaty the least important. The high incidence of male C tesselatus has been related to high DDT concentrations. It appears as though DDT biochemically resembles steriod hormones. Methyl parathion appears to be immobile once it reaches the brain of mammals. Preliminary data indicates a linkage between methyl parathion concentrations in the brain and motor behavior.

SUPPORTED BY Texas State Government - Austin

4.0988, PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES AND ENVIRONMENTS

F.W. PLAPP, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX02731)

OBJECTIVE: Perform fundamental methodology studies concerned with state residue programs. Participate in referee sample exchange involving regional problems. Conduct fundamental studies on the fate of pesticides in plants, animals and soils. Determine rates of disappearance of pesticide residues from agricultural commodities and environments.

APPROACH: Methods appropriate for the determination of residues under Texas conditions will be developed. This involves work on sampling, extraction, and clean up to selected research samples prior to analysis. Research will be conducted on the fate of pesticides in insect species of major importance in Texas with particular reference to lepidopterous species attacking cotton. This work will involve assays and comparisions of insect populations from different areas of the state. Persistence of residues of important pesticides in the environment will be measured by appropriate analytical techniques.

PROGRESS: Investigations were undertaken on insecticide resistance, particularly resistance to the organophosphates methyl parathion and Azodrin, in Heliothis virescens as compared with the more susceptible H. Zea. C experiments showed a greater conversion of toxicants to watersolubles in virescens and that the reaction was of the NADPH-dependent type. Attempts to block the reaction by synergists have been unsuccessful, but substitute organophosphate insecticides, not detoxified by NADPH-dependent reactions have been found which block resistance. In house flies, induction of detoxifying enzymes as a consequence of exposure of insects to chlorinated insecticides is being investigated. Other work involves measurement of pesticide residues in water and animals of the Brazos River system.

SUPPORTED BY U.S. Dept. of Agriculture

4.0989, AGRICULTURAL CHEMICAL RESIDUES IN PLANT AND ANIMAL PRODUCTS

E.L. WISMAN, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0626105)

Objective: Determination of residues and their metabolites in agricultural commodities and in their environment.

Approach: The effects of certain chemicals on market quality factors (egg shell thickness, albumin quality as measured by Haugh units, yolk color), and chemical residues in market eggs when the chemicals are fed in the diet in graded levels, will be evaluated. The chemicals to be tested are planned to include DDT, Sevin, Malathion, Diazinon, Heptachlor, Chlordane and ethylene dibromide. Test chemicals drugs that are used directly in poultry rations or in the environment.

Progress: This project is being reassigned from S-22 to S-73. Continuous feeding of Sevin up to 50 ppm fro 28 days resulted in egg residues. Up to 1000 ppm level caused slight egg residues but they disappeared upon immediate withdrawal of the pesticide from the feed. Continuous feeding of Diazinon up to 50 ppm for 28 days resluted in no egg residue. Beyond this level, feed consumption ceased indicating a palatibility factor. Following withdrawal of Heptachlor after 49 days of continuous feeding at 1.0 ppm, egg residues were detectable until 31 weeks later. Supracide (GS 13005), an organophosphate, left no residue in egg yolk when fed to hens at a 10 ppm for 30 days. At 100 ppm, small residue appeared but quickly disappeared once the dietary source was withdrawn. At 500 ppm, feed consumption and egg production were reduced. The level of any environmental contamination would never be expected to exceed 1 ppm.

SUPPORTED BY U.S. Dept. of Agriculture

4.0990, AGRICULTURAL CHEMICAL RESIDUES IN PLANT AND ANIMAL PRODUCTS

R.W. YOUNG, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0626103)

Objective: Development, adaptation and standardization of chemical, instrumental and biological methods of residue analysis. Investigate behavior of chemicals as related to residues in agricultural commodities. Determine residues and their metabolites in agricultural commodities in their environment.

Approach: Persistent data from promising new pesticide introductions and others will be tested on vegetables. The effect of temperature and light intensity on pesticide residues will be studied. Improvements of analytical methods will be made. Collaborative work with the Tennessee Experiment Station and the Virginia Truck Experiment Station will be continued on the study of 5 clean-up procedures for collards with DDT at lower levels of pesticides and the effect of cooking upon pesticide residues.

Progress: Residue studies on the uptake of DDT and dieldrin in peanuts and turnip greens and their persistence in the soil was completed and prepared for publication. A collaborative project with the Florida Laboratory, studying the effects of plant oil (as a contaminant of the sample) on the sensitivity of the detectors and columns, is in progress. The detectors included are electron capture and microcoulometric. Columns with and without prior use are being tested to determine if these factors may effect the stability of the columns injected with oil contaminanted samples. The two columns being used are 10% Dow 200/500 on 50/60 mesh Chromosorb p and 4% SE - 30 plus 60% QF 1 and 80/100 mesh Chromosorb Q. The detectable level of dieldrin (contaminated samples) was depressed on one column and one detector. Further studies are in progress. We have found that the rate of pesticide breakdown is faster in the coastal area of Virginia than in the mountain area. Studies are in progress to improve the Sevin method and to determine the persistence of Sevin in eggs from hens fed the pesticides. The persistence of GS 13005 in hens and feed has been determined, a method developed, and papers submitted for publication. Cooperative projects on the movement of 2-4-D and picloram in trees are in progress with the plant pathology department. Further persistence studies on residues in apple orchard soils are in progress in cooperation with horticulture.

SUPPORTED BY U.S. Dept. of Agriculture

4.0991, NUTRITIONAL INTERACTION BETWEEN UREA AND APPLE POMACE RELATED TO REPRODUCTIVE FAILURE

K.P. BOVARD, U.S. Dept. of Agriculture, Animal Science Research Div., *Front Royal, Virginia* 22630 (0330055221349)

OBJECTIVE: Determine if a biological interaction occurs between urea and the pesticide residues or ether extract portion of apple pomace within pregnant beef cows to cause abortions and/or malformed fetuses.

APPROACH: At the Beef Cattle Research Station, Front Royal, Virginia, pregnant beef cows will be used in a factorially designed experiment to study the effects of pesticide residues, urea and oil when added to a low protein diet other than apple pomace. Primary measurements to be taken concern survival or health of the calves produced when cows are exposed to these materials. Physiological aspects of these treatments will be considered under CRIS Unit 055-1.

PROGRESS: Forty-eight pregnant cows were placed in 8 lots and fed diets to determine the influence of starch vs. soybean oil, urea vs. cottonseed meal and pesticides vs. no pesticides on reproductive performance. Results indicate that cows fed urea required longer eating times, had lighter calves (6 lb. average) at birth and lost considerably more weight during the study than did cows fed cottonseed meal. Adding pesticides to the urea treatment seemed to intensify these results. No stillborn or abnormal calves were observed in this study.

SUPPORTED BY U.S. Dept. of Agriculture

4.0992, RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT
K. GROVES, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01634)

OBJECTIVE: The metabolism of pesticide residues by plants and microorganisms as factors in modifying residue levels in food chains and in the environment.

APPROACH: Soils will be incubated with chloro-phenyl type pesticides, including DDT for periods of time to enrich them in microorganisms capable of utilizing them as substrates. Carbon-14 labeled pesticides will be added, and labeled metabolic products separated by thin-layer chromatography and scanning. Chlorine-36 labeled dichloran will be used to investigate chlorine carbon bond metabolism.

PROGRESS: DCNA (Botran (R)) disappearance from onion field soil, and the evolution of C-14 labeled carbon dioxide from the soil after application of labeled DCNA suggest microbiological destruction. No labeled carbon dioxide evolved from steam or chemically sterilized soil. Destructive activity of the soil increased by incubation with applied DCNA. Three of the six labeled carbon atoms of DCNA were evolved. Combustion of evolved gases gave same ratio. Non-volatile portion not identified. Cultures of two segregated unidentified organisms decomposed DCNA. Persistence of DCNA may be increased when applied to soil previously treated with chloropicrin or a mixture of methyl bromide and chloropicrin. Residual bromine, as determined by neutron activation analysis, was higher in soils treated with methyl bromide-chloropicrin mixture than with methyl bromide alone even though the latter was applied at higher rates. Further investigation is planned. Sodium arsenite field studies continued as described in 1967. No evidence of phytotoxicity to potatoes after four annual applications. Analyses of potatoes, soil, and irrigation run-off water are pending.

SUPPORTED BY U.S. Dept. of Agriculture

4.0993, NORTHWEST TREE FRUIT INSECTS
H.R. MOFFITT, U.S. Dept. of Agriculture, Entomology Research Division, *Wenatchee, Washington* 98801 (00ENTB0802500700)

OBJECTIVE: Development of chemical, biological, and other non- chemical methods for control of insect and mite pests that attact deciduous fruits.

APPROACH: Screen and evaluate miticides and biologically active chemicals that may affect reproduction or metabolism in mite and insect pests. Evaluate and determine the nature of resistance to insecticides in codling moth, pear psylla, and McDaniel mite. Develop strains of natural enemies of insect pests of deciduous fruits better able to resist insecticides. Develop integrated control programs that will prevent economic injury by the pests through at least partial employment of biological methods and greatly reduce or minimize contamination by persistent residue and other problems associated with insecticide usage.

PROGRESS: A study of mite populations in an orchard treated with insecticides for codling moth control and in one in which sterile codling moth males were released for codling moth control showed that the mite populations peaked about 3 weeks earlier in the release orchard than in the sprayed orchard. Data from sampling mite populations indicated that P. ulmi and A. schlectendali were present in low numbers, rarely averaging over one mite per leaf. Z. mali was not encountered in any of the samples. T. mcdanieli and T occidentalis were the only mites present in appreciable numbers which reached a maximum number of about 67 adults per leaf. Economic damage was not determined. Codling moths irradiated as adults with 25 or 40 krad were more tolerant to azinphosmethyl, carbaryl, and p.p.'DDT than untreated moths. Females were 1.4 to 1.6 times more tolerant and males were up to 1.5 times more tolerant to the insecticides than their untreated counterparts.

SUPPORTED BY U.S. Dept. of Agriculture

4.0994, PESTICIDE RESIDUE INVESTIGATIONS, YAKIMA
L.M. MCDONOUGH, U.S. Dept. of Agriculture, Entomology Research Division, *Yakima, Washington* 98902 (00ENTM0304500800)

OBJECTIVE: Determine the amount, persistence, and fate of residues of new insect control chemicals and their metabolites or breakdown products in agricultural crops of the Pacific Northwest, soils, animal products, and wildlife.

APPROACH: Obtain information through analysis on rate of deposition, distribution, persistence, and fate in plants, animals including wildlife, and soils of residues of chemicals applied for insect control and of their metabolites and breakdown products. Analyze pesticide formulations to be used in experiments on control of insects attacking fruits and vegetables.

PROGRESS: During the past year 526 analyses were completed. The analyzed samples included alfalfa, mint hay, oranges, lemons, soil, potatoes, tomatoes, tomato foliage, lettuce, and cucumbers. The pesticides determined included aldicarb and toxic metabolites, parathion and paraoxon, DDT and metabolites, malathion, and carbofuran and toxic metabolites.

SUPPORTED BY U.S. Dept. of Agriculture

4.0995, EFFECTS OF BIOCIDES ON PROPERTIES OF NURSERY STOCK
J.R. BOYLE, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01438)

OBJECTIVE: Evaluation of effects of eradicant treatments on biological and chemical aspects of soil fertility and the development of nursery stock.

APPROACH: Chemical and microbiological analyses of soils treated with various biocides, particularly Mylone, Dacthal, and Vapam. Morpho- anatomical and physiological analyses of nursery stock produced in the presence of different agricultural chemicals. Bioassays. Determination of degradation products and residual accumulation of eradicants. Determination of mycorrhiza formation and structure compared to untreated and naturally reproduced seedlings.

PROGRESS: Prolonged use of biocidic fumigants of methyl bromide type has resulted in suppression of symbiotic fungi, nodule bacteria, and extra-matrical chelating organisms. The subsequent disruption of the symbiotrophy of tree seedlings in some instances rendered planting stock of unsatisfactory growth potential. Restoration of the productive capacity of biocide-treated soils was achieved by the use of certain types of forest humus incorporated with the soil or applied in the form of fertilizer-reinforced suspensions. The costly collection of humus debris dictates introduction of less expensive carriers of humate suspensions harboring beneficial microorganisms, viz., fermented sawdust, tree bark, and sedge or wood peat. The amelioration requires certain adjustment of both composted carriers and inoculating humate suspensions. Promising results were also obtained by foliar sprays of nursery stock with ammonium phosphate and by periodic applications of weak solutions of allyl alcohol; the latter encourages invasion of Trichoderma spp., fungi augmenting availability of phosphorus.

SUPPORTED BY Wisconsin State Government - Madison

4.0996, SWEET CLOVER TOXICITY AND CHEMICAL AND PHYSIOLOGICAL STUDIES ON DICUMAROL AND WARFARIN
K.P. LINK, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS00850)

Warfarin and its metabolites are excreted by the rat in urine (2/3 of the dose) and feces (1/3 of the dose). For metabolic fate

studies in rats, 1 mg i.j. doses of 4- C warfarin sodium were administered weekly. Urine and feces were collected and frozen daily during the seven days following dosing. All of the urinary radioactivity was extracted and identified, using ether extraction, chromatographic (paper and thin-layer) and inverse isotope dilution techniques. The urinary metabolites were unchanged warfarin (6.6% of urinary radioactivity) several hydroxylated warfarin derivatives: 7- hydroxywarfarin (35%), 4- hydroxywarfarin (21%), 6-hydroxywarfarin (15.4%), 8-hydroxywarfarin (8.9%), a glucuronide of 7-hydroxywarfarin (6%) and an intramolecular condensation product: 2,3-dihydro-2-methyl-4- phenyl-5-oxo-gamma-pyrano (3,2-C) (1) benzo pyran (6.6%). Chromatographic data indicated the presence of these metabolites in feces but in different relative amounts than in urine.

SUPPORTED BY Wisconsin State Government - Madison

4.0997, EFFECTS OF PESTICIDES USED IN DAIRY INDUSTRY

D.D. DEANE, Univ. of Wyoming, Agricultural Experiment Sta., *Laramie, Wyoming* 82071 (WYO00930)

Objective: Determine the minimum concentration of various insecticides required to affect the growth of microorganisms used in the manufacture of dairy products. Determine the effect of such toxic levels of insecticide upon the growth characteristics of pure cultures of the organisms studied.

Approach: The effect of various levels of insecticide upon the growth of pure cultures of representative strains of the microorganisms used in the manufacture of dairy products will be studied. Growth characteristics including rate of growth, total population, rate of acid production and cell morphology will be studied. The insecticides studied will be representative of those used by the dairy industry.

Progress: Lactic cultures showed a varied growth response to presence of insecticides depending upon insecticide added, concentration, number of culture transfer and culture strain. Neither malathion nor trichlorfon at 100 ppm affected acid production by Streptococcus lactis, Streptococcus cremoris, Streptococcus diacetilactis or Lactobacillus bulgarious. Greatest effect was on morphology. L. casei (Wisc.) formed longer chains of cells after 15 to 20 transfers in milk to which 100 ppm malathion had been added prior to sterilization. A lesser effect was noted with 500 ppm trichlorfon. Morphology appeared normal following subsequent transfers in insecticide-free milk. Five other strains of L. casei failed to exhibit as consistent a change in morphology. Two of seven strains of S. thermophilus showed variation in cell size after several transfers in milk to which 100 ppm malathion or 500 ppm trichlorfon had been added prior to sterilization. Adding the insecticide as an alcoholic solution to the milk following sterilization did not increase effect of the pesticides. Carbohydrate fermentation patterns were not affected by culturing the organisms in presence of the two insecticides used. The effect noted following growth of the lactic organism in presence of these two insecticides was morphological. Degree of change produced depended upon species and strain of organism tested and the level of insecticides required was above that previously found in milk.

SUPPORTED BY U.S. Dept. of Agriculture

4.0998, UPTAKE OF MERCURY BY PLANTS AND ITS DISTRIBUTION IN LIVING ORGANISMS IN AN ENVIRONMENT WITH INCREASED CONCENTRATION OF THIS ELEMENT

L. KOSTA, Inst. Jozef Stefan Nuklearne, *Ljubljana, Yugoslavia*

The studies proceedings on the uptake, distribution and body burdens of plants, animals and human subjects will be continued, with increased stress on the latter.

The intake, distribution and excretion of mercury in certain subjects will be measured, and methods for the identification of some metabolites by TLC, GLC and disc electrophoresis developed. Special attention will be paid to possible transformation processes of inorganic to organomercury compounds in vivo for some organisms.

Results will be compared for the Idrija area with some obtained from an area contaminated by organomercurial pesticides and another area with a naturally high soil mercury content but no atmospheric contamination. Experimens will be made with animals (fish and/or rabbits) to investigate whether local Idrija varieties have developed resistance to high mercury levels (e g. by natural selection) compared to animals from uncontaminated areas.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

F. ANALYSIS, MONITORING, AND INSTRUMENTATION

Residue Analysis, Long-term Monitoring, Or Pesticide Detection Techniques and Instrumentation.

4.0999, RADIOTRACER STUDIES ON THE MECHANISM OF INSECTICIDAL TOXICITY

J.E. CASIDA, Univ. of California, School of Agriculture, *Berkeley, California* 94720 (AT(04-3)34,0113)

The studies generate information needed on metabolism, photodegradation, biochemistry, fate, and mode of action of important insecticide chemicals to evaluate conditions for their safe and efficient use. They concern 1) degradation and mode of action of pyrethroids, rotenone, ubiquinone, certain esterase inhibitors, synergists, phosphorylation uncouplers, and certain juvenoids, 2) binding sites of rotenone, ubiquinone, and piericidin A in the respiratory chain components, 3) biochemistry of induction of abnormal chicken embryos, 4) biochemical genetics of resistance in house flies, 5) sensitization of photoalteration of insecticide residues, 6) mechanism of oxon formation from organophosphorothionate compounds, 7) degradation and mode of action of new insecticide chemicals, and 8) factors that control the selectivity and persistence of insecticide chemicals. An important aspect of these studies and, frequently, the critical factor is the synthesis of radiolabeled insecticide chemicals, of high stereochemical and radiochemical purities, with high specific activity for use in analytical and characterization studies.

Results: Much is now known about the metabolism and biochemistry behavior of esterase-inhibiting compounds, rotenone, pyrethroids, methylenedioxyphenyl synergists, and certain respiratory uncouplers in mammals and insects, but, except for carbamates, there is a paucity of such data in plants. There is a better understanding of the binding of rotenone, piericidin A, and ubiquinone in submitochondrial particles, of factors involved in resistance and in the biochemical genetics of resistance, of the photoalteration of insecticide chemicals on plants, of the mechanism of oxon formation by organophosphorothionate compounds, and of the metabolism of esterase inhibitors by mixed-function oxidases.

SUPPORTED BY U.S. Atomic Energy Commission

4.1000, SYSTEMS APPROACH TO CONTROLLING PESTICIDE CONTAMINATION OF SAN JOAQUIN VALLEY

W.W. KILGORE, Univ. of California, School of Agriculture, *Davis, California* 95616

The long-term objective of the San Joaquin Valley Project is to develop a body of knowledge to help minimize the environmental contamination attendant upon continued large-scale use of pesticides in this heavily cultivated valley.

The San Joaquin Valley, the southern part of the central valley of California, is ringed on three sides by mountains and is drained by the San Joaquin river and its tributaries to the north, then westward into San Francisco Bay. Within this partially enclosed system lies one-third of California's farmland, including the most extensive area of irrigated land in the U. S. About a fifth of America's table food is grown here, but a part of this high productivity of vegetables and other crop is achieved through the annual application of one-seven of the pesticides used in the U. S.

This grant is for a one-year planning project that will (1) establish a computerized data bank with the detailed information on past and current pesticide use, (2) plan for investigations of the incorporation of these toxic compounds into the biota, and the degradation of these compounds left in the inorganic environment, and (3) begin the simulation modelling of the dispersal and fate of the pesticides.

SUPPORTED BY U.S. National Science Foundation

4.1001, THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS
W.W. KILGORE, Univ. of California, School of Agriculture, *Davis, California* 95616

This is a program project concerned with the chemistry and toxicology of selected agricultural chemicals. The program is broad in scope, encompassing not only a number of specific research projects, but also a program planning and coordination activity. The activities of the Director's Office involve the planning, activation and coordination of research and training projects related to the mission of the Food Protection and Toxicology Center.

All research projects relate to the Chemistry and Toxicology of Agricultural Chemicals. They are categorized under three general headings: 1) Analytical Methods and Instrumentation, 2) Biological Manifestations of Toxicity, and 3) Environmental Fate of Pesticides and their Effects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.1002, ENVIRONMENTAL DECONTAMINATION, ESPECIALLY FOR FEEDSTUFFS AND ASSOCIATED FOODS
G.F. STEWART, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D0-ETX-2301-RR)

OBJECTIVE: Environmental decontamination of pesticides in relation to animal feeds and associated human foods, and ecological contamination; basic knowledge for removal or conversion to innocuous products of pesticides by treatment with chemical, physical or combination of both procedures.

APPROACH: Research will be directed toward the pesticides most likely to present problems in the more important feedstuffs and associated foods. Samples will be studied physically to determine possibility of surface or internal contamination. Volatile substances will be detected by gas-liquid and thin-layer chromatography; non- volatile substances may require hydrolysis to release the residue from the polysaccharides, glycols, protein, etc., prior to extraction and cleanup for quantitative analysis. Quantitative analysis will involve separation of parent compounds and their breakdown products. Emphasis will be placed on the search for the quantitation of each major contaminant or breakdown product.

PROGRESS: Green alfalfa, sprayed in the laboratory with large concentrations of DDT 2,2 bis(p-chlorophenyl)-1,1,1-trichloroethane , was air dried in the dark, dried in sunlight, and dried under ultraviolet lamps at 2537 A to observe the effects of these treatments on the pesticide stability. Gas-liquid chromatography (GLC) and thin- layer chromatography (TLC) procedures were employed routinely, either separately or in combination. No changes occurred to the DDT in the dark treatment, excpet 49% of the original residue was lost by the eighth day of the drying process and no further loss was observed during the 11th day of the experiment. On the fourth day of the ultraviolet lamp treatment DDD 2,2-bis(p-chlorophenyl)-1-1-dichloroethane was formed from the DDT, but no change occurred with the DDE 2,2,-bis)p- cholorophenyl)-1,1-dichloroethylene present, and a maximum of 67% of the total original residue was lost by the sixth day during the eleven day drying process. On the sixth day of the sunlight treatment, DDD was found from the DDT, but no change occurred with the DDE present, and a maximum of 72% of the total original residue was lost by the eleventh day of the drying porcess.

SUPPORTED BY U.S. Dept. of Agriculture

4.1003, RESIDUES AND BREAKDOWN PRODUCTS OF CHEMICAL FUNGICIDES IN PECAN NUTS
A.A. PIRINGER, Stanford Research Institute, *Menlo Park, California* 94025 (0860-05-19(C))

OBJECTIVE: Determine the extent to which residues of the fungicides, duter, dodine, and zineb, enter the pecan nut as a result of applying these compounds for scab control, and determine whether residues of these chemicals persist in orchard-floor vegetation.

APPROACH: Initially, methods will be developed to detect the fungicides and their breakdown products in pecan nuts and in the vegetation under treated trees. The analytical methods used will range from classical chemical methods for extraction of the tin and zinc of duter and zineb, respectively, to modern methods of selective organic analyses for the organic compounds and fragments of the fungicides. After suitable methods of analysis have been developed, the USDA will provide the Stanford Research Institute with appropriate samples of pecan nuts and orchard-floor plants from trees and orchards having known fungicide application histories. The developed analytical methods will be used to determine the amounts and distribution of dodine, duter, and zineb and their breakdown products in the pecan kernels and the orchard- floor plants.

PROGRESS: Pecan kernel and cover crop samples with known fungicide spray histories are being analyzed. Methods of analysis for residues of dodine and duter in pecan kernels have been developed. The method for dodine is based on a procedure described by Steller, et al. (J.Agr.Food Chem.,8,1960). Dodine is extracted from the sample and the extract is purified. The purified extract is treated with bromocresol purple which forms a complex with dodine. The concentration of dodine is determined by measuring the concentration of bromocresol purple that is liberated from the complex. The optical absorbance is measured at 590 millimicrons. A new method of analysis for residues of duter based on polarography was developed in this study. The duter residue is extracted into petroleum ether, then into dimethyl sulfoxide and finally into methylene chloride. The methylene chloride is evaporated off and the residue is oxidized with sulfuric, nitric and perchloric acids. The resulting inorganic tin is measured with single-sweep polarograph.

SUPPORTED BY U.S. Dept. of Agriculture

4.1004, ANALYTICAL METHODS FOR INSECTICIDES AND ACARICIDES AS RESIDUE METHODS AND AS COMPOSITION METHODS
F.A. GUNTHER, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-1576)

OBJECTIVE: Develop and apply microanalytical methods for residues of pesticide chemicals persisting in foodstuffs.

APPROACH: Residue evaluation of the new compounds dimethoate and 'OW-9' on a variety of crops, and the occurrence of carcinogenic polynuclear aromatic compounds in citrus tissues from both preharvest and postharvest applications of petroleum derived substances in the production and marketing of citrus fruits.

PROGRESS: Methods of analysis for residues of Plictran, Omite, phosalone, Torak, and Temik were checked for use on citrus fruits, modified where necessary and used for residue persistence studies for these insecticides and acaricides in and on oranges and lemons. Substantial progress has been made on an improved procedure for determining residues of Plictran. Procedures for determining residues of the insecticide Dursban in aquatic life and habitat were developed to aid research on the use of this compound as a mosquito larvacide. The methods developed were used to analyze samples of vegetation, mud, water, fish, ducks, crustaceae and insects. A method for determining residues of Ciodrin insecticide in animal tissues and milk, utilizing oscillographic polarography, was developed and published. During this investigation, an excellant gas chromatographic procedure was also found that may prove useful when polarographic equipment is not available. Research is under way to develop a more rapid and dependable procedure for determining residues of organochlorine pesticides in meat, utilizing the microcoulometric gas chromatograph as the detection method. The need for improved methods for this purpose is particularly critical because of the general occurrence of organochlorine residues in meat and the resulting tremendous analytical load for regulatory agencies throughout the world.

4. PESTICIDES

SUPPORTED BY California State Government - Sacramento

4.1005, AUTOMATED ANALYSIS OF PESTICIDE RESIDUES

F.A. GUNTHER, Univ. of California, School of Agriculture, *Riverside, California* 92502

Automated pesticide residue determinative methods suitable for food, soil, and water monitoring purposes have been developed for pesticides that contain Cl, P, S, and for those that are ChE inhibitors. Automated general and specific cleanup methods are under development, and some specific residue methods have been developed in conjunction with the thus far successful cleanup unit operations. Automated methods for the extraction of soil and water samples are under development.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.1006, PESTICIDES AND WILDLIFE

M.S. MULLA, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2131)

OBJECTIVE: Study the relationship of insecticides to wildlife species. Develop specific public health insect control measures in wildlife habitats, with the hope to eliminate or diminish hazards to non- target species.

APPROACH: The productivity, food chain relationships and biological characteristics of predominant components of the ecosystem will be investigated. Degradation and detoxification avenues and mechanisms in a variety of habitats and organisms will be elucidated. Residues of insecticides in water, surface and sub-soil strata, aquatic vegetation and non-target organisms, by means of gas chromatography. Colorimetric procedures and other appropriate analytical methods will be studied. The biological and toxicological effects of insecticidal treatments influencing animal populations in the treated area will be investigated will be investigated.

PROGRESS: Residue analytical methods were developed and applied in a field project for Dursban that could accumulate in mud, water, aquatic plants, aquatic organisms, fish, ducks, and insects. Analytical methods were developed for reproductively determining. The true and apparent solubilities of organochlorine pesticides in very pure water and in 'soil water.' The utility of the forced volatilization technique for the cleanup of pesticide or residue-containing extractives was precisely evaluated for several organochlorine insecticides. Biological effects of Dursban an organophosphate larvicide was studied in a freshwater ecosystem. This material was highly toxic to Cladocera, less toxic to Copepods, but not toxic to rotifers.

SUPPORTED BY California State Government - Sacramento

4.1007, PHYSIOLOGY OF CITRUS FRUIT ABSCISSION

B.J. ROGERS, Univ. of California, U.S.D.A. Crops Research Div., *Riverside, California* 92507 (0840-04-16)

OBJECTIVE: Determine the physiological basis of abscission of citrus fruit and search for effective abscission chemicals for commercial use on fruit harvested for fresh fruit purposes.

APPROACH: Conduct basic studies on the nature of the biochemical changes in the abscission zone of citrus fruit following treatment with ethylene-producing chemicals and various growth regulators. Develop suitable laboratory test methods for potential abscission-inducing chemicals. Conduct field trials with the most promising chemicals to determine their commercial feasibility. Determine chemical residues on citrus following chemical treatment and determine the breakdown products of abscission chemicals.

PROGRESS: The effectiveness of cycloheximide as an abscission agent was studied for Valencia and navel oranges for inland (i.e., Riverside) conditions and for lemons, grapefruit, and Valencia oranges under desert conditions. Grapefruit appeared to be most sensitive. Abscission is controlled by tree growth stage, temperature, and humidity. Under inland winter conditions it is extremely difficult to induce abscission of navel oranges. Sensitivity of citrus fruit to ethylene was approached by studying the enzymology of abscisson of fruit on the tree and in the laboratory. Pectinase formation was selected for study, since on a priori grounds the enzyme appears necessary and sufficient for abscission. A method for extracting the enzyme from woody tissue was worked out. Increased synthesis of the enzyme is dependent on temperature and ethylene, and can be halted by appropriate inhibitors. Synthesis of the new enzyme is localized with respect to occurrence in the abscission zone. Preliminary results indicate that the formed enzyme is extremely labile and requires the continued presence of ethylene for formation. Divalent ions also have an effect.

SUPPORTED BY U.S. Dept. of Agriculture

4.1008, RADIOACTIVITY, PESTICIDE RESIDUES CONTENTS AND CONSTITUTION OF MILKS OF ARCTIC AND SUB-ARCTIC SPECIES

B.E. BAKER, Mcgill University, *Montreal, Quebec, Canada* (AT(30-1))

The aim of this investigation is to provide information on (a) the levels of Sr-90, Cs-137, and pesticide residues in the milks of Arctic and Sub-Arctic species and (b) the constitution of these milks. Attempts will be made to correlate the radioactivities of the milks with the eating habits and environmental conditions of the animals or humans. From the detailed study of the constitution of the milks it is hoped that the function of certain milk components can be explained. The methods and procedures that will be used will be those which are already in use in the study of bovine milk. Milk has been collected from the following mammals in the Northwest Territories and Yukon (Canada), Alaska (U.S.A.) and Lapland (Finland) - polar bears, grizzly bears, wild sheep and goats, wolves, huskies, muskox, hare, caribou, reindeer, whales, seals, moose and humans. Samples of milk are being sent to us continuously by scientists from the following institutions: - Wildlife Service, Dept. of Indian Affairs and Northern Development, Canada (Yukon and Northwest Territories); Dept. of Fish and Game, State of Alaska; Dept. of Health, Education and Welfare, Public Health Service, Alaska; University of Alaska; University of Helsinki, Finland; and Hankkija Company Helsinki, Finland.

SUPPORTED BY U.S. Atomic Energy Commission

4.1009, DETERMINATION OF PESTICIDES IN BIOLOGICAL AND ENVIRONMENTAL SPECIMENS

W.H. ROBINSON, U.S. Dept. of the Interior, Bureau of Sport Fish. & Wlife., *Denver, Colorado* 80225

Objectives: To supply analytical services to all Pesticide Wildlife study projects, Division of Wildlife Services operational personnel, other federal, state and local governmental agencies requiring limited amounts of analytical services.

Procedures: The major portion of the work performed in this segment of the project involves: (1) paper, thin-layer, column and gas chromatography, (2) conventional 'wet' methods, (3) standard bioassay procedures, (4) infrared, ultraviolet, emission and atomic absorption spectroscopy, (5) Colorimetric and other methods as required.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1010, INDUCED PHOTOLYSIS OF ORGANIC HALIDES PATHWAYS FOR PHOTODECOMPOSITION OF DDT

L.L. MILLER, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00048)

OBJECTIVE: The feasibility of inducing the photochemical decomposition of organic halides will be investigated. The induced photochemical decomposition of DDT will receive special attention.

APPROACH: Photolyses at wavelengths 0 3000 A will be undertaken with a variety of representative donors in a brief screening process to discover what sort of structural characteristics are necessary for induced decomposition. A more intensive study of those donors which are most effective will involve isolation and characterization of the photoproducts and elucidation of the reaction mechanism. The products and pathways of induced DDT photolysis will also be investigated.

PROGRESS: The induced photolysis of DDT has been investigated. Irradiation of DDT in cyclohexane solution at 3100 A gives no reaction. Addition of suitable inducers, however, dehalogenates DDT forming up to 2 equivalents of HCl/equivalent of DDT initially present. Products identified are DDD, DDCO and DDE. Two requirements for the inducer are 1) Adsorption of solar light, e. g. 3000 A; 2) A low ionization potential.

SUPPORTED BY Colorado State Government

4.1011, COLLABORATIVE STUDIES OF ANALYTICAL METHODS

M. FUZESI, Conn. Agric. Expt. Station, *New Haven, Connecticut* 06504 (CONH00108)

OBJECTIVE: Study analytical methods in the areas of feeds, fertilizers, foods and pesticides and to check the performance of this laboratory as compared with other laboratories doing similar works.

APPROACH: Collaborative samples furnished by the A.O.A.C. and other organizations are analyzed. The results are compared with results obtained by other laboratories.

PROGRESS: Study of published methods and devising of new methods for the analysis of foods, drugs, cosmetics, feeds, fertilizers, pesticides, and plant materials. Messrs. Keirstead, Mueller, Squires, Wickroski and Mrs. Fusezi have served as collaborators in A.O.A.C. and other studies of methods in the feed, fertilizer, food, pesticide and residue areas.

SUPPORTED BY Connecticut State Government

4.1012, CHEMICAL CONTROL OF WEEDS IN NURSERY AND TURF PLANTINGS

I.F. AHRENS, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONH00604)

OBJECTIVE: Evaluate single and repeated pre-emergence treatments of nursery plants and turf, determine persistence of herbicides in soil, investigate factors affecting response of nursery plants to herbicides, determine need for cultivation and investigate control of Poa annua, quackgrass and nutgrass in turf and nurseries.

APPROACH: Apply herbicides in single and double dosages on transplanted nursery crops (replicated plots). Determine growth of new plants. Assay soil for persistence of residues. Studies will be made on turf. Determine interactions of rate of fertilization, rate of application and type of herbicide on phytotoxicity to nursery plants. Determine need for cultivation in nurseries treated for weed control. Study life history of Poa annua, and test herbicides on it and on quackgrass and nutgrass in nurseries.

PROGRESS: The effect of dichlobenil on assimilation and transport was studied in peach seedlings. At levels of 1-1/2 ppm or higher in a sand-peat mix, dichlobenil inhibited root and shoot growth. At 12 or 18 days after planting, fixation of C O(2) by peach leaves was depressed by dichlobenil in the root zone. At 32 or 49 days, leaves of dichlobenil- treated plants fixed about as much C O(2) per unit leaf weight as untreated plants. Transport of C - labelled assimilates was depressed by dichlobenil after 12 days but later on slightly greater percentages of labelled assimilates were transported from leaves to roots of dichlobenil treated plants than untreated plants. In Douglas fir seedlings, dichlobenil incorporated into the soil was phytotoxic to roots at 2 ppm and to lower stems (transition zone) at about 4 ppm, the lowest concentrations used. Leaching of herbicides was studied in container-grown plants, using bioassay techniques to indicated depth of phytotoxic residues. Trifluralin, nitralin and DCPA remained in the upper inch of a sand-peat mix after 2 months of daily irrigation. Dichlobenil leached 3 to 4 inches down; simazine leached to intermediate depths.

SUPPORTED BY U.S. Dept. of Agriculture

4.1013, ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY

J. BINIEK, U.S. Dept. of Agriculture, Natural Resource Econ. Div., *Washington, District of Columbia* 20250 (NRE)

OBJECTIVE: Develop economic information and techniques of analysis for determining national compromises between production efficiency and adverse monetary and non-monetary effects arising from deterioration of resources quality.

APPROACH: Formal and informal cooperative relations are established with other research and action agencies to exchange information and data. Physical and economic research and information is reviewed and analyzed to determine the severity of specific pollution problems. Conceptual and qualitative studies are undertaken to improve analytical techniques for appraisal of adverse impact situations. Alternative poliution control systems are analyzed with the intent of selecting an optimum control system for policy decisions. Initial attention is given to adverse effects from chemical pesticides and animal waste.

PROGRESS: Preliminary investigations of animal waste and sedimentation problems were continued. A paper was presented at the Cornell Agricultural Waste Management Conference, January 10-13, 1969. The paper stressed the role of economics in merging the alleged conflicting goals of environmental quality and production efficiency. Contribution was also made to a paper presented at the Seminar 'Modifying the Soil and Water Environment for Approaching the Agricultural Potential of the Great Plains,' March 17-19, 1969 at Kansas State University. The paper identifies changes in livestock numbers, feedlot size and erosion as emerging problems of environmental quality.

SUPPORTED BY U.S. Dept. of Agriculture

4.1014, PESTICIDE MONITORING PROGRAM

P.A. BUTLER, U.S. Environ. Protection Agcy., Office of Res. & Monitoring, *Gulf Breeze, Florida* 32561

Cooperative program involving 15 private, state and federal laboratories who collect duplicate samples of mollusks from approximately 175 estuarine stations on Atlantic, Gulf and Pacific coasts at monthly intervals. Program initiated 1965, proposed to continue until 1969; 1500 analyses completed September 1965. Samples are sent to the Gulf Breeze Laboratory for pesticide residue analysis. Eastern oyster is chief bioassay animal, also used Mya arenaria, Mercenaria mercenaria, Ostrea luria, Crassostrea gigas and some fish species. Each sample is screened for Aldrin, BHC, Dieldrin, DDD, DDE, DDT, Endrin, Heptachlor, Heptachlor epoxide, Lindane and Methoxychlor. Analyses are made with electron capture gas-liquid chromatography techniques.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

4.1015, CHEMICAL ANALYSES

A.J. WILSON, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Sabine Island, Florida* 32561

In order to evaluate data now being obtained by a nationwide surveillance of organochlorine pesticide pollution in estuaries, studies are in progress to determine rates of uptake and the metabolism of these pollutants in marine species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

4.1016, DDT RESIDUES IN EGGS AND BODY TISSUES OF HENS

K.N. MAY, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (032901870111)

OBJECTIVE: Effect of forced molting and/or induced hyperthyroidism on elimination of DDT from eggs and tissues of hens contaminated with the pesticide.

APPROACH: DDT will be given to hens by capsule in amounts equivalent to .5, 1. and 5. ppm of feed intake. Some groups will be force molted by severe feed restriction and others will be fed thyroprotein. The DDT content of the tissues and eggs will be determined by gas chromotography to determine effect of treatments on elimination of residues.

PROGRESS: A study of the effect of forced molt of hens by feed restriction on rate of elimination of DDT from tissues and eggs showed that the residue in the fat of the molted hens did not decrease as fast as that in the nonmolted hens. The molted hens were using their stored fat and thereby concentrating the DDT in the remaining fat. The DDT content of eggs from the molted hens

was lower than that in the nonmolted hens when the hens first came into production. However, after one month of production the level of DDT residue in eggs from both groups was essentially the same.

SUPPORTED BY U.S. Dept. of Agriculture

4.1017, REDUCTION OF PESTICIDE RESIDUES ON FOOD AND FEED PRODUCTS

J.D. BROWN, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO00192)

OBJECTIVE: Estimate costs of alternative techniques for the commercial reduction of pesticide residues in food and feed products.

APPROACH: Data will be obtained from federal and state regulatory agencies, and supplemented where necessary by additional survey data. This information will be utilized to make estimates of the variability of pesticide residues among market size lots of selected food and feed products; the quantity of removal from market channels of such products to insure that no product exceeding specified levels of residue tolerance would reach the consumer; the cost to the public of the product removed in terms of value of the product; and the cost of any identification, reduction, or neutralization process in the market channel. Data from secondary sources on total supply and price of specific products will be used in estimating the total quantity and value of product removal at the specified levels of tolerance. Special emphasis will be given to peaches and leafy vegetable crops in the initial stages of the work.

PROGRESS: This study indicated the absence of pesticide residues above established tolerances at the retail level of the marketing channel. It also indicated that a greater proportion of the limited number of residue violations occurred at the farm level at or before harvest except in 1967. Such results do not preclude the continued need of monitoring our food supplies for possible pesticide residue contaminations. However, they are assurances of the relative safety of our food from pesticide residues. Research should continue in the development of possible techniques of removing residues from crops (such as collards and cabbage) at harvest in marketing channels, plus education of growers in selection and use of pesticides. Manuscript 'Pesticide Residue Levels Among Fresh Fruits and Vegetables in Georgia' in process.

SUPPORTED BY U.S. Dept. of Agriculture

4.1018, BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

W.S. HARDCASTLE, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO01016)

OBJECTIVE: Investigate the absorption, translocation, accumulation, and degredation of herbicides in plants. Determine the effects of herbicides on anatomical and morphological responses, seed germination and growth, and selected metabolic systems.

APPROACH: Radiolabeled samples of the selected herbicides will be used in determining their absorption, translocation, and accumulation by plants. Root absorption will be determined both by measuring the total radioactivity accumulating in the plant and by loss of radioactivity from the rooting media. Similar procedures will be used to determine the amounts of leaf absorption. Autoradiography will be used in determining the distribution of the herbicide in plants.

PROGRESS: Plant and soil arsenic analyses by neutron activation of arsenic were reproducibly quantitative at 10 ng arsenic and might be extended to as low as 3 ng arsenic with long counting periods. This method was tested on soil and cotton (Gossypium hirsutum L. var Atlas 67) leaves treated with repeated applications of monosodium methanearsonate (MSMA). Leaves from untreated plants contained 55 ng arsenic/g whereas leaves from treated plants showed higher levels of arsenic. Total petiolar fatty acid content of sicklepod (Cassia obtusifolia L.) treated with ethydipropylthiocarbamate (EPTC) was measured by gas-liquid chromatography. Neither total petiole fatty acid content nor percents of the various 53 identified constituents changed in relation to herbicide application. Isostearate (17.5%), stearate (5.7%), oleate (5.7%), linolate (9.8%), and arachidate (8.2%) accounted for 46.9% of total petiolar fatty acid content. Derivatives of C(15) to C(31) were identified and quantitated at concentrations of 0.25 to 2.00%. Studies of changes in metabolic processes by herbicides could lead to: altered desirable component concentration; decreased undesirable component concentration; and markedly altered plant response to concomitantly applied pesticides.

SUPPORTED BY U.S. Dept. of Agriculture

4.1019, INSECTICIDE RESIDUES FROM EXPERIMENTAL TREATMENTS TO PREVENT OR CONTROL INSECTS IN STORED PRODUCTS

H. LAUDANI, U.S. Dept. of Agriculture, Market Quality Research Div., *Savannah, Georgia* 31405 (SP62)

OBJECTIVE: Provide data on deposits and residues of insecticides which can be used to guide research, to correlate chemical with biological data, to indicate toxicological hazards, and to help establish FDA tolerances for pesticides.

APPROACH: Do chemical work for all other inhouse Work Units in Branch. Improve, adapt, or develop standard chemical procedures for extraction and determination of pesticides, as necessary for specialized problems. After method routine is established, analyze samples as provided from other Work Units. Accumulate and present chemical data for cooperating stations and agencies.

PROGRESS: A total of 7,085 samples was analyzed for insecticide residues in the past year. These samples originated within the Stored- Product Insects Research Branch from experimental treatments to prevent or control insects in various stored products. The percentage distribution of the stations submitting requests was: Savannah, Ga.-- 71.2; Manhattan, Kans.--19.3; Tifton, Ga.--7.7; Richmond, Va.--1.1; and Fresno, Calif.--0.8. The percentage distribution of the analyses was: piperonyl butoxide--61.4; dichlorvos--17.1; malathion--10.7; Gardona-- 5.4; Bay 77488--2.6; total chloride--1.0; total bromide--1.0; others-- 0.8.

SUPPORTED BY U.S. Dept. of Agriculture

4.1020, ANALYTICAL INVESTIGATIONS OF PESTICIDE RESIDUES, TIFTON

M.C. BOWMAN, Georgia Coastal Pl. Expt. Sta., *Tifton, Georgia* 31794 (00ENTM0302111300)

OBJECTIVE: Determine the amount, persistence, and fate of residues of new insect control chemicals in grain and forage crops, animals, and soils.

APPROACH: Determine analytically the amount, distribution, and rate of disappearance of residues of insect control chemicals and their metabolites or breakdown products in small grain and forage crops, silage, and animals fed these products, in the milk of these animals, and in soils. Analyze pesticide formulations to be used in experiments on insect control.

PROGRESS: The field persistence of phorate in treated corn and grass forages was determined by sampling at intervals of 0-28 days. Residue analyses showed almost immediate oxidation occurred, mostly to phorate sulfoxide. Total residues at the highest rate (2 lb./acre) fell to 1 ppm after 14 days in corn and 21 days in grass. Residues remained generally stable when corn was ensiled in glass jars 1 day after treatment and aged at 85 F 30 days. Field persistence tests with Velsicol VCS-506 were sampled over 0 to 42 days. At the highest rate (2 lb./acre) residues of VCS-506 fell from 132 to 5.3 ppm after 42 days. Residues of the O-analog peaked (0.58 ppm) after 1 day and disappeared after 35; phenolic residues peaked at 7 days (2.5 ppm) then fell to 1.3 ppm at 42 days. Accothion residues in silage were fed to dairy cows for 29 days. The maximum rate (100 ppm, dry) produced 35.6, 5.6, and 0.02 ppm of the amino analog in the urine, feces, and milk, respectively, but no Accothion, O-analog, or phenolic residue in any sample. Eight days after feeding ceased no residues were detected. Corn silage field- treated with Accothion was fed to dairy cows for 8 weeks. The sole residue in the milk was a trace (0.005 ppm) of amino analog from corn treated at the maximum rate (3 lb./acre). Analysis of the silage itself showed that Accothion residues of 14.5 ppm (wet) at ensiling fell to 7.0 ppm after 8 weeks, the amino analog from 0.26 to 0.14 ppm. The hydrolyzed phenol rose from 1.8 to 3.3 ppm.

SUPPORTED BY U.S. Dept. of Agriculture

4.1021, ANALYTICAL METHODS FOR PESTICIDES, TIFTON
M.C. BOWMAN, Georgia Coastal Pl. Expt. Sta., *Tifton, Georgia* 31794 (00ENTM1102111300)

OBJECTIVE: Develop sensitive, accurate, specific methods for analysis of insect control chemicals and for their residues, metabolites, or breakdown products in grain and forage crops, animals tissues and products, and soils.

APPROACH: Study chemical and physical properties and reactions of new insect control chemicals and their metabolites to find specific measurable characteristics; develop quantitative analytical methods based on these characteristics. Develop efficient procedures for extraction and cleanup of residues from plant and animal tissues, milk, and soils preliminary to analysis. Develop gas chromatograph detectors specific for chlorinated and carbamate insecticides.

PROGRESS: An indium-sensitized flame photometric detector was designed and evaluated for the gas chromatographic determination of compounds containing chlorine, bromine, and iodine (but not fluorine). In a log-log plot the response was linear for nanogram quantities of halogenated compounds and 10,000 times greater than the response for nonhalogen compounds. A sodium sulfate-sensitized flame photometric detector was also designed and evaluated for the gas chromatographic determination of halogenated compounds. The response was linear with concentrations at nanogram or subnanogram levels. For compounds of chlorine and bromine the response was 1000 to 5000 times greater than for nonhalogen compounds. Iodine compounds give a poorer response and fluorine compounds are essentially nonresponsive. Lithium and potassium sulfates were less satisfactory than sodium sulfate for sensitization. When the detector was used to determine chlorinated pesticide residues in extracts of corn and milk no extract interference was found. A study concerning GLC retention times of 138 pesticides and metabolites containing phosphorus and sulfur on 4 thermally stable columns was completed. An analytical method was developed for Dasanit and 3 of its metabolites in corn, grass, and milk.

SUPPORTED BY U.S. Dept. of Agriculture

4.1022, DEVELOP WEED CONTROL PRACTICES FOR SOUTHEASTERN COASTAL PLAIN VEGETABLE CROPS
N.C. GLAZE, Georgia Coastal Pl. Expt. Sta., *Tifton, Georgia* 31794 (0710-03-03)

OBJECTIVE: Develop suitable weed control practices for horticultural crops in the Southeast. Determine persistence and possible metabolites of herbicides within soil and plant tissues.

APPROACH: Conduct field, greenhouse, and laboratory studies to determine the physiological effects of herbicide treatments and analyse for residues and metabolites of these compounds primarily by gas chromatography. Evaluate biological, chemical, and physical factors involved and their relationships.

PROGRESS: Weed research was conducted on direct-seeded tomatoes, peppers, lima beans, cucumbers, watermelons, turnips, and mustard greens. Nitrofen applied preemergence gave excellent weed control without injuring turnip or mustard greens. Pebulate was safer on direct-seeded tomatoes when applied 4 inches deep with sweeps than when incorporated with a rotary hoe. Diphenamid and the methyl ester of chloramben were the best treatments on peppers. The preplant application of the combination of bensulide plus naptalam appears promising on cucurbits. The methyl ester of chloramben and 2,4-bis(isopropylamino)-6-(ethylthio)-s-triazine were effective in lima bean plantings. Combinations including either trifluralin or chlorpropham as one of the components gave adequate results in lima bean plantings. Terbacil at 2 and 4 lb/A severely injured established blueberries. Simazine, floumeturon, dichlobenil, and diuron produced adequate weed control without reducing blueberry yields.

SUPPORTED BY U.S. Dept. of Agriculture

4.1023, PSEUDOCHOLINETERASE ACTIVITY AS AFFECTED BY MODERN AGRICULTURAL CHEMICALS
J.E MONTOURE, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00466)

OBJECTIVE: To establish the effect of present day agrichemicals upon the activity of purified colostrum pseudocholinesterase. To determine the levels of anti-cholinesterase chemicals needed for detection in blood and milk. To determine whether or not it would be practical to use pseudocholinesterase activity level as an indicator for the presence of chemical residues in the blood plasma and milk of dairy animals.

APPROACH: Pseudocholinesterase will be purified from colostrum and the activity will be determined manometrically using Warburg equipment. Twelve modern agrichemicals including carbamates, organophosphorus compounds and chlorinated hydrocarbons will be used and the pseudocholinesterase activity determined in the presence of known concentrations of the chemical. The concentration of each chemical used will be dictated by its effect upon the activity of the enzyme.

PROGRESS: Summary of the data indicates that a spot test for the detection of pesticide residues appears to be practical for pesticides of the carbamate and organic phosphate group. Investigations are being continued. The spot test is based on the blue color that is formed when an esterase reacts with the substrate indoxyl-acetate. In the absence of inhibitory substances an intense blue color will develop. In the presence of either organophosphates or carbamates, the intensity of the blue color is reduced and at high pesticide concentrations, color does not develop. Presently the detection limits appear to be about the 1.0 ppm level for carbamates and slightly higher for the organophosphates.

SUPPORTED BY U.S. Dept. of Agriculture

4.1024, REDUCTION OF PESTICIDE RESIDUE HAZARDS
J. FAHEY, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01533)

OBJECTIVE: Determine the fundamental physical, biochemical, and biological factors influencing occurrence, magnitude, interaction, and persistence of insecticidal chemical residues in soils, water air and raw agricultural commodities.

APPROACH: The effect of cultural practices on distribution and persistence of residues will be studied. This will include the effects of environmental factors such as temperature, relative humidity, and pH. The mechanism of translocation will be determined in greenhouse tests or growth chambers.

PROGRESS: Investigations of Gardona & Azodrin were conducted to determine practicality of using these chemicals to control insect pests to develop data that could be used to obtain tolerances and labels for their use. At recommended dosages the Gardona residues on raw vegetables and fruit varied from 1.2 to 19 ppm. Canning process removed from 97 to 100% of Gardona residues from vegetables, pears and peaches. Except with cherries, the Gardona residue found in canned fruit and vegetables was less than 0.1 ppm. Canned cherries contained 0.2 to 0.8 ppm of Gardona. In the study of Azodrin residues in green beans and tomatoes, 1.6 to 7.3 ppm of Azodrin on raw vegetables and .1 to .3 ppm of Azodrin was in canned products. Methods for the study of DDT residues in mint hay and mint oil were developed. Samples of mint hay analyzed for phygon residues contained less than 0.1 ppm. 0.05 to 0.1 ppm of chlorinated hydrocarbon residues in swine permitted to forage in corn stover or soil that had been treated for corn root pests. Methods for study of Gardona and Ronnel residues in manure were developed.

SUPPORTED BY U.S. Dept. of Agriculture

4.1025, METABOLISM AND TOXICITY OF ORGANOPHOSPHORUS INSECTICIDES
R.M. HOLLINGWORTH, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01571)

OBJECTIVE: Properties of the enzyme dealkylating organophosphates. Determine the importance in detoxication and

selective toxicity. Investigate factors influencing competition between different enzymes degrading organophosphates and to set up mathematical models to describe them.

APPROACH: The occurrence and activity of the systems dealkylating methyl paraoxon will be examined in vitro and in vivo in insect and mammalian tissues. Purification of the enzyme found in the soluble fraction of the cell will be carried out by column techniques and the reaction products identified chromatographically. The activity of the system against related compounds with different alkyl groups will be examined and related to selected toxicity. Competition between this dealkylating system and other detoxifying enzyme will be studied with methyl paraoxon under varying conditions. Mathematical models of each component and of the overall detoxication will then be set up with the aid of an analog computer.

PROGRESS: Attempts to find oxidative demethylation in mouse liver microsomes with a series of dimethyl esters have not been successful and it appears that glutathione-dependent dealkylation is the major pathway of detoxication. Relationship between liver glutathione levels and toxicity of organophosphates has been examined. Several compounds strongly reduce liver glutathione levels and synergize toxicity of some dimethyl phosphate esters. A clear relationship between liver glutathione and toxicity has been established in these cases. Species differences in activity and substrate specificity are great and of probably toxicological significance. Vertebrates fall into 2 classes-- those degrading diethyl esters faster than dimethyl and those in which this order is reversed. Horse liver has the highest activity of any spp. tested. Substrate specificity of mouse liver microsomal phosphotriesterase can be explained in terms of the electron-withdrawing power of phenyl substituent (Hammett σ).

SUPPORTED BY U.S. Dept. of Agriculture

4.1026, EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANO-TOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES

E.J. MONKE, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907

Laboratory experiments will be utilized to study sorption mechanisms of the organo-toxicant materials to mineral and organic fractions in the soil and the movement of these substances through soil profiles. Incubation studies using enrichment culture techniques will be used to isolate microorganisms capable of decomposing those materials which offer the greatest water pollution hazards. Special studies will be made to determine relationships between molecular structure and decomposability of specific toxic substances to determine the feasibility of altering molecular structures. The feasibility of treating reservoirs with special adsorbing or chelating materials in order to flocculate, precipitate, or otherwise deactivate the organo- toxicant materials or their residual decomposition products will be studied using radiological tracer techniques with model filters. Accompanying biological experiments with similar organotoxicant materials will be conducted in laboratory aquaria to determine the effects of different concentrations and synergisms.

Field studies will be conducted on well characterized, controlled watersheds and associated reservoirs to determine the effects of application practices on pollution hazards. The rate of the applied organo-toxicant materials both on the watershed and subsequently in the small reservoir will be determined possibly using radioisotope tracer techniques. Attention will be given to the development of ready means of detecting the toxic substances or its residue in water storages. Both aquatic and terrestrial indicator organisms will be used to assess the movement and concentration of the organo-toxicant, soil-borne organo toxicant, or organo-toxicant residue on the watershed and in associated small reservoirs. Samples of water, bottom muds and watershed soils will be subjected to chemical, biological and physical analyses during pretreatment, treatment, and post-treatment periods for possible organo-toxicant residue and pertinent fauna.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.1027, ANALYTICAL METHODS FOR HERBICIDES AND RESIDUES

E.D. SCHALL, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01230)

OBJECTIVE: Develop improved methods for the analysis of herbicides and their residues, including degradation products, on plant tissues. Develop criteria for determining the tendency of a herbicide to volatilize or 'drift' from the area of application.

APPROACH: Methods having high specificity for individual compounds will be developed by the use of instrumental techniques, including gas chromatography, infrared spectral analysis, polarography, and combinations of these analytical tools. Classical methods will be employed to determine the vapor pressure to a series of 2,4-D and 2,4,5- T derivatives and to investigate vapor pressure relationships and solvents which may affect, in one way or another, the tendency of herbicides to volatize. If necessary, the vapor pressure data obtained will be correlated with biological tests.

PROGRESS: A procedure for estimating herbicide volatility by gas chromatography was developed. The vapor pressures of 24 esters of 2,4- dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyaceti cid (2,4,5-T) were determined, using this technique, over the temperature range 170 to 300 C. These data were extrapolated to 25 C in order to provide data for use as a criterion of herbicide volatility under field conditions. The 25 C data support the previous gage of volatility--that a phenoxy ester with five or less carbons in the ester portion is highly volatile--and indicate that the phenoxy-type herbicides with a vapor pressure greater than 1.5 X 10 mm. of Hg at 25 C should be classified as 'highly volatile.' A solution of boron trichloride in methanol was employed for the complete transesterification of 2,4-D and 2,4-5-T esters to the corresponding methyl esters. Gas chromatographic analysis of the methyl esters permitted mixtures of 2,4-D and 2,4,5-T esters in commercial formulations to be analyzed both qualitatively and quantitatively with no sample cleanup. The method is highly specific and detected the presence of other contaminating isomers of dichlorophenoxyacetic acid. Gas chromatography was also used to qualitatively analyze mixtures of various alkyl esters of 2,4-D.

SUPPORTED BY U.S. Dept. of Agriculture

4.1028, MALATHION RESIDUES IN POULTRY MEAT AND EGGS

W.W. MARION, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (032901670116)

OBJECTIVE: Quantity and method of administration of malathion to chickens on residues in tissues and egg, and effect of metabolic regulators on disappearance of residues.

APPROACH: Administer P32-labeled malathion to laying hens in feed, by capsule or by spraying cages. Administer malathion to growing chickens by feed and by spraying on feathers and skin at different periods of growth. Samples of eggs, feces, liver, kidney, spleen, depot fat and pectoral muscle will be tested for presence of malathion and its metabolites. The effect of metabolic regulators on rate of disappearance of residues will be tested.

PROGRESS: The chicken is very effective in degrading malathion, for only one percent of the ingested pesticide is excreted as the intact molecule. A liver enzyme, thought to be carboxyesterase, was isolated from chicken and rat liver and partially purified. The enzyme was very effective in degrading malathion. Comparison of enzyme activity of fresh chicken liver with that of rat liver showed the enzyme activity of the former to be about one-sixth of that of the latter. Although a system was developed to separate standard solutions of malathion from its mono and diacid forms and malaoxon, the technique was not satisfactory for separating the various compounds after enzymatic degradation. The results indicate that the faster the rate of degradation, the less toxic malathion will be to an animal.

SUPPORTED BY U.S. Dept. of Agriculture

4.1029, USE AND MISUSE OF PESTICIDES
UNKNOWN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01640)

OBJECTIVE: Not Provided.

APPROACH: Not Provided.

PROGRESS: Two additional reports were written and have been accepted for publication by the Extension Service. One report deals with the farm pesticide dealer phase of the project, the other deals with the urban retailer phase of the project. A third report dealing with the urban consumer phase of the study is in final draft form. Additional analyses have been completed on the interrelation of variables in each of the four phases of the study and comparisons among the findings from each of the four phases is being carried out.

SUPPORTED BY Iowa State Government - Des Moines

4.1030, BIOLOGY AND CONTROL OF VEGETABLE INSECTS
J.C. BOLING, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00520)

OBJECTIVE: Study life history, habits, type of injury, hosts and control of insects attacking vegetable crops.

APPROACH: Study biology of insect species. Evaluate insecticides and determine rate of disappearance of residues. Study predators and parasites. Compare susceptibility of various vegetable varieties to insect attack, particularly the corn earworm.

PROGRESS: Eight insecticides were applied to sweet corn at 3-4 day intervals for 5 applications to control corn earworm. Based on the per cent worm-free ears, all treatments significantly reduced the earworm population below the check. Only Furadan performed as well as the Sevin standard.

SUPPORTED BY Kansas State Government - Topeka

4.1031, EFFECT OF PESTICIDES ON ENZYMES
B.A. CUNNINGHAM, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00689)

OBJECTIVE: Test the effects of certain organophosphates and related compounds. We want to see whether these compounds inhibit soluble and mitochondrial enzymes which are currently being studied in this laboratory. Parathion and chloroxon would be typical examples of compounds to be studied.

APPROACH: The proposed work will involve spectrophotometric determination of the enzyme reaction rates in the presence and absence of the pesticide. From an analysis of the spectrophotometric data, it should be possible to determine whether inhibition exists; the type of enzymatic inhibition involved.

PROGRESS: Chloro-containing pesticides such as DDT are refractory to most enzyme systems as shown by their long biological half-life. Research was therefore initiated on the enzyme chloroperoxidase as a possible candidate for transhalogenation of organic chlorine. The organism Caldariomyees fumago (which produces chloroperoidase as an exoenzyme) was found to grow well in the presence of appreciable DDT and therefore it might be capable of metabolizing pesticide residues. The enzyme chloroperoxidase was isolated by gel adsorption, DEAE chromatography and was prepared in crystalline form. A reaction mechanism for oxidation of chloride at pH3 or phenols at pH6 was elucidated. Experiments to demonstrate transhalogenation from DDT in the presence of dimedone are not presently successful. The use of alternate halogen acceptors is planned.

SUPPORTED BY U.S. Dept. of Agriculture

4.1032, MODE OF ACTION OF INSECTICIDES
T.L. HOPKINS, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00476)

OBJECTIVE: Investigate in insects and plants: Rates and routes of entry and distribution of insecticidal chemicals, intoxication processes, detoxication and excretion mechanisms.

APPROACH: Investigating modes of absorption through the integument or alimentary tract, translocation from the site of absorption, and distribution in the organs and tissues of the body. Insecticides labeled with radioisotopes are traced and assayed by radiometric techniques. Metabolic routes of intoxication or detoxication are indicated by the identification of insecticide-derived metabolites produced in the insect. Metabolites are separated by paper chromatographic methods and their presence determined by radio or enzyme assay. Routes of excretion or elimination are examined for their importance as defense mechanisms. The metabolism of systemic insecticides in mammals and plants is also under investigation.

PROGRESS: The metabolism of aromatic compounds in insects in different physiological states has been investigated with radioisotope- labeled molecules and the techniques of radiorespirometry and chromatography. Metabolism of phenylalanine (1- C-ring labeled) in cockroaches revealed aromatic ring cleavage to be of minor significance with less than 3 percent oxidized in 25 hours. Cockroaches deprived of their intracellular symbionts produced only one-eighth as much CO(2). Apparently the symbiotic bacteria perform most if not all of the aromatic ring oxidation in the insect.

SUPPORTED BY U.S. Dept. of Agriculture

4.1033, REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT
T.L. HOPKINS, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00481)

OBJECTIVE: Determine fundamental physical, biochemical, and biological factors influencing occurrence, magnitude, interaction, and persistence of insecticidal chemical residues in soils and raw agricultural commodities, evaluate factors influencing the magnitude and mechanism of air and water pollution; develop studies related to the metabolism and detoxication of insecticidal chemical residues in animals, plants, soils and water; evaluate effects of residues of insecticidal chemicals on ecosystems on fish and wildlife; develop analytical techniques.

APPROACH: Degradation and metabolism of organophosphorus insecticides studied with environmental effects of solar radiation, temperature, and humidity. Field studies are in progress.

PROGRESS: The disappearance and residues of several organic insecticides applied to soil and corn have been studied for the fourth consecutive year in the Cedar Bluff Irrigation District. Diazinon and parathion soil treatments disappeared rapidly but heptachlor, aldrin and their epoxides persisted in slowly decreasing amounts after soil application and small residues were detected from the 1967 treatments. Corn plant samples taken from plots treated with foliar sprays of diazinon, methyl parathion and endrin showed organophosphorus residues to be very low after one month and moderate endrin residues. Wild mice trapped in the area contained small dieldrin residues. Fish collected from various river sites showed only small DDE residues. A microcolumn cleanup method has been extended to include additional pesticides and modified to handle larger samples. Photodegradation studies with five organophosphorus insecticides applied to glass and leaf surfaces both under field and laboratory conditions reveal step-wise reactions of oxidation, isomerization and hydrolysis induced by various wavelengths of radiation.

SUPPORTED BY U.S. Dept. of Agriculture

4.1034, PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES AND ENVIRONMENT
H.W. DOROUGH, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00480)

OBJECTIVE: To perform fundamental methodology studies including sampling, extraction, cleanup, and analysis, to participate in referee sample exchange prior to the analysis of samples from cooperative research experiments designed to solve primary residue problems in a region, to conduct fundamental studies on the fate of pesticides in plants, animals and soils including intermediate and final breakdown products; and to determine the residue breakdown of pesticide chemicals and their toxic metabolites in agricultural commodities and soil.

4. PESTICIDES

APPROACH: Existing analytical methods will be adopted and evaluated in our laboratory. Selected residue samples will be collected and exchanged with other laboratories in the area. Radiotracer techniques will be utilized to determine the fate of pesticides in plants, animals and soils. After the insecticide has been synthesized and purified it will be administered to the test organism and means of extraction will depend upon the individual compound and substrate involved. Components of the radioactive extract will be resolved by column, thin-layer and paper chromatography. Residue samples will be analyzed using colorimetry, gas chromatography, infra-red spectrophotometry and/or enzymatic techniques.

PROGRESS: Sorghum plants were sprayed twice at a 5 day interval. At the first application 50% of sorghum heads had completely emerged from the boot and when second applications were made, all of the heads had emerged from boot. Samples of whole plants were taken 20 days after last treatment and mature sorghum grain was harvested 60 days after last treatment. Insecticides and rates of application were as follows: methyl parathion - 0.5 lb/A, malathion - 1.2/A and ethion - 0.5 lb/A. Approximately 4 p.p.m. malathion and ethion residues were detected on whole plants. Residues on mature seeds were 0 p.p.m. for methyl parathion, 0.03 p.p.m. for malathion and 0.72 p.p.m. for ethion. Water-diluted sprays of GS-13005 showed a residual persistence on plants and grain very similar to that of methyl parathion. Milk from cows fed carbaryl in diet at rates of 10, 30 and 100 p.p.m. contained residues of 0.023, 0.068 and 0.278 p.p.m. carbaryl equivalents.

SUPPORTED BY U.S. Dept. of Agriculture

4.1035, BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

J.F. FREEMAN, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00173)

OBJECTIVE: Determine the effects of climatic and edaphic factors on persistence, movement, and toxicity of two specific herbicides in selected soil types common to two or more southern states.

APPROACH: Prometryne and C-2059 (Cotoran) both promising new soil residual herbicides for southern row crops will be tested for persistence in certain important soil types of predetermined characteristics by use of a range of rates of the herbicide mixed with the soil and the resulting growth of suitable bioassay crops, grown repeatedly in the greenhouse, will be used to estimate the loss of toxicity with time in soils with the various characteristics. Leaching rate of these herbicides applied at selected rates on the surface of soil columns contained in pre-sectioned pipe will be estimated by first leaching with selected rates of simulated rainfall and then growing suitable crops in the different sections of the disassembled soil column to bioassay the amount of herbicidal residues contained at the different depths. Greenhouse bioassay of soil samples from field-treated plots taken at selected intervals after treatment will be used to estimate the toxic herbicidal residues present at different depths.

PROGRESS: A field bioassay experiment was conducted on a Maury silt loam with two herbicides. Atrazine and S6115 (2-chloro-4- cyclopropylamino-6-isopropylamino-1,3,5 Triazine) was applied pre- and post-emergent on corn with an indicator crop of Brave oats being seeded at monthly intervals after corn plants were removed. Atrazine and S6115 used pre-emergent 2 and 3 lb/A gave equal grass and broadleaf control with Atrazine 2 lb/A killing 85% and S6115 2 lb killing 60% of the oats after two months. After three months, both herbicides dropped to 45% oats killed. Atrazine 2 and 3 lb/A 1 gal crop oil applied post- emergence after 3 months still gave 85% and 93% oats killed, while S6115 applied post-emergence gave 33% and 45% oats killed. Both herbicides gave excellent grass and broadleaf control applied pre-emergent while Atrazine oil applied post-emergence appeared to be slightly better than S6115. Both gave satisfactory control.

SUPPORTED BY U.S. Dept. of Agriculture

4.1036, BIOLOGY, ECOLOGY, AND CONTROL OF INSECTS ATTACKING TOBACCO

R. THURSTON, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00458)

OBJECTIVE: Investigate the biology and ecology of insects (e.g. hornworms budworms, wireworms, cutworms, flea beetles, the green peach aphid, green June beetle, and grasshoppers) which feed on or damage tobacco plants; evaluate chemical control measures for preventing insect damage to tobacco; relationships between certain insects injurious to tobacco and the disease organisms, parasites, and predators affecting those insects.

APPROACH: Replicated small-plot field tests insecticides will be compared. Insecticide-treated burley tobacco will be sampled for residues analyses and smoking evaluation tests. The effect of weathering, curing, and processing on residues will be studied.

PROGRESS: Pupal diapause of the tobacco hornworm of both Kentucky and California strains was induced by short photophases and/or low temperatures. Although photophase length appears to be the major factor, diapause can be induced or prevented by low and high temperatures. Morphological differences in the pupae of the California strain are genetic and selections for these characteristics bred true. The larvae of Apanteles congregatus, a wasp parasitic on tobacco hornworm larvae, was affected adversely by nicotine, azinphosmethyl, and carbaryl incorporated in an artificial diet of the hornworm. The developmental period of hornworm larvae was lengthened and the pupal weight was reduced when they fed on diets containing carbaryl and azinphosmethyl. Imidan, azodrin, Monitor, N-2596, R-15792, C-9491, and RE-11-755 gave excellent control of tobacco hornworms and flea beetles; Monitor, C-9491, and azodrin were the most promising materials to tobacco budworm control. Diazinon, Dasanit, Bux, disulfoton, and carbofuran were the most effective materials tested for wireworm control.

SUPPORTED BY U.S. Dept. of Agriculture

4.1037, DISTRIBUTION, ABUNDANCE AND CONTROL OF HELIOTHIS SPECIES IN COTTON AND OTHER HOST PLANTS

D.F. CLOWER, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01215)

OBJECTIVE: Population surveys to determine relative importance of the various hosts of Heliothis spp. Monitor insecticide resistance. Investigate the use of insect hormones for control and screen new candidate insecticides. Screen and evaluate plant characters which provide plant resistance, tolerance and non-preference to Heliothis spp. Develop new pest management systems.

APPROACH: Heliothis populations on various hosts will be surveyed throughout the season in several areas of the state and correlated with those occurring on cotton. Susceptibility to recommended insecticides will be constantly monitored by treating topically F(1) progeny reared in the lab from field collected larvae. The effects of certain hormones and hormone mimicking compounds will be studied on Heliothis and on selected beneficial insects in the laboratory. If laboratory studies show promise these will be further evaluated in small plots in the field. Promising new candidate insecticides will be routinely screened for Heliothis control in field plots at the Red River Experimental Station. plant characters which inhibit oviposition, provide antibiosis or non-preference will be evaluated in the field in randomized replicated tests at several locations in Louisiana. New pest management systems will be developed which put less dependence on insecticides.

PROGRESS: Heliothis populations in cotton presented no unusual problems during 1969. Some H. virescens activity occurred in late June and early July but these were suppressed by predators and did not require treatment. H. zea from near St. Joseph; H. zea and H. virescens from near Lacassine were subjected to topical application of M. parathion, Azodrin, Toxaphene-DDT and Carbaryl. The response indicated that these populations are still susceptible to these pesticides. Also since the Lacassine populations (S.W. La.) were susceptible this indicates that these are probably resident Heliothis and not migrants from lower Texas or other areas where insecticide resistance is common. Shell 17250 at 1 lb/A was the only insecticide tested which gave Heliothis control equal to Toxaphene-DDT, M.parathion. Bayer 93820 showed some promise. Predator populations were decreased and Heliothis populations increased following a soil application of Termik at planting.

SUPPORTED BY U.S. Dept. of Agriculture

4.1038, PESTICIDE CONTAMINATION OF ENVIRONMENT

L.D. NEWSOM, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01204)

OBJECTIVE: Determine the extent to which the environment is contaminated and to develop a continuing monitoring system. Develop more satisfactory analytical techniques and methodology than those which presently exist for residues of some insecticides. Furnish pesticide analytical services to cooperating departments.

APPROACH: Amounts of insecticide residues currently present will be determined in representative samples of soil, water, bottom sediments, aquatic and terrestrial animals, and plants from five areas differing in ecology and land use. Particular attention will be devoted to developing more satisfactory techniques for determining levels of organophosphorus and carbamate residues as well as any new materials which come into widespread use. Capability for analyses can be done for all cooperating departments.

PROGRESS: Residues in fish samples from 5 monitoring sites established 3 years ago continued to reflect pesticide use. Endrin residues had virtually disappeared in fish from Bayou Chevreuil in the sugarcane area, reflecting change from endrin to guthion for control of sugarcane borer. DDT residues still high in fish from streams draining cotton producing areas. Sacks used for treated seed rice or seed corn and used second-hand for sacking feed found to be an important source of contamination of milk. Coastal bermuda forage produced on cotton farms proved to be a major source of DDT contamination; rice bran of dieldrin in milk. Residues of chlorinated hydrocarbon insecticides still ubiquitous in all species of wildlife examined. Continued work on chlorinated hydrocarbons in the Louisiana environment. Emphasis has been on residues in milk. A new and heretofore unsuspected source of contamination was discovered. Studies of residues in commercial catfish are in progress.

SUPPORTED BY U.S. Dept. of Agriculture

4.1039, BROMIDE RESIDUES AND THYROID FUNCTION

D.A. BENTON, U.S. Dept. of Agriculture, Human Nutrition Research Div., *Beltsville, Maryland* 20705 (HN2-41)

OBJECTIVE: Learn if bromide residues in fumigated wheat alter thyroid function of rats fed diets adequate and marginal in iodine.

APPROACH: Feed weanling rats diets containing methyl bromide- treated and untreated wheat with either adequate or marginal iodine. Measure metabolic rate and blood pressure at intervals. Kill at 100 or 300 days of age. Determine total and protein bound iodine and bromide in serum and thyroids. At autopsy evaluate gross changes and where indicated evaluate tissue changes histologically.

PROGRESS: A feeding study with diets containing wheat fumigated once with methyl bromide was completed. Tissue and blood samples were taken. Final evaluation of results await the analysis of samples for iodine and bromide. A second study using wheat more extensively fumigated is underway.

SUPPORTED BY U.S. Dept. of Agriculture

4.1040, METHODS OF ANALYSIS FOR PESTICIDES

K.R. HILL, U.S. Dept. of Agriculture, Entomology Research Division, *Beltsville, Maryland* 20705 (00ENTM1101210200)

OBJECTIVE: Develop sensitive, accurate, specific methods for analysis of insect control chemicals and for their residues, metabolites, or breakdown products in crops, animal tissues, milk, poultry, eggs, and soils.

APPROACH: Study chemical and physical properties and reactions of new insect control chemicals and their metabolites to find specific measurable characteristics; develop quantitative analytical methods based on these characteristics. Develop efficient procedures for extraction and cleanup of residues from plant and animal tissues, milk, and soils preliminary to analysis. Develop gas chromatographic detectors with improved specificity for different chlorinated und carbamate-type insecticides. Develop scanning and measuring instruments for sensitive quantitative thin-layer chromatographic analysis of pesticide residues.

PROGRESS: An improved colorimetric method for the analysis of hydrogen cyanide residues in vegetables was developed. It is more accurate and consistent at the 0.01 ppm level than the titrimetric methods currently in use. A fluorescence method for determining carbaryl in mixed formulations and 2-naphthol impurity in carbaryl manufactured outside of the United States was developed which is superior to existing methods based on infrared spectrometry. A method was developed for the analysis of pyrethrum extracts using quantitative thin layer chromatography. 'p' Values were determined for the gas chromatographic peaks of 8 Arochlor mixtures (polychlorinated biphenyls) in 2 pairs of solvent systems for distinguishing these compounds from pesticides during residue analyses.

SUPPORTED BY U.S. Dept. of Agriculture

4.1041, HISTOLOGICAL PROCESSING AND PATHOLOGICAL EXAMINATION OF SELECTED ANIMAL TISSUES

UNKNOWN, Litton Industries Incorporated, *Bethesda, Maryland* 20014 (NIH-70-2121)

Independently and not as an agent of the government, the Contractor will perform histologic processing and pathological examination of selected tissues from animals which were administered pesticides by the oral route under Bionetics Research Laboratories, Contract No. PH-43-67- 735. Selected treatment groups, consisting of 3,082 animals, will be examined as outlined in the attached schedule. Additionally, one negative control group of approximately 72 animals will have the same organs examined as the treated groups.

Specifically the Contractor will perform: 1. Gross examination of the selected organs. 2. Select and histologically process one appropriate section of each organ (more sections may be required in the animals with several grossly visible abnormalities). On those compounds where sections of the brain, pituitary, and thyroid glands are to be examined, the head and neck will be skinned and decalcified and then sliced coronally from front to back. 3. Pathological and neuropathological examination and reporting of the approximately 4,100 slides will be done by Dr. B.Ulland and Dr. J.R.M. Innes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.1042, BIOLOGICAL DEGRADATION OF AGRICULTURAL INSECTICIDES

R.E. MENZER, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-H-100)

OBJECTIVE: Identify and characterize the intermediates and end products of the degradation of agricultural insecticides, and investigate the mechanisms and pathways of biological degradation of insecticides.

APPROACH: Initially, studies will utilize the organophosphorus insecticides Bidrin, Azodrin, phosphamidon, dimethoate, C-2307 (CIBA Agrochemical Co.), and Mocap. The degradation intermediates that are formed as the original insecticide is converted either to stable synthetic molecules or to natural environmental constituents will be determined. For the most part, plants will be used for these studies, but soil, animals, or in vitro preparations will be used when it is apparent that more information can be obtained using these systems. Most of the studies will utilize radiolabeled insecticides, most of which it will be necessary to synthesize. Conventional chemical and radiochemical techniques of analysis will be used in characterization studies.

PROGRESS: Studies on dimethyl phosphate, ester with (N over -)- methyl-(N over -) methoxycrotonamide, C-2307, a new organophosphate insecticide, have been initiated. Preliminary studies with P-labeled C-2307 in rats have revealed the presence of two organoextractable metabolites in addition to the parent compound in urine. One of these is the unsubstituted amide analog, while the other is unidentified. Studies on the synthesis of C-labeled C-2307 are in progress so that the metabolic route of the compound in plants and further work in animals can be done. Characterization of metabolites of MOCAP in plants continues. Evidence has been obtained for the presence of ethyl propyl sul-

foxide in plants. Rats have been treated with MOCAP, but almost all of the recovered radioactivity was present in the water fraction of urine after extraction with chloroform, indicating the hydrolysis of the compound to non-toxic metabolites. Further analysis of the small amount of organoextractable radioactivity is under way. A method for the analysis of water-soluble metabolites using ion exchange column chromatography has been developed, and the water fractions from both plant extracts and rat urine will be analyzed for MOCAP metabolites in the near future. An experiment to test the behavior of MOCAP in three different soils is underway.

SUPPORTED BY U.S. Dept. of Agriculture

4.1043, BIOLOGICAL DEGRADATION OF AGRICULTURAL PESTICIDES

H.B. GUNNER, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01002 (MAS00240)

OBJECTIVE: Identify the products of degradation of insecticides by plants and determine quantitative significance of products. Determine the absorption and translocation of insecticides and degradation products by plants. Investigate mechanisms of decomposition of insecticides by plants.

APPROACH: Representative chlorinated hydrocarbon, organophosphate and carbamate insecticides will be applied to alfalfa, ladino clover, onion, spinach, beet, bean and carrot plants grown aseptically and under natural soil conditions.

PROGRESS: Diazinon, O, O-diethyl O-(2-isopropyl-4-methyl-6- pyrimidinyl) phosporothioate but not its hydrolysis products (2- isopropyl-4-methyl-6-hydroxypyrimidine and diethylphosphorothioate) effected sharp changes in microfloral and microfaunal population distribution. It induced ecosystem stress effects when applied directly to soil or plant, even disrupting an aquatic rhizosphere ecosystem associated with Duckweed (Lemna minor). Diazinon was found to be largely localized in the cell wall components of resistant bacteria. It was able to halt sporogenesis. Anaerobic degradation of Diazinon was enhanced by microbial metabolism.

SUPPORTED BY U.S. Dept. of Agriculture

4.1044, ENVIRONMENTAL OCCURRENCE OF N-NITROSO COMPOUNDS

G.N. WOGAN, Mass. Inst. of Technology, School of Science, *Cambridge, Massachusetts* 02139 (NIH-70-2180)

Independently, and not as an agent of the government, the Contractor shall exert its best efforts to perform a systematic study of the environmental occurrence of N-nitroso compounds.

In performing this effort, the Contractor shall: 1. Develop methodology for isolation, determination, and identification of volatile N-nitroso compounds in foods. 2. Study conditions which are favorable to the formation of various classes of N-nitroso compounds in foods and model food systems. 3. Develop methodology for isolation, determination, and identification of nonvolatile N-nitroso compounds. 4. Determine biological activity (toxicity, mutagenicity, and carcinogenicity) of novel N-nitroso compounds produced experimentally (as above) or discovered in natural sources.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.1045, MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES

R. REINERT, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Ann Arbor, Michigan* 48107

A monitoring program to measure levels of insecticides in various species of fishes and water from each of the five Great Lakes.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

4.1046, QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH

L.J. BRATZLER, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL03061)

OBJECTIVE: Determine the effect of the spawning process (period) on the quality of Coho salmon flesh. Determine the level of possible pesticide residues in Coho salmon flesh.

APPROACH: Flesh quality characteristics of Coho salmon prior to and during the spawning period will be studied. Such factors as muscle pigmentation change, muscle firmness, protein, fat, moisture, cooking shrink, and taste panel evaluation of aroma, flavor, and acceptance will be used to characterize flesh quality changes that may occur. The effect of freezing and frozen storage will be studied and would include such criteria as defrosting drip loss, rancidity measurements, cooking shrink, and taste panel evaluation. Pesticide determinations would be made on the fresh, cooked fresh, frozen, frozen stored, and cooked frozen salmon. It is contemplated using salmon from three or four periods. These would include fish samples taken from Lake Michigan sometime prior to the normal spawning period as examples of first quality Coho salmon flesh. Samples would also be taken during the spawning period to obtain information relative to quality degradation that may occur due to the physiological process of spawning.

PROGRESS: Coho salmon (78) were obtained that presented 1968 spawning or post-spawning (A); 1969 pre-spawning (B); and 1969 spawning or post-spawning (C) periods. Taste panel scores were highest for B with little difference between A and C; females were scored higher than males. Peroxide values showed more relationship (negative) to taste panel scores than percent protein, fat, moisture, or fish size. DDT levels in uncooked whole salmon steaks ranged from 2.2-13.8 ppm and were 1.7-10.2 ppm in comparable cooked steaks. Trimming fatty regions from the steak reduced residues proportional to the amount of fat removed, but never exceeded 40%. Wide variation between individual samples made comparison of residues between pre-spawning and spawning fish impossible. Results for DDE and TDE showed similar variation.

SUPPORTED BY Michigan State Government

4.1047, TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS

D.R. DILLEY, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00968)

OBJECTIVE: Methods for the prevention or reduction of pest damage or pesticide residues in agricultural commodities during transportation, processing and/or storage. Processing procedures for the removal, reduction or detoxification of pesticide residues and conversion products in agricultural commodities. Alterations of atmospheric gas composition, treatments with heated water as sprays, drenches and dips, methods to retard senescence and thus to reduce the need for pesticides; and the use of volatile gases will be tested for the control of pests. Devise and test methods and materials for protective packaging. Sterilization within the package, protection against mechanical damage and the use of protective coatings or films will be considered.

APPROACH: Examine the values of washes, water handling, brushing and heat for removal of residues. Study handling and storage sanitation procedures to reduce the need for pesticides.

PROGRESS: Thiabendazole at 250, 500 and 1000 ppm and benomyl at 75, 150 and 300 ppm applied as a post-harvest dip to apples effectively reduced fruit rot caused by Penicillium expansum. No significant effect of either was noted on fruit metabolism as measured by respiratory activity. Orchard applications are under study for this carry-over effect on the fruit during storage. Both materials reduced rot development on carrots and preliminary trials indicate some value for prestorage washes. Residue samples of materials treated with thiabendazole were supplied to the manufacturer to assist their application for clearance on apples. Ethrel hastened the maturation and red color development of Jonathan apples without apparent adverse effect on fruit keeping quality. Alar and 2, 4, 5-TP were of no effect on calcium uptake of Jonathan apples when applied to reduce internal breakdown; calcium nitrate sprays increased Ca content of the fruit and leaves, and its effect on the storage life of the fruit is under test. Paraffin as a surface coating on sugar beet roots reduced respiration and sugar loss more effectively than other coatings tested, however, the effect was insufficient to justify commercial use. Preliminary trials of sub-atmosphere pressure storage of apples

and pears as a substitute for chemical treatment to retard ripening, senescence and decay yielded results that suggest further study.

SUPPORTED BY U.S. Dept. of Agriculture

4.1048, TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS

J.T. HUBER, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00967)

OBJECTIVE: Develop procedures for the removal, reduction or detoxification of pesticide residues and conversion products in agricultural commodities.

APPROACH: Determine the effect of processing on insecticide residues in dairy products; modify present processing techniques to remove or reduce toxicity of chemical residues in dairy products. Separate and fractionate milk fat containing contaminant DDT and dieldrin into neutral lipid and phospholipids and determine the distribution of insecticide residue in each lipid class; determine with natural and model system whether insecticide is present through fat solubility or through affinity to specific components; apply ion- exchanged resin, molecular sieve and other column techniques to determine effectiveness of removing insecticide residues from milk; study the effects of spray dry on distribution and binding of insecticides in lipid classes; apply techniques developed to present processing techniques at plant level.

PROGRESS: Work is continuing on the problem of developing methods to isolate, purify and crystallize metabolites of dieldrin found in urine, feces, body fat and milk from cows. Studies of the structure of the pesticide metabolites are being made using the mass spectrometer. At present there appears to be one metabolite in milk, blood and body fat. There are five metabolites in feces. The structure of these metabolites have not been determined. It appears that dieldrin metabolites are present in animal food products but the metabolites are not being detected by the routine techniques now used to measure pesticides in meat and milk.

SUPPORTED BY U.S. Dept. of Agriculture

4.1049, TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS

N.C. LEELING, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00970)

OBJECTIVE: Processing procedures for the removal, reduction, or detoxification of pesticide residues and conversion products in agricultural commodities. Development of improvement of methods for the determination of pesticide residues in agricultural commodities.

APPROACH: Specific attention is to be directed to the determination of the actual site(s) of origin and magnitude of pesticide contamination in dairy products after they enter marketing channels. Research is planned to attempt to develop standard and more flexible techniques for routine analysis of dairy products.

PROGRESS: Following the preliminary studies of chlorinated hydrocarbon insecticide residue reduction due to cooking which was reported last year, more detailed studies were undertaken. Little difference in magnitude of residue reduction was observed due to cooking method (baking, broiling, frying, deep-fat frying or boiling). Each of these methods reduced the total DDT complex (DDT, DDE and TDE) residue level by about 25%. It was further established that trimming off the belly-flap, lateral line and dorsal fatty regions prior to cooking reduced residue levels between 30% and 40%. Thus, the trimming away of fatty regions coupled with cooking reduces chlorinated hydrocarbon insecticide residue levels in coho salmon to about one-half the level found on a fresh-weight basis.

SUPPORTED BY U.S. Dept. of Agriculture

4.1050, ECONOMICS OF PERSISTENT INSECTICIDE RESIDUES

N.C. LEELING, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00957)

OBJECTIVE: Determine the magnitude of the persistent residue problem and associated economic changes.

APPROACH: An intensified survey is proposed at the commercial grower and processor level to determine the economics of Michigan Pest Control Programs and evaluate the costs and problems of adjusting to changes in recommendations and tolerances. Detailed residue studies will be initiated to follow the build-up, degradation and movement of pesticides in relationship to normal agricultural programs.

PROGRESS: A gas chromatographic technique was developed which permits the analysis of methyl parathion with little degradation during the analysis. The system is comprised of an all-gas column and injection port with the following temperature parameters: injection port - 160 , column - 140 , detector 170 . Helium flow was 60 ml/mim. The six foot by 1/4 inch column was packed with 4% diethyleneglycolsuccinate on 60/80 mesh Gas-Chrom Q. A sodium thermionic detector was used which allowed the quantitation of residue levels as low as 0.1 ppm.

SUPPORTED BY U.S. Dept. of Agriculture

4.1051, ROLE AND FATE OF HERBICIDES, ANTIBIOTICS, ETC. IN SOILS

A.R. WOLCOTT, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00123)

OBJECTIVE: Study residual effects of herbicides, antibiotics and plant hormones in different soil types. Find effect of various compounds--herbicides and growth-regulating substances and antibiotics-- on the microbial flora of soils. Find species of bacteria which might prove helpful in bringing about disintegration of herbicides. Determine effect of biuret on plant growth, cause of transformation of urea to biuret, and biuret content of various commercial sources of urea.

APPROACH: Growth regulators and related chemicals are added to different soil types. Residual effect is then determined after regular intervals of time by either biological or chemical tests. In certain instances studies are made to determine the chemical effect on microbial activity and nitrification at different incubation temperatures of 15 , 22 , and 35 C.

PROGRESS: Nine chemicals inhibited ammonium oxidation at 2.5 ppm or less but had no effect on nitrate oxidation in the same nutrient solution cultures at 250 ppm. Two others were equally specific inhibitors of nitrite oxidation. Activity of non-anionic chemicals was greatly reduced in the presence of soil solids but not by aqueous extracts of soil. Synergism was shown for several combinations of chemicals. In perfusion systems, inhibition of ammonium oxidation by amitrole increased as nitrification proceeded and was shown to be accompanied by release of initially adsorbed amitrole into the perfusate. These results have significance for understanding side- effects of chemicals used for specific pest control purposes and suggest a multiple use for some chemicals which inhibit ammonium oxidation at very low concentrations. This effect would promote control of nitrogen stability in soils.

SUPPORTED BY U.S. Dept. of Agriculture

4.1052, EQUIPMENT AND METHODS FOR DECONTAMINATION AND DISPOSAL OF PESTICIDES AND PESTICIDE CONTAINERS

W.C. SHAW, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (0710-01-32(GR))

OBJECTIVE: Determine the combustion temperatures and the volatile products of selected pesticides. Investigate the use of chemicals and other materials as aids in the decomposition of pesticides and containers. Investigate the use of indigenous soil microflora as an aid in the decomposition of pesticides in soils. Determine the requirements for pesticide containers that are readily combustible. Develop specifications for an incinerator or other device for the disposal of pesticides and containers.

4. PESTICIDES

APPROACH: Three general avenues of approach will be followed in the investigations concerning decontamination and safe disposal of selected pesticides, their formulations and pesticide containers: combustion, treatment with chemicals, and exposure to microbial flora of soils.

PROGRESS: In combustion studies, pesticide standards and formulations were ashed at 900 C and analyzed by spectrograph and X-ray diffraction. Effects of ashing will be determined after all results are keyed and read. Instrumentation and methodology were developed for analysis of volatile compounds; standard gases were characterized by gas chromatograph and mass-spectrometer. In thermal shock studies, heating of all pesticides was completed and coding is proceeding. A computerized infra-red retrieval search system was procured to facilitate anlytical work. Progress was made in the use of NaOH, sulfuric acid, and several organic solvents as decomposition aids. Mono- and triethanolamine appeared very promising for phosphate insecticides. Of 16 pesticides evaluated in soil studies with indigenous microflora, only carbaryl decomposed readily. Phenoxy herbicides also degraded but less extensively. Except for carbaryl and diuron, the pesticides inhibited microbial nitrification processes. Storage facilities were developed and six container materials - amber and clear polyethylenes, polyprolylene, polyvinylchloride, teflon, and pyrex glass- were evaluated under four temperature regimes for their effects on twenty pesticides, for pesticide effects on the containers, and for interactions between chemicals and containers. Forty-two containers have failed in the continuing test. Of five surveys on disposal methods, one was essentially completed, two others are still in progress, and two remain to be initiated.

SUPPORTED BY U.S. Dept. of Agriculture

4.1053, A STUDY OF THE HORTICULTURE SPECIALTY INDUSTRY IN MISSISSIPPI

UNKNOWN, Mississippi St. University, Agricultural Experiment Sta., *State College, Mississippi* 39762 (MIS-3-206-0732)

OBJECTIVE: Not Provided

APPROACH: Not Provided

PROGRESS: Tomatoes, spinach, turnip greens and green beans were planted from April through December. Recommended herbicides and insecticides were used to control weeds and insects. The crops were harvested at regular intervals and frozen and canned samples were obtained. Samples are being analyzed for pesticide residues, but the analyses have not been completed. The samples analyzed thus far have been below the tolerance level for the pesticide involved, for both canned and frozen samples. Pesticides used were Sevin (carbaryl), dacthal, Treflan (trifluralin).

SUPPORTED BY U.S. Dept. of Agriculture

4.1054, SCREENING AQUATIC INVERTEBRATES TO DETECT AN ORGANISM SUITABLE FOR USE IN A MONITORING PROGRAM

J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Various aquatic invertebrates will be screened in an attempt to find one or more organisms which can be used to monitor for the presence of anticholinesterase agents. Ideally, such an organism should exhibit a reaction to levels of anticholinesterase agents which are not toxic to fish. Should such an organism be found, it could then be used to detect the presence of anticholinesterase agents beofre they can reach levels which are harmful to other members of the aquatic ecosystem. Initially, various invertebrates will be selected on the basis of availability and sensitivity to various anticholinesterase agents as indicated by bioassay test results. Dependent upon initial results, the enzyme system will be characterized in regard to optimum substrate, optimum substrate levels, both in vitro and in vivo reaction to various anticholinesterase agents, sex, date of sampling, etc. After a number of organisms have been screened, one or two of the more promising will be selected for use in an actual monitoring program in the field.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1055, BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES

B.T. JOHNSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Degradation of polychlorinated organic compounds by representative organisms from various levels of an aquatic community are investigated. Under controlled laboratory conditions microorganisms, algae, protozoa, crustacea and insects are exposed to environmental levels of both labeled and non-labeled toxaphene and chlordan. Exposure periods are varied in accordance with the organisms investigated. Degradation products are identified and characterized utilizing thin-layer and gas chromatography, infrared and mass spectroscopy, and autoradiography. Potential degradation pathways are postulated. The influence of non- pesticidal polychlorinated biphenyl compounds (PCBs) alone and in combination with chlorinated pesticides is investigated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1056, DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY

D.L. STALLING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

A Perkin Elmer Model 270 mass spectrometer-gas chromatograph will be installed and employed to identify pesticides and their metabolites and other compounds of interest in fish, water, and related samples. Carbon-14 labeled insecticides will be employed to aid in the separation and purification of pesticides prior to mass spectrometric examination. The study of metastable ions by defocusing normal ions will be employed and should greatly assist structure identification.

The initial efforts will be directed toward developing techniques and optimizing operating parameters as well as obtaining standard spectra of pesticides and metabolites. The use of the direct probe for introducing samples chromatographed by thin layer chromatography (introducing the sample while still on the adsorbent) will be studied. The use of capillary columns for separation of compounds by GLC will also be evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1057, PREPARATION OF CHLORINE-36 LABELED ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS (PCB'S)

D.L. STALLING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The use of radio-labeled materials greatly facilitates the determination of residue levels in acquatic organisms resulting from exposure to chlorinated pesticides or other multiple component materials such as polychlorinated biphenyls. Non-radioactive chlorinated materials will be exposed to a flux of thermal neutrons to produce radioactive chlorine-36 labeled compounds. Other short-lived byproducts will be allowed to decay and impurities resulting from radiation damage will be removed by chromatography.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1058, IMPROVED CLEANUP PROCEDURE FOR THE REMOVAL OF LIPIDS FROM FISH EXTRACTS--CHLORINATED HYDROCARBON RESIDUE ANALYSIS

R.C. TINDLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of this research is to develop improved techniques for the cleanup of fish extracts. This cleanup is necessary as the fatty material removed from fish during extraction causes degradation of gas chromatographic columns and contamination of the detector, as well as giving rise to extraneous peaks which limit the sensitivity and accuracy of the analysis.

Thin-layer chromatographic techniques combined with column chromatography and sweepco-distillation will be used. The function of TLC will be primarily to follow the degree of cleanup; it may also be used as an actual cleanup procedure if the separations which it achieves cannot be achieved with column chromatography.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1059, EVALUATION OF NATURALLY OCCURRING HALOGENATED COMPOUNDS AS POSSIBLE INTERFERENCES IN PESTICIDE RESIDUE ANALYSIS
R.C. TINDLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

It has recently been observed that a group of naturally occurring poly-chloro biphenyl derivatives may often constitute interferences in the analysis of pesticide residues in the environment.

The objective of this work is to review any pertinent available literature and to determine if any of the recurring interferences in our residue analysis are compounds of this type.

Extracts which contain large quantities of interferences will be concentrated and fractionated by gas-liquid and thin-layer chromatography; the resulting fractions will be examined by IR spectrophotometry to determine the presence of chlorine. Substances which are frequently found to interfere will be collected for structure elucidation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1060, DEVELOPMENT OF ANALYTICAL METHODS FOR SELECTED HERBICIDES
R.C. TINDLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The purpose of this work unit is to survey the literature for possible methods for use with selected herbicides; and to evaluate any method which seems to show promise. The evaluation process will also include the development of modifications when necessary. Radioactive pesticides will be used when available.

When possible, GLC will be used for the analytical determination, and, consequently, it will be necessary to form derivatives of some of the compounds. Possible derivatives will be prepared on the macro scale for evaluation and for direct preparation of standard solutions.

Reports will be in the form of stepwise procedures for inclusion in the Residue Analysis Handbook. In addition, if the developed method represents a sufficiently new technique, a manuscript for publication will be prepared.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1061, METHODS FOR EXTRACTION OF PESTICIDES FROM POND MUD PROJECT - METHODOLOGY IN CHEMICAL ANALYSIS AND SAMPLING
R.C. TINDLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The purpose of this work unit is to develop satisfactory methods of extracting pesticides from pond mud. The pesticides considered will include endrin, DDT (and metabolites), methoxychlor, malathion, parathion, diazinon, carbaryl, zectran, 2,4-D, simazine, etc. The analytical methods used in the study will include GLC, TLC, and other types of chromatography, mass spectrometry, IR spectrometry, and other techniques required.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1062, UPDATING THE 'HANDBOOK OF PROCEDURES FOR PESTICIDE RESIDUE ANALYSIS' - METHODOLOGY IN CHEMICAL ANALYSIS AND SAMPLING
R.C. TINDLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of this work unit is to bring together any material necessary to update the existing handbook. Periodic updating is necessary so that the handbook will reflect the current state-of-the- art in residue analysis. The report for this work unit will consist of a supplement to the handbook which should be ready for review in late fall 1971.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.1063, ANALYSIS OF PESTICIDE RESIDUES
W.A. AUE, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00574)

OBJECTIVE: Develop an analytical services and research program for the experiment station for the analysis of pesticide residues and their metabolites in agricultural products and water. Develop simplified, rapid, and accurate quantitative gas chromatographic methods for the determination of residues of pesticides.

APPROACH: This work will be supplemented with thin layer chromatography and other instrumental methods of analysis.

PROGRESS: Service Work: Chlorinated hydrocarbons in soil, tobacco, and water. Several chlorinated hydrocarbons, thiophosphates, and carbonates in leached soils. Research: A number of gas chromatographic columns were developed, in which the liquid phase is chemically bonded to the surface of the support. These columns show excellent chromatographic behavior and minimal bleed. They have been successfully used in the analysis of chlorinated hydrocarbons. The alkali-flame detector has been modified to allow the analysis of crude soil extracts for chlorinated hydrocarbon residues without purification. At present, accuracy and precision of this method are being determined.

SUPPORTED BY U.S. Dept. of Agriculture

4.1064, HERBICIDE RESIDUE METHODS
W.A. AUE, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00473)

OBJECTIVE: Develop simplified, rapid, and accurate quantitative gas chromatographic methods for the determination of residues of herbicides, i.e., the chlorinated ureas and the symmetrical triazines such as atrazine, simazine, prometone, propazine, and prometryne. Application of the developed methodology in studies on the herbicide molecules and breakdown products present in plant tissues and soils.

APPROACH: Investigations will be conducted to determine the most efficient columns for separation, packed or capillary; types and amounts of substrates and stationary phases; optimum column temperatures, pressures, and other instrumental operating conditions; and column temperature programming.

PROGRESS: Several herbicides have been determined by microwave induced plasma emission after gas chromatographic separation. The sensitivity of detection is comparable to that using the hydrogen flame detector. Several 2-hydroxy-s-triazine metabolites have been silylated and determined by gas chromatography. An initial, twenty nanogram sample of a 2-hydroxy-s-triazine standard can be processed and detected. Studies are presently underway to develop analytical methods for picloram and methylarsonic acid.

SUPPORTED BY U.S. Dept. of Agriculture

4.1065, STRUCTURE ANALYSIS OF TRACE PESTICIDE RESIDUES BY GLC
W.A. AUE, Univ. of Missouri, School of Agriculture, *Columbia, Missouri* 65201

Several gas chromatographic detector systems (alkali-flame, microwave emission, electron capture, etc.) are adopted to give structural information on pesticide metabolites as GLC effluents. Pure decomposition products and bioextracts are derivatized and selectively determined by one or a series of detectors after gas chromatographic separation. An approximation of the empirical formula and other structural information should be obtainable with only micrograms of substance available.

The research project comprises detector and column development , the investigation on various derivatization procedures and, in the final stages of the program, practical applications of the developed methods.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.1066, TOXICOLOGY OF INSECTICIDES
C.O. KNOWLE, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00571)

4. PESTICIDES

OBJECTIVE: Develop basic studies related to the metabolism and detoxication of insecticidal chemical residues in animals and plants.

APPROACH: Studies will be conducted in vitro to determine the nature of the cholinesterase(s), aliphatic esterase(s), and phosphoryl phosphatase(s) in certain insects. Also, enzymes responsible for insecticide degradation in insects will be studied with regard to type of insecticide destroyed, site of enzymic attack on the molecule, and rate of insecticide destruction. Concurrently, the metabolic fate of certain insecticides will be investigated in plants and animals. Chromatographic, manometric, colorimetric, electrophoretic, and radioisotope techniques will be utilized.

PROGRESS: Before acaricides can be used extensively for mite control on crops, their metabolic fate in plants and animals must be studied. Degradation of the systemic acaricide N'-(4-chloro-o-tolyl)- N,N-dimethylformamidine (Galecron) occurred at a slow rate in and on apple seedlings. When Galecron was applied to the upper surface of apple leaves in situ and the leaves were analyzed after 20 days, 41% of the total applied radioactivity was recovered as the parent compound. Concentrations of Galecron in the leaves and stems (including main stems, branches, and roots) were 17 and 24%, respectively, in terms of total applied radioactivity recovered 20 days after the compound was injected into the main stem. Galecron metabolites characterized from apple seedlings included N'-(4-chloro-o-tolyl)-N-methylformamidine, N- formyl-(4-chloro-toluidine) and 4-chloro-o-tolluidine; the glucoside N- (2-methly-4-chlorophenyl)-D-glucosylamine was tentatively identified. Three benzilate acaricides, chlorobenzilate- C, Chloropropylate - C (isopropyl 4,4'-dichlorobenzilate) and GS 19851- C (isopropyl 4,4-dibromobenzilate) were applied topically to soybean leaves in situ. Analysis of the treated plants revealed that the 3 compounds were quite stable and that they were translocated to other plant tissues to a limited extent.

SUPPORTED BY U.S. Dept. of Agriculture

4.1067, MISCELLANEOUS CHEMICAL INVESTIGATIONS

E.E. FRAHM, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715 (MONB00225)

OBJECTIVE: Provide for miscellaneous chemical work that is so varied in nature that it cannot be provided for by a current research project. Such chemical work is expected to be limited and of only several months' duration.

APPROACH: Chemical work undertaken is expected to require two to three months attention to complete. If answers sought are not attained in that length of time, a project specific for the problem will be initiated or the work discontinued.

PROGRESS: The Iodine and Nitrate Activity Electrodes are routinely used for the determination of Iodine and Nitrate. The procedures for these determinations have been worked out and could be written for publication after a final check against standard samples. The Vitamin A procedure has been modified from the A.O.A.C. method by using special glassware for digestion and extraction of the sample, and a short chromatographic column. These modifications need to be written up for publication when time permits. Hay, milk and fat biopsy samples have been analyzed for chlorinated insecticide residues during the past year. Analytical procedures used are those adopted from the FDA pesticides manual. Better confirmation methods are presently needed, and are being investigated. The surface lipids of Canada thistle are being investigated in cooperation with Mr. J.M. Hodgson, Assoc. Agronomist, ARS, Crops Research Division, USDA. We are attempting to correlate the surface lipid content and composition to the resistance to 2,4-D. We have identified over 80% of the surface lipids. The content and composition of ten ecotypes of Canada thistle were studied during this past summer but the data have not all been correlated.

SUPPORTED BY Montana State Government

4.1068, MECHANISMS OF THE OXIDATIVE DEGRADATION OF PESTICIDE MALEIC-HYDRAZIDE

R.D. GEER, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715 (MONB00228)

OBJECTIVE: Conduct coordinated investigations into the fate of pesticide residue on or in plants, animals or soils. Such factors as metabolism growth and climatic variables may be investigated. Conduct coordinated investigations in the prevention, removal, or destruction of pesticide residues in or on treated plant parts, animals, or animal products which may enter marketing channels.

APPROACH: Reaction rates will be determined by following the course of the reaction spectrophotometrically in combination with stopped-flow reactor techniques where needed. Studies to determine the reaction products will be carried out using isotope dilution techniques, employing 14C labeled reactants. Thin-layer, column, and gas chromatography will be employed to purify reactants and isolate products.

PROGRESS: Under the above W-45 regional project title we have been investigating the rates and mechanisms for the autoxidative degradation of DDT and possible metabolic products under model environmental conditions. An apparatus for recording accurately and automatically the rate of autoxidative degradation of pesticides has been developed. Autoxidation rate data for DDT, DDE, (p-fluoro)DDD, and seven analogs (where one or more of the chlorine atoms in DDT and DDE have been replaced with hydrogen) have been obtained in chlorobenzene at 60 C both with and without cumene as co-substrate. The results indicate that under these conditions ALL the compounds investigated form free radicals which are relatively stable to oxygen and tend to inhibit autoxidation of cumene. The autoxidative rate of these compounds increases as hydrogen is substituted for chlorine in the trichloromethyl group. DDT is autoxidized very slowly under these conditions even though DDT free radicals are formed at an appreciable rate. This behavior gives some chemical rationale for why DDT is so persistent in the environment.

SUPPORTED BY U.S. Dept. of Agriculture

4.1069, DEVELOPMENT OF PRINCIPLES AND PRACTICES OF WEED CONTROL FOR NEBRASKA

G.A. WICKS, North Platte Agric. Expt. Sta., *North Platte, Nebraska* 69101 (NEB-43-002)

OBJECTIVE: Study phenological and ecological characteristics of selected weed species. Develop mechanical, cultural, and chemical weed control measures for crops in Nebraska. Study herbicide persistence and modes of dissipation.

APPROACH: Studies will be made on germination and emergence of troublesome weeds as affected by depths and dates of planting, moisture levels, and dates of seed maturation. Mechanical, cultural, and chemical weed control treatments will be directed toward finding satisfactory control methods for weeds in various crop rotations. Studies will be made on the dissipation and persistence of promising herbicides by planting sensitive crops in the field and by bioassaying soil samples taken at various crop rotations.

PROGRESS: Preplant soil incorporation treatments of pyrazon TD283, cycloate, and postemergence application of pyrazon dalapon gave better weed control and more sucrose/A than pebulate applied preplant and soil incorporated. Herbicide-treated sugarbeet plots kept weed-free by handweeding did not differ from the handweed check in sucrose production. Under most conditions, atrazine applied to sorghum at recommended rates will not persist long enough to cause yield losses of winter wheat in a winter wheat-sorghum fallow rotation. Silvex gave the best control of plains prickly pear with the least grass injury when compared with dicamba, picloram, and 2,4,5-T. Rotary hoeing just prior to spraying improved herbicide performance. Weed competition had a more marked effect on sorghum grain yields than did row spacings (20 vs 40- inch rows) or sorghum populations (42 to 50,000 vs 26 to 28,000 plants/A). Sorghum yields were reduced 4, 12, and 18% by delaying weeding of plots 3, 4, and 5 weeks as compared with 2 weeks after planting. Weeds that did not emerge until 4 weeks after planting did not reduce sorghum yields. Normal use rates of atrazine for weed control in corn applied 3 consecutive years at 3 locations across Nebraska had no significant effect on corn yield or 8 corn yield components.

SUPPORTED BY U.S. Dept. of Agriculture

4.1070, RESIDUE OF PESTICIDES - NATURE, DISTRIBUTION AND PERSISTENCE IN PLANTS, ANIMALS AND ENVIRONMENT

R.S. PARDINI, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00115)

OBJECTIVE: Investigate in detail the effect of selected pesticides on mitochondrial enzyme systems. Study metabolic alterations caused by selected pesticide ingestion.

APPROACH: Mitochondria will be isolated and the effect of selected pesticides on various mitochondrial enzymes determined by published methods. Various selected species of experimental animals will be fed residual amounts of selected pesticides and the resulting metabolic alterations established and studied. Each year the primary research effort will be on the pesticide selected for coordinated study by the W- 45 technical committee.

PROGRESS: DDT, DDE, Kelthane and Methoxychlor inhibited mitochondrial NADH-oxidase and succinoxidase activities in vitro. The site of inhibition by DDT, DDE and Methoxychlor appears to be on the substrate side of cytochrome c in the electron transport chain whereas Kelthane appears to inhibit on the oxygen side of cytochrome c. None of the pesticides checked were as potent as some of the standard electron transport inhibitors. The breakdown products of DDT, p-chlorophenol and dichlorobenzophenone showed little toxicity towards mitochondrial electron transport. Sevin was relatively non-toxic to mitochondrial electron transport. Dihydroxynaphthalene, one of Sevins breakdown products was as potent an inhibitor of mitochondrial electron transport as the most potent chlorinated hydrocarbon tested. Preliminary studies on crystalline carbonic anhydrase indicated that DDT was not a potent inhibitor of the enzyme.

SUPPORTED BY U.S. Dept. of Agriculture

4.1071, PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES

B.R. PAYNE, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00155)

OBJECTIVE: Determine what effect pesticide residues in the environment (air, water, and soil) have on the marketability of crops produced in Nevada. Determine if soils in Nevada formerly treated with DDT and other chlorinated hydrocarbons are at a safe residue level to permit crops to be grown without contamination of the crop.

APPROACH: In cooperation with members of the Plant, Soil and Water Division of the University of Nevada and the County Extension Agents, a thorough survey will be made in each of Nevada's major agricultural areas to determine the degree of contamination by pesticide residues of the air, soils and water in areas that have received heavy applications of chlorinated hydrocarbon pesticides. Many of these fields may be unsuitable for growing crops which have a zero tolerance for the chlorinated hydrocarbon pesticides; therefore affecting the marketability of Nevada's export crops. A monitoring of the same soil and water run-off areas for the substituted pesticides and their metabolites will be made to see if any future problems will arise as a result of the switch from the hard pesticides, the chlorinated hydrocarbons, the less persistent pesticides, the organo phosphates and the carbamates.

PROGRESS: In areas of alfalfa seed production, alfalfa hay is commonly grown for commercial shipment within and out of state. These areas produce over 3 million dollars annually of alfalfa hay. Seed growers use heavy insecticide dosages (usually DDT, toxaphene and Systox) to obtain good insect control. Drift of these insecticides to adjoining hay fields could affect the commercial value of hay if residue tolerances are exceeded. Surveys were made to determine the type of insecticides used in alfalfa seed areas and the potential dangers to the commercial hay growers. Drift studies were conducted in several locations and residue data was collected for DDT and toxaphene. Thirty one samples of alfalfa were analyzed for DDT and toxaphene. DDT ranged from 0.02 to 2.17 ppm residue on baled alfalfa, and toxaphene ranged from 0.1 to 4.35 ppm residue on baled alfalfa. A definite residue problem does exist when DDT and toxaphene are used in fields adjacent to commercial alfalfa hay fields.

SUPPORTED BY U.S. Dept. of Agriculture

4.1072, PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS

B.R. PAYNE, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00106)

OBJECTIVE: Screen new pesticides and determine residues under Nevada conditions. Develop improved methods for analysis of pesticides and their degradation products. Determine pesticide results and degradation products on research and field plots in Nevada. Determine residues on hay and other agricultural commodities.

APPROACH: Develop specific methods for determining pesticide residues under Nevada conditions. Determination of residues of pesticides and their metabolites using these methods. The residue information obtained will be used to set recommended pesticide usage in Nevada.

PROGRESS: Applications of Furadan at 0.2, 0.41, and 0.64 lbs. per acre were applied to first crop alfalfa, and 15 samples were collected at various intervals for analysis by Niagara Chemical Co. Guthion was applied at rates of 0.34 and 0.46 lbs. per acre and 10 samples were collected at various dates after application for residue analysis by Chemagro. Results have not been reported. Both products may be useful in alfalfa insect control. Cubing alfalfa from the swath is a new method of handling alfalfa for feed. Eight cubed alfalfa samples were collected in the Yerington and Lovelock areas for methyl parathion analysis. Samples were analyzed to determine if cubing might affect the residues. There was no methyl parathion residue found in the cubed samples. This data agreed with data from samples of baled and dry chopped alfalfa. Due to the nesting habits of pheasants in alfalfa fields and a recent decline in Nevada pheasant populations, extensive lab and field studies were conducted on the effects of methyl parathion on 3, 10, and 17 day old pheasant chicks. Methyl parathion was applied with a ground spray rig at rates of 1/4, 1/2, 3/4, and 1.0 lbs. per acre to each of the three age groups of pheasant chicks and with aerial application at 1/2 lb. rate to the same age groups of pheasant chicks with and without brood hens in field pens. Deaths occurred at 3/4 and 1.0 lb. rates for 3 and 10 day old chicks in lab studies and with and without brood hens for 3 day old chicks in field studies.

SUPPORTED BY U.S. Dept. of Agriculture

4.1073, SEVIN PARATHION ANALYSIS

L.L. STITT, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00192)

OBJECTIVE: Determine pesticide residues from air and ground applications.

APPROACH: Determine residues on alfalfa from applications of a methyl parathion-Sevin mixture. Data obtained will be used to determine the safety in use of produce from a residue standpoint.

PROGRESS: The Sevin-methyl parathion residue study was an Union Carbide Grant-in-Aid project for 1967-68. The object was to determine the residues on or in alfalfa from the application of the mixture. Material was applied in August of 1967 by air to an alfalfa field in Lovelock and one in Yerington. The mixture was also applied by ground equipment to the plots at the Newlands Field Laboratory. The approximate rate of the mixture was 2.25 pounds which was 1.0 pound actual Sevin and 0.25 pound of methyl parathion. Green alfalfa samples were collected for residues at zero, 3, 7, and 10 days after treatment and alfalfa hay samples were obtained shortly after baling. The alfalfa was cut on the tenth day after treatment. The Division of Biochemistry- Entomology section, University of Nevada analyzed the samples for methyl parathion and Union Carbide analyzed the samples for Sevin. Methyl parathion residues were below the 1.0 ppm tolerance in the green alfalfa samples collected at 7 and 10 days after treatment and for the alfalfa hay samples. Duplicate analyses were made on the green samples from two of the three tests.

Methyl parathion residues at zero day were 7.0, 15.5, 16.5, 19.0, and 18.0. Residues at 3 days after treatment were 1.1, 2.0, 1.8, 1.7 and 1.5. Sevin analyses for all samples were below the established tolerance of 100 ppm; the range was from a high of 43 ppm to a low of 1.64 ppm.

SUPPORTED BY Nevada State Government

4.1074, CLEARANCE OF SAFE, EFFECTIVE CHEMICALS FOR MINOR USES

C.C. COMPTON, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00432)

OBJECTIVE: Evaluate current data and determine research needed for the clearance of chemicals for minor uses on agricultural products.

APPROACH: Pesticide clearances for which the chemical industries will not assume the initiative but which are desired in the public interest will be compiled for all states. Data requirements of the Food and Drug Administration and the Pesticide Registration Division for the clearance of these chemicals will be determined. Available data will be assembled from State Experiment Stations, ARS and industry. Additional data requirements will be met through the conduct of additional research in these agencies. When adequate data for the processing of a clearance on the basis of establishment of tolerance, extension of use involving a tolerance or on a no residue use is available, initiative will be taken to obtain clearance and to stimulate industry to market a product approved and labeled for the desired use.

PROGRESS: A tolerance and registered labels were obtained to cover the use of methyl parathion on sunflowers to control the head moth. Petitions have been submitted for tolerances covering the use of malathion on hops; dichlorvos and calcium cyanide on cucumbers, lettuce, tomatoes, and radishes grown in greenhouses; commercial sulfuric acid for control of weeds on onion and garlic. Label extension problems include detailed data procurement for the clearance of the milky disease bacteria, Bacillus sp. for Japanese beetle control in pastures; calcium cyanamid for the control of mummy disease on blueberries in New Jersey; (4-CPA) to improve fruit set on tomatoes; smear EQ 335 for control of screw-worm in livestock; sodium trichloroacetate as a herbicide in sugar beet and sugarcane plantings; sodium arsenite for the control of black measles, and dead arm on grapes in California; DNOC as a thinning agent for apples; 1-naphthaleneacetic acid on olives; pyrethrins and piperonyl butoxide on stored potatoes, on chickens, and for the control of blow flies on fish and meat; dichlone on mint; 4-(2,4DB) on canning peas and other legumes; 4-MCPB on canning peas, and copper arsenate on pears.

SUPPORTED BY U.S. Dept. of Agriculture

4.1075, FATE OF PESTICIDES

W.A. MACLINN, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00901)

Progress: This is a heavily supported interdepartmental research program involving 8 scientific co-investigators and 12 technicians. The study has involved the reaction of 2 herbicides and 4 pesticides on exposure to sunlight, water, plants, and soils in terms of (a) kinetics of the reactions, (b) environmental conditions affecting the reactions, and (c) identification of the intermediate and final oxidation products. At least one family of herbicides containing analine appears to be catalyzed by microbial enzymes (peroxidase) to azo compounds. Thin layer and gas chromatographic methods were devised for the separation and measurement of residues of diazinon and its possible metabolites. Photolysis products were produced from moban, metobromuron, linuron and monuron. Phototoxicity studies of the phenylurea photoproducts are in progress. Chemical oxidation of an organophosphorus compound, parathion, was studied in water. An intermediate product, Paraoxon, was formed and is considered to be more toxic than Parathion. A herbicide, diphenamid, was shown to reduce absorption of mineral nutrients from the soil in tomato plants. Linuron and chlorobromuron reduced transpiration on a leaf area basis. Degradation of Diazinon and Diazoxon was found to be a function of pH in water. These products undoubtedly have a long residual life in natural waters of a pH of 5.5 to 8.5. The biological oxidation of the herbicide 2,4-D, is tentatively assumed to result in 8CO(2) plus 2H(2) O plus 2HCL. In activated sludge systems the reaction seems to be of zero order kinetics. A technique was developed for recovery, separation and confirmation of four pesticides, their oxygen analogs and their organic hydrolysis products in aquatic environments.

SUPPORTED BY New Jersey State Government - Trenton

4.1076, PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES

S.B. RANDLE, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00478)

OBJECTIVE: Develop and standardize sampling and analytical methods for the determination of pesticide residues in or on raw agricultural commodities. Determine composition and persistence of residues resulting from the use of pesticides and plant growth regulators applied to plants and animals, determine how to achieve the purpose of each use with the least residue in or on the raw agricultural product and without undue contamination of other commodities, soil, water or other parts of the environment.

APPROACH: Research will include improvement of methods of residue and metabolite determinations; and determination of residues on forage, animal products, fruits, and vegetables.

PROGRESS: Personnel submitted samples from treated plots for residue analysis. Applications were controlled and environmental factors noted. Disappearance curves were plotted. The experiments completed were: azodrin on cranberries; azodrin, dieldrin and gardona on blueberries; gardona on cranberries; and DDT on lettuce. Other samples are in analysis. Most of the work used gas chromatography for the final determination and positive results were obtained with most of the samples although many were extremely low. The object of the DDT-lettuce experiment was to determine whether a spray program could be devised so that tolerance requirements could be met without removing the outer leaves. There was only one project on development of new methods successfully completed this year. However, numerous modifications were made to accomodate existing methods to the analyses. A modified re- ignition system for the flame photometric detector was developed for use with the Micro Tek gas-liquid chromatograph and it has been submitted for publication. This information is used by our extension specialists in formulating recommendations.

SUPPORTED BY U.S. Dept. of Agriculture

4.1077, BIO-ASSAY OF SMOKE CONDENSATE FROM TOBACCO TREATED WITH AGRICULTURAL CHEMICALS

F.G. BOCK, Health Research Incorporated, *Buffalo, New York* 14203 (709-053-A102(C))

OBJECTIVE: Perform bio-assay of cigarette smoke condensate from experimental tobacco samples to determine carcinogenic activity.

APPROACH: Five cigarette samples, approximately 60,000 cigarettes per sample, will be subjected to bio-assay of smoke condensate using thirty or more rodents per sample. Cigarettes will be made of flue- cured tobaccos produced in North Carolina from fields treated with specified agricultural chemicals used for pest control.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

4.1078, KIT, OPERATIONS, AERIAL DISPERSAL

R.W. UPHAM, U.S. Army, Med. Equip. Res. & Dev. Lab., *Flushing, New York* 11359

Technical Objective: To design and fabricate a kit that will be used by ground personnel in support of aerial dispersal of insecticides for control of disease vectors affecting troops in the field.

SUPPORTED BY U.S. Dept. of Defense - Army

4.1079, BIOLOGICAL DEGRADATION OF AGRICULTURAL PESTICIDES
J.B. BOURKE, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00022)

OBJECTIVE: Identify and characterize intermediate and end products of agricultural pesticides and the mechanisms and pathways of their biological degradation.

APPROACH: Paper, thin layer, gas-liquid, and column chromatographic techniques will be used to isolate metabolites and end products. Characterization will involve: ultraviolet, infrared, and mass spectroscopy; chemical degradation, elemental analysis, optical rotary dispersion, autoradiographic and chromatographic techniques. Products will be bioassayed on rats and invertebrates. Studies will include effect of enzyme systems isolated from plant tissue, insects and rats. Radioactive and unlabeled materials will be employed.

PROGRESS: Toxicological experiments in which varying doses of the insecticide Torak were fed via stomach tube to male and female rats demonstrated lower LD(50) for females than males. Dietary protein did not appear to affect toxicity. This pesticide was also shown to be rapidly metabolized in both male and female rats and the three metabolites excreted in the urine (60%) and feces (40%). Urinary excretion was predominantly within 24 hours and fecal excretion essentially complete within 48 hours. Absorption of the pesticide into plants was small resulting in very minor translocation, probably as a metabolite.

SUPPORTED BY U.S. Dept. of Agriculture

4.1080, PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES
J.B. BOURKE, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00020)

OBJECTIVE: Determine the composition and persistence of residue resulting from the use of pesticides and plant growth regulators applied to plants and animals and determine how to achieve the purpose of each use with the least residue on or in raw products when marketed without undue contamination of other commodities such as soil, water or other parts of the environment. Develop and standardize sampling and analytical methods for the determination of pesticide residues and resulting metabolites as degradation products in or on raw agricultural commodities.

APPROACH: Analysis of residues on samples submitted by station biologists using existing methods or by the development of new methods where necessary.

PROGRESS: The pesticide laboratory has received approximately 900 samples for residue analysis of 42 different chemicals. These represented 17 categories of commodities submitted by station personnel. In addition over 150 feed samples were examined for Dieldrin in an animal feed monitoring program. Only one sample was found to be in excess of the FDA 0.05 ppm action level. Method development resulted in the adoption of the flame photometric gas chromatographic detector. Persistence of Aldicarb and Disulfoton on red raspberry after granular application was studied by laboratory bioassay of single leaves with Amphorophora agathonica to ensure continuance of control data in periods of low field populations of the aphid. Considerable variations were found within each plot. In general, control was optimal within 1-2 weeks after heavy rain and dropped near zero in dry periods.

SUPPORTED BY U.S. Dept. of Agriculture

4.1081, TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURE COMMODITIES
M.C. BOURNE, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00104)

OBJECTIVE: Develop procedures for the removal, reduction, or detoxification of pesticide residues and conversion products in agricultural commodities.

APPROACH: An attempt will be made to devise new methods of washing to remove pesticide residues from the surface of agricultural commodities that are more effective than existing washing techniques. Fruit and vegetable commodities will be washed using new techniques that have been suggested by the fundamental studies on detergency recently published by Bourne and Jennings. In particular, the effectiveness of Dupre washing to remove residues, and methods of making the residues more easy to remove (conversion of species 2 into species 1) will be investigated.

PROGRESS: Apples sprayed with a uniform load of DDT were used to study the effectiveness of the Marangoni effect in removing pesticide residues from sprayed crops. (The Marangoni effect occurs when a solid surface passes through an air-liquid interface). The Marangoni effect removed about one third of the pesticide residue, with most of the reduction occurring in the first 20 dips through the surface, and almost no residue being removed after 40 dips. A test for saturation of the surface of the detergent solution with the removed pesticide proved negative. Agitation of the fruit in the detergent solution helps remove pesticide residue by means of the increased work function. Rome variety apples usually give up more of the DDT residue in washing treatments than do the McIntosh and Golden Delicious varieties.

SUPPORTED BY U.S. Dept. of Agriculture

4.1082, DEVELOPMENT OF APPLE SPRAY PROGRAMS IN RELATION TO SPRAY RESIDUE RESTRICTIONS
E.H. GLASS, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00503)

OBJECTIVE: Develop control programs for apple pests which will produce residues within the limits established by Federal Authorities.

APPROACH: Sample fruits periodically from experimental field plots and conduct residue analyses for quantities of residual pesticides to determine degradation curves and harvest residues under orchard conditions resulting from established or new control programs.

PROGRESS: Several fruit samples were taken from control experimental plots at invervals after treatment and at harvest and sent to the manufacturers for analysis of spray residues. Six seasonal control programs were evaluated and compared with a fungicide check in orchard 12A on six apple varieties. The entire block was treated with appropriate prebloom fungicide sprays and one application of petroleum oil at tight cluster bud stage. Experimental treatments were applied at petal fall and in 6 cover sprays. All programs (Guthion, Gardona, Zolone, Imidan, GS 13005 and Furadan) gave good insect control. Golden Delicious fruits were so badly russeted by early season weather that comparisons between programs were not valid. Gardona caused lenticel enlargment on R.I. Greening and Monroe fruits. GS 13005 caused enlarged lenticels on R.I. Greening, McIntosh and Rome fruits. Residue samples were taken as needed.

SUPPORTED BY New York State Government - Albany

4.1083, PESTICIDE RESIDUES IN AND ON RAW AGRICULTURAL COMMODITIES
W.B. DUKE, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00058)

OBJECTIVE: Determine residues of herbicides in or on forage crops from foliage and soil applications, and in animal products produced from these forage crops.

APPROACH: Established stands of bluegrass and timothy will be sprayed with 2,4-D. Residues of 2,4-D will be determined at weekly intervals on the forage produced. Seedling stands of alfalfa and birdsfoot trefoil will be treated with different rates of dalapon and the levels of residue determined at 8, 10, 12 and 16 weeks after treatment. The regrowth after an August harvest will also be sampled. The work on the development of a chemical method for 2,4,5-TP determination in forage will be continued. Crops to be studied are birdsfoot trefoil and timothy. Work will also be initiated on wheat grain under this phase of the project.

PROGRESS: During 1969, studies were conducted to determine the fate of the herbicide VCS 438 in seedling alfalfa. Initial work has been the development of an analytical method of detection of the parent material. A glc method involving column partition clean-up and electron affinity detection seems to be best. Field samplings of alfalfa treated with 2 and 4 lb/A VCS 438 have

been taken at 2, 4, 6 and 8 weeks after application and are being analyzed for parent product disappearance. Residue samples were taken from plots treated with several levels of the herbicide combination alachlor (LASSO) plus atrazine for submission to Monsanto Chemical Company. Other residue samples taken for submission to various companies involved the following material: BASF 2903-H; C- 6313; C-6989; and BASF 2903-H plus atrazine. During 1969, 1700 residue analyses were made including 19 pesticides and 17 commodities. New sensitive analytical methods were developed for 5 compounds. The metabolism of seven new agricultural chemicals (the insecticides Gardona and Hercules 14503 and the herbicides Amiben, Bromacil, Fenac, Herbisan and Planavin) were studied in dairy cows. Analysis of milk, urine and feces was conducted for these compounds and possible metabolites. The possibility of their decomposition in rumen fluid and liver microsomes was investigated to learn possible sites of metabolism. Most of this work has been submitted for publication. Research on analysis and metabolism of pesticides is essential for obtaining federal approval for pesticide use by the public.

SUPPORTED BY U.S. Dept. of Agriculture

4.1084, A STUDY OF RESIDUES RESULTING FROM GROWTH REGULATOR SPRAYS USED IN APPLE INDUSTRY

L.J. EDGERTON, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00226)

OBJECTIVE: Determine by use of tagged chemicals the amounts of residue that may result from these sprays.

APPROACH: Preliminary studies on the absorption of naphthaleneacetic acid (NAA) and naphthaleneacetamide (NAD) by apple leaves using C labeled compounds has indicated that this procedure is suitable for quantitative determination of these growth regulators. The radioactive compounds will be applied at appropriate concentrations with hand sprayer or calibrated pipette to limbs bearing sufficient fruit for periodic sampling and analysis.

PROGRESS: Orchard tests in 1969 confirmed the earlier trials on the effectiveness of preharvest sprays of 2-chloroethylphosphonic acid (Ethrel) for promoting abscission of cherries and apples. Because of the need for such a treatment in connection with mechanical harvesting of these fruit, residue and metabolism studies were conducted using C labeled Ethrel. Following application of the isotope to fruit and leaf surfaces, samples were collected for analysis periodically up to the typical harvest period 7 to 14 days after application. In both sweet and sour cherries Ethrel was found to move into the fruit from adjacent leaves with the residue reaching a peak 1 to 3 days after application. From then to harvest the level decreases as degradation of the Ethrel continues. No labeled metabolites were found to persist in the fruit. Previous work had shown that Ethrel decomposes to ethylene in fruit tissues. Similar results were obtained with apple fruits although the level in the fruit at harvest was somewhat lower than that in the cherry varieties. Good agreement was obtained between these studies with labeled Ethrel and the analytical results obtained on similar fruit samples treated conventionally with cold Ethrel and analyzed with a gas chromatograph using a method under study by the Pesticide Residue Laboratory. Further studies were made on the residues resulting from the use of Alar, alone and combination with Ethrel, on two apple varieties which were mechanically harvested for processing. Samples were collected at harvest for residue analysis and processing trials. Similar trials were also made on Alar-treated cherries and peaches.

SUPPORTED BY U.S. Dept. of Agriculture

4.1085, CYCLING AND EFFECTS OF CL36 LABELED DDT ON SOIL INVERTEBRATES IN AN OLD FIELD COMMUNITY

D.L. DINDAL, State University of New York, School of Forestry, *Syracuse, New York* 12224 (AT(30-1)3974)

The relationships of technical DDT to invertebrates in soil litter are being analyzed in a 10 A field near Urbana, Ohio. DDT residues in the invertebrates are being identified and quantified. Also, storage equilibria and magnification of residues are being determined. Treated and non-treated areas are compared, showing alterations in the invertebrate food-web relationships. This includes the lethal and sublethal effects on the quantity and quality of population densities and changes in species diversity. These objectives will clarify the ecology of non-target invertebrates as affected by pesticides.

The field use of Cl36 labeled DDT permits flexibility in realizing these goals. Assay methods for pesticide residues include liquid scintillation spectrometry, thin layer and gas chromatography, and microautoradiography. Wet and dry funnel extraction methods, and grease plating techniques are employed for invertebrate sampling.

Results: Many accurate illustrations have been made representing more than fifty microarthropod families collected in both treated and untreated sites. These are used to implement the solution of taxonomic problems thus providing understandable records for educational and reporting purposes.

Soil invertebrate population numbers on the treated site show a stimulatory response especially during Nov. and Dec. Between sample variation during each month is greater in treated versus untreated microarthropod populations. Trends in soil microbial respiration are very similar to those in microarthropod populations.

SUPPORTED BY U.S. Atomic Energy Commission

4.1086, MECHANISM OF PHOTOSYNTHESIS INHIBITION BY HERBICIDES

G. ZWEIG, Syracuse University Res. Corp., *Syracuse, New York*

Our studies indicate that certain quinone pesticides cause a disruption of the cell structure of Chlorella. In the coming year, we propose to study in greater detail the effect of quinones on the ultrastructure of Chlorella and to correlate these effects with the observed physiological-biochemical changes. Special attention will be given to characterizing the alterations in the cytoplasmic membrane by both conventional cytological and freeze-etching techniques. The possibility of damage to the cell membrane will also be investigated by studying the release of soluble cellular components from the treated cells. It is hoped that a study of the changes in the cell ultrastructure resulting from treatment with certain quinones will provide additional information on the site of action of these pesticides. It is proposed to extend this investigation to include the effects of the quinones on the ultrastructure of animal cells grown in tissue culture. Such studies will indicate if these pesticides exert effects on animal cells similar to the ones they produce in plant cells, thus enabling us to ascertain their potential as a health hazard.

We have observed that certain quinone herbicides cause an increase in sucrose synthesis accompanied by a reduction in lipids and amino acids in Chlorella. Parallel studies will be conducted to determine if these chemicals produce similar effects on the photosynthetic incorporation of CO_2 by higher plants. Also, the mechanism by which quinones and diquat alter the flow of carbon along various biosynthetic pathways in Chlorella and chloroplasts will be investigated.

The effects of photosynthesis-inhibiting herbicides like substituted ureas and s-triazines on the photosynthetic bacterium Rhodospirillum rubrum will be studied and compared with the effects on the green algae Chlorella. It is hoped such studies may demonstrate photosynthetic reactions common in aerobic and anaerobic organisms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.1087, EFFECT OF ENVIRONMENTAL PARAMETERS ON PESTICIDAL STABILITY

Z. GAIBEL, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The elaboration of the nature of the degradation products (as well as their rates of formation) of diverse classes of pesticidal agents and related derivatives is of importance in the identification of any potential hazardous agent that may be produced under environmental conditions.

The irradiation of methylenedioxy benzene derivatives such as the isomeric safroles, and the pesticidal synergist piperonyl butoxide, both per se and in polar and non-polar solvents is being in-

vestigated. The irradiation of safrole has been shown to yield a cyclic methylenedioxyphenyl derivative as well as a complex mixture of phenolic products.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.1088, METHODS OF CONTROLLING TOBACCO DISEASES WITH CHEMICALS NOT LEAVING HARMFUL RESIDUES

J F. CHAPLIN, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (0500-03-14(CA))

OBJECTIVE: Develop better methods of controlling certain tobacco diseases including brown spot, black shank, nematodes and black root rot through use of chemicals which leave no harmful residues.

APPROACH: Suitable field sites will be located where the infestation of the various diseases is moderate to high and the disease distributed uniformly throughout the test area. Plants for evaluation of the chemical treatments will include one or more resistant varieties, where available, as well as a susceptible variety. The extent of disease control will be determined by leaf and root examinations, as well as indirectly by yield of leaf produced. Leaf samples will be taken for chemical analysis, including investigations of residual compounds or metabolic products resulting from application of the chemicals.

PROGRESS: Vidden D or DD (1, 3 dichloropropene and 1, 2- dichloropropane), EB-85 (Ethylene dibromide), Telone PBC (1, 3 dichloropropene and related chlorinated C(3) hydrocarbons) and Vorlex (17 percent methyl isothiocyanate, 15 percent chloropicrin, 68 percent DD) reduced incidence of root knot. Telone PBC or Vorlex reduced the incidence of black shank of 4 varieties with resistance from low to high. Several chemicals reduced the incidence of black root rot, but none gave satisfactory control with a susceptible variety. For bacterial wilt, the most effective control and highest value increase over the untreated check were obtained when Telone PBC or Vorlex was used with highly resistant varieties. Dyrene (2,4-dichloro-6-0-chloroanilino-5-triazine), Duter TPTH (triphenyl tin hydroxide), Polyram (zinc polyethylene thiuram disulfide complex), and Maneb (Manganous ethylenebis (dithiocarbamate), and MH-30 (Diethylamine salt of maleic hydrazide) reduce the incidence of brown spot. Chemical analysis of the cured leaf suggest that the balance of alkaloids, sugars, and chlorine was not significantly affected. The bromide content in leaf treated with Telone PBC was 93 ppm compared with 36 ppm in the untreated. No residues from Mocap (O-Ethyl S, S-dipropyl phosphorodithioate) were found in rates of 8 lbs/A. Residues in cured leaf sprayed with Duter ranged from 6 to 12 ppm vs. 0.3 to 0.4 ppm in the untreated. Residues of 13 to 17 ppm were found in leaf from foliage applications of Dyrene; 13 to 18 ppm from Maneb.

SUPPORTED BY U.S. Dept. of Agriculture

4.1089, KINDS AND LEVELS OF PESTICIDES OR METABOLIC PRODUCTS IN TOBACCO LEAF AND SMOKE

J.F. CHAPLIN, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (0500-03-20(CA))

OBJECTIVE: Identification of kinds and levels of pesticides or their metabolic products in tobacco leaf and smoke condensate when treated with various pesticides.

APPROACH: Employ standard chemical methods to identify and determine levels of pesticides and sucker control agents from tobacco leaf and cigarette smoke condensate treated with these chemicals. Three types of cigarette tobaccos will be used, Maryland, burley and flue- cured. Sucker control agents used will include MH-30, Penar, and Methyl caprate. Tobacco plants will also be treated with nematocides and fungicides; and residues will be determined on the material.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

4.1090, THE CONTROL OF TOBACCO DISEASES BY CULTURAL PRACTICES AND CHEMICALS

C.J. NUSBAUM, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC05028)

OBJECTIVE: Develop, evaluate, integrate efficient tobacco disease control systems involving cultural, chemical treatments - effects on pathogen ecology, tobacco yield quality, leaf analysis.

APPROACH: Long range, standarized field experiments underway and planned at selected sites involve combinations of chemical and cultural treatments to control black shank, Granville wilt, black root rot, root knot and disease complexes in varieties having different resistance levels. Field studies on brown spot control by fungicides, sanitation, cultural practices and harvesting methods. Data obtained on plant stands, growth, pathogen populations, inoculum levels, disease indices, crop yield and value, chemical and residue analysis of cured leaf. Statistical analysis of variance, treatment x location x season interactions, and inoculum x disease correlations.

PROGRESS: Factorial experiments having various combinations of control practices have shown the relative roles of host resistance, crop rotation and chemical soil treatment in complex disease situations involving root knot and black shank or southern bacterial wilt. For varieties susceptible to black shank or southern bacterial wilt, either crop rotation, chemical soil treatment, or a combination of these practices is inadequate. However, performance of resistant varieties, even those with high level resistance is greatly improved either by rotation, or soil treatment and especially by a combination of the two. Moreover, the combination of root-knot resistance with black shank or wilt resistance greatly reduces losses to these diseases whether crop rotation or soil treatment were used or not. For example, in field infested with both the root-knot and black shank pathogens, acre value for variety Coker 254 (highly resistant to both) were $1261, $1270, and $1309 for no rotation and no soil treatment, for rotation and no treatment and for treatment and no rotation, respectively. Comparable values for variety Speight G-36 (highly resistant to black shank but susceptible to root knot) were $931, $1122, and $1257. These performance data were well correlated with black shank development. Disease indices for Coker 254 ranged from 2 to 7 and for Speight G-36 from 24 to 45. In these tests, soil treatment with Telone C (dichloropropene 85% - chloropicrin 15%) was comparable in effectiveness to crop rotation.

SUPPORTED BY North Carolina State Government - Raleigh

4.1091, PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER

T.J. SHEETS, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC05015)

OBJECTIVE: Perform analytical phases of research jointly undertaken by the Pesticide Residue Research Laboratory and cooperating departments on the disappearance of pesticides from plants, animals, and soils. Cooperate with IR-4 project personnel to establish tolerances and label clearances for minor uses of pesticides. Determine movement of selected pesticides in runoff from cultivated fields and downward into soil profiles and ground water.

APPROACH: Experimental samples will be collected by personnel in cooperating departments and samples will be analyzed for pesticides at different times after application. Residue data on minor uses of pesticides will be submitted to the IR-4 project coordinator to assist in developing tolerances. Under Objective 3 selected pesticides will be applied to soils under field conditions, and samples of soil and surface runoff will be collected periodically and analyzed for residues.

PROGRESS: An electron-capture gas chromatographic method was developed for the determination of trifluralin and Daxtron in soil and water. The method will detect as little as 10 ppb in soil and 1 ppb in water. Residues of DDT were determined on sweet potatoes removed from storage at several times after dusting for sweetpotato weevil control. Residues on unwashed potatoes ranged from 0.16 to 9.2 ppm. On washed potatoes the range was 0.09 to 2.3 ppm. These data were used to support a request for extension of the 7 ppm tolerance of DDT on sweet potatoes. Experiments were initiated to study (1) movement of DDT, toxaphene, and trifluralin in surface washoff from cotton fields and (2) movement and persistence of the three pesticides in soil. Preliminary results indicate that 50 percent or more of the pesticides in washoff from heavily sprayed fields was associated with suspended particulates that were retained by paper filters.

Concentrations of Daxtron in washoff from peanut fields were greatest during the first two rains after application. Thereafter, concentrations decreased rapidly to low levels (about 1 ppb). About 5% of the Daxtron applied was found in surface washoff from a sprayed sandy loam soil over a 5-month period.

SUPPORTED BY North Carolina State Government - Raleigh

4.1092, PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES AND ENVIRONMENTS

T.J. SHEETS, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC01073)

OBJECTIVE: Participate in analyses of samples from preplanned cooperative research experiments designed to solve residue problems of regional interest (cooperative sample analysis). Study the movement and ultimate fate of pesticides in plants, animals and soils including toxic intermediate and final breakdown products (Behavior). Determine the rates of disappearance of pesticide residues from agricultural commodities and environments (Dissipation).

APPROACH: Research to be conducted under Objective 1 will be planned jointly by the S-73 technical committee, and selected samples will be analyzed for pesticides in North Carolina as a part of a larger effort to determine variation in analytical results among laboratories. Under objective 2 and 3 soils and plants will be treated with pesticides and samples assayed periodically for the parent compounds and their degradation products.

PROGRESS: Residues of diazinon, chlordane, and Bayer 39007 (Baygon) on dishes in storage cabinets were determined at five intervals from 0 to 28 days after application for control of household pests. Over the 28-day period residues of diazinon decreased from 325 to 0.7 micrograms/dish; residues of chlordane dropped from 281 to 23 micrograms/dish; and those for Bayer 39007 dropped from 570 to 56 micrograms/dish. Several experiments have been initiated since this project was approved in July 1969. Research now in progress includes a cooperative study with Louisiana State University on residues of DDT, carbaryl, azinphosmethyl, and SD-8447 (Gordona) on sweet potatoes after application for sweetpotato weevil control; surveys of manufactured tobacco products and cured tobacco leaf from different market areas for insecticide residues; and the effects of oral administration of phenobarbitol and charcoal on levels of DDT in milk from contaminated cows.

SUPPORTED BY U.S. Dept. of Agriculture

4.1093, PEPTIDE HYDROLASES IN PESTICIDE METABOLISM BY PLANTS

G. GRAF, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-H-02-013)

OBJECTIVE: Isolate and purify peptide hydrolase enzymes from plants. Evaluate quantitatively the role of these enzymes in pesticide metabolism.

APPROACH: Proteinases and peptidases that may be responsible for metabolism of certain pesticides (carbamates, thiocarbamates, ureas, anilides) by hydrolysis will be isolated and purified to obtain enhanced specific activities. Individual enzymes will be characterized and the kinetics and the mechanism of pesticide degradation will be investigated.

PROGRESS: N -benzoyl-DL-arginine p-nitroanilide activity is quite widespread in the roots and shoots of many crop plant seedlings. Similar activities could be detected with the related chromogenic p- nitroanilides of L-lysine, L-cystine, succinyl-L-phenylalanine, glutaryl-L-phenylalanine and L-leucine. Three amidohydrolases have been isolated from the shoots of soybean seedlings and one amidohydrolase from soybean roots has been purified fifty-fold. A soluble peptide hydrolase has been insolated from sunflower roots and purified thirty- fold through salt precipitation, gel filtration and hydroxylapatite chromatography. An attempt has been made to develop new chromogenic substrates to detect amidohydrolase activity. o-Nitroacetanilide can be used as a direct chromogenic substrate to assay enzymatic deacylation and the usefulness of this compound was demonstrated by using it as a substrate with isolation and partial purification of deacetylase enzymes. The survey for the detection of herbicide hydrolase activity seems to indicate that Taraxacum officinale (dandelion), Hordeum jubatum (squirrel tail) hydrolyzes propanil, whereas Asclepias syriaca (milkweed), Triticum durum (wheat) and Pisum sativum (pea) hydrolyzes IPC, fenuron and propanil.

SUPPORTED BY U.S. Dept. of Agriculture

4.1094, PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES

D.C. NELSON, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-H-12-014)

OBJECTIVE: Effects of pesticides on acceptability and/or nutritive value of agricultural commodities.

APPROACH: Work will be concentrated on trace levels of 2,4-D in potato tubers; determine the level or residues found in potato tubers after harvest and in storage, study the effect of storage on the retension or breakdown of residues, evaluate the effects of trace levels of 2,4-D on market quality of potatoes. Residue analysis will be by standard gas chromatographic techniques on appropriate tuber samples obtained at harvest and during storage to determine levels and retension of 2,4-D. Quality will be measured by evaluation of skin color and sheen of red varieties, skin blemishes, keeping quality in storage and uniformity in size and shape, and cooking quality.

PROGRESS: Effort in 1968 has been limited to developing the methodology for and analysis of 2,4-D residues in potato tubers. A method developed earlier under this project by Smith & Klosterman for potatoes was abandoned in favor of the Yip method because of wide-spread use of the Yip method on other crops. Good quantitative results were obtained with acid fractions of 2,4-D from potatoes sprayed with 2 ounces or more of 2,4-D and analyzed after harvest, 2,4-D acid residues in samples left in storage for 6 months were too small to quantify unless rates of 4 ounces per acre or more had been used. The sample clean-up of acid fractions using the method of Yip was satisfactory. A more general procedure used for both acid and esters has not been completely satisfactory, with the ester portion particularly difficult to clean-up. The microcoulometric detector has at times picked up halogen containing compounds in the potato extracts that are naturally occurring, 2,4-D metabolites or florisil contaminants. The PGBE esters have been difficult to elute from the florisil columns, and work is continuing to develop a satisfactory technique to separate these ester(s) from potatoes. Continuing problems, particularly with our microcoulometric detecter as well as some other instruments have caused appreciable delays in this work.

SUPPORTED BY U.S. Dept. of Agriculture

4.1095, FATE AND PHYSIOLOGICAL EFFECTS OF CHEMOSTERILANTS AND OTHER COMPOUNDS

A.C. TERRANOVA, U.S. Dept. of Agriculture, Metabolism & Radiation Lab., *Fargo, North Dakota* 58103 (00ENTQ0101360100)

OBJECTIVE: Study the absorption, storage, excretion, metabolism, and mode of action of chemosterilants, certain insecticides and potential insecticides such as natural products extracted from various insect species and develop analytical methodologies for these chemicals and for their metabolites.

APPROACH: Develop analytical methodologies for those chemosterilants that probably will be used in pilot eradication tests in order to assess residue hazards and stability of the chemosterilant in medicated diets, baits, and other formulations. Determine the metabolic fate of chemosterilants in invertebrates and vertebrates. Determine the pathological, physiological, and biochemical effects of chemosterilants and potential insecticides on vital life processes in insects.

PROGRESS: Among a number of new juvenile hormone analogs synthesized, none showed unprecedented activity. The monohydrogen phosphate ion in phosphate buffers strongly attacks alkylating chemosterilants. A novel synthesis was developed for 3-aryl-2- oxazolidone. A series of phenyl aziridines and their precursors were synthesized and the activation of substituents on benezene by other substituents was determined in order to explain and predict structure activity relationships of chemosterilants. The colorimetric analytical procedure for alkylating agents

was adapted for busulfan, automated and used to determine the persistence of busulfan in boll weevils and to determine the uniformity of busulfan in medicated diets. 10-epoxy farnesenic acid ethyl ester sterilized newly emerged female house flies.

SUPPORTED BY U.S. Dept. of Agriculture

4.1096, METABOLITE FORMATION IN METABOLISM OF TRIAZINE HERBICIDES BY THE ANIMAL

E.J. THACKER, U.S. Dept. of Agriculture, Metabolism & Radiation Lab., *Fargo, North Dakota* 58103 (039900870136)

OBJECTIVE: Isolate and identify metabolites produced in animal metabolism of triazine herbicides.

APPROACH: Synthesize ring- and side-chain analogues of Propazine, Simazine, Atrazine and Prometone to administer to rats, goats, and sheep. Rats will be used to develop techniques, determine constancy of metabolism, effect of adaptation to chemical and dose level on metabolism. Lactating goats and sheep will be used to determine metabolite formation in ruminants. Techniques of isolation will include all forms of chromatography and other chemical procedures depending on chemical properties of the compound. Identification procedures will involve physical characterization by spectrometry (infrared, ultraviolet, nuclear magnetic resonance mass) and comparison with properties of synthesized hypothesized metabolites.

PROGRESS: Metabolic studies with the experimental triazine herbicide, 2-methoxy-4-ethylamino-6-sec-butylamino-5-triazine (I) and its 2-hydroxy analogues, 2-hydroxy-4-ethylamino-6-sec-butylamino-5- triazine (II), 2-hydroxy-4-amino-6-sec-butylamino-5-triazine (III), and 2-hydroxy-4-ethylamino-6-amino-5-triazine (IV) have been conducted with the rat. Compounds I, II, and III were excreted in the urine (70%) and feces (20%). Fifty percent of the administered dose of compound IV appeared in the urine. No radioactivity appeared in the expired CO(2) or as residual in the animal carcass from these compounds. The urinary excretion from compound I was separated into 16 metabolites. Four of these, constituting 90% of the urinary radioactivity, were identical to the major metabolites isolated from cow and goat urine. Ammilene (2- hydroxy-4,6-diamino-5-triazine) was the major metabolite of compound I metabolism in the rat, goat, and cow. Comparison of the metabolic pathway of compounds II, III, and IV with that of I suggests that the metabolism of these triazines by the rat may be directed by the type of substitution of the 2-position. With a 2-methoxyl group N-demethylation is extensive (90%); with a 2-hydroxyl group no N-demethylation occurred, but minor N-debutylation (9%) and significant butyl hydroxylation (79%) took place.

SUPPORTED BY U.S. Dept. of Agriculture

4.1097, METABOLISM OF CHLORINATED HYDROCARBON INSECTICIDES IN LIVESTOCK

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OBJECTIVE: Analyze physiological conditions related to metabolism of chlorinated hydrocarbon insecticides in livestock.

APPROACH: Deildrin, a typical chlorinated hydrocarbon, will be fed sheep in a factorial design with 120 head at 0, 0.5, 1.0, 2.9 mg. dieldrin per kg. body weight at restricted, carbohydrate or fat supplemented energy levels. Two treated sheep will be slaughtered at 0, 4, 8, 16 and 32 weeks. Various tissues, fluids, and whole carcass samples will be saved for fat, dieldrin, and metabolite analyses. Radiolabeled dieldrin will be administered sheep at high dieldrin intake, each energy level and slaughter period to trace metabolism and identify possible metabolites.

PROGRESS: Rats were fed three levels of dieldrin, 0.04, 0.2, and 2.0 ppm, with total feed consumption fixed. Equilibrium between dieldrin intake and excretion was reached in 42 and 49 days, respectively, by male and female rats. When the rats were killed at the end of 273 days, 5% of the total dose remained in the carcasses of the females and 2% in the carcasses of the males regardless of the level fed. Sheep are being fed two levels of C dieldrin, 0.04 ppm and 2 ppm. It appears that plateauing will also occur in sheep with the C of dieldrin being approximately equally distributed between feces and urine. Chickens have been fed diets containing 10 and 20 ppm dieldrin or 100 and 200 p,p-DDT to determine the effects of these insecticides under normal dietary conditions on egg production, shell thickness, and liver microsomal enzymes. Analysis of egg production and shell thickness data is not completed, although preliminary evaluation suggests no effect of treatment on these parameters. Hydrolylase enzyme activity was reduced in those chickens fed DDT; and demethylase and P 450 enzyme activities were higher in those fed 20 ppm dieldrin. In rats o,p'-DDA; o,p'-DDD; and o,p'-dichlorobenzhydrol have been identified as products of o,p'-DDT metabolism. Oxidized p'-DDT and DDD and these oxidized forms with an added CH(2)O group have been isolated and partially identified. An apparent conversion of o,p'-DDT to p,p'-DDT in rats has been associated with the preferential accumulation in the body fat of less than 0.1% p,p'-DDT contamination of the o,p'-DDT dose.

SUPPORTED BY U.S. Dept. of Agriculture

4.1098, GASTROINTESTINAL ABSORPTION OF AGRICULTURAL CHEMICALS IN ANIMALS

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OBJECTIVE: Identify agricultural chemical structure related to gastrointestinal absorption, effect of tissue secretions on absorption rate, chemical degradation, and gastrointestinal function.

APPROACH: Analyze gastrointestinal absorption of radiolabeled carbamate pesticides of high and low toxicities in intestinal loops and everted sacs by perfusion techniques in swine and rats. Analyze samples of perfusate, lymph, arterial and venous blood for parent compound and metabolites. Characterize mechanism of absorption. Select and synthesize structural variations of chemicals on basis of absorptive mechanism to enhance or obliterate absorption.

PROGRESS: The small intestines of male rats were divided into three equal parts and everted. The serosal space of the sacs was filled with 4 ml of Krebs-Ringer medium containing either 10 M 1-naphthyl-1- C methylcarbamate (carbaryl) or 10 M 1-naphthol-1- C at pH 6.5. The sacs were individually incubated for 2 hours in 100 ml of the same medium (mucosal fluid) under an atmosphere of 95% 0(2)-5%CO(2). After incubation, the mucosal and serosal fluids were recovered separately and lyophilized. The major polar metabolite was extracted from the dried residue and isolated by column chromatography. The major water-soluble metabolite isolated from the respective mucosal and serosal fluids of the sacs was identified as naphthyl glucuronide by comparison of its infrared spectrum with that of authentic 1-naphthyl-beta-D-glucuronide. Hydrolytic, probably enzymatic, liberation of naphthol from carbaryl, and its subsequent conjugation with glucuronic acid is apparently an active intestinal function. Hydrolysis is more active in the cranial section of the intestinal tract than in the caudal section. Substantial facilitated transport of naphthol glucuronide from mucosal to the serosal side occurred at all levels of the small intestine. However, the rate of transport in the caudal sac was approximately 3 times that in the cranial sac. These data indicate that the gastrointestinal tract plays an important function in the metabolism and/or detoxification of pesticidal chemicals.

SUPPORTED BY U.S. Dept. of Agriculture

4.1099, METABOLISM OF AGRICULTURAL CHEMICALS BY RUMEN MICROORGANISMS

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OBJECTIVE: Determine anaerobic metabolism of agricultural chemicals by ruminants.

APPROACH: Three calves will be maintained in isolation to provide predictable populations of single species of ruminal ciliated protozoa and constant bacterial populations. Agricultural chemicals (insecticides, herbicides, steroids) will be examined with these populations to determine respiration response, growth, volatile fatty acid production, use as a carbon source. Chemicals causing a microbial response will be examined further for production of metabolites and characterization of metabolites by chemical and physical methods. Ability of microbes to adapt to agricul-

tural chemical substrates will be tested by in vitro and in vivo methods. Initial experiments are to be with the triazine herbicides.

PROGRESS: Certain obligately anaerobic gram-negative bacteria isolated from rumen digesta were demonstrated to degrade tributyrin and di-n-butyl succinate (Tabutrex). Sonified cell preparations of these bacteria degraded alpha-naphthylacetate to alpha-naphthol and acetic acid, and fluorescein 3', 6'-diacetate (FDA) to fluorescein and acetic acid. Incubation of the sonified cell preparations with pesticides for 30 minutes, followed by a FDA assay for esterase activity, indicated that Mobam, Bidrin, Paraquat, and Phosdrin were inhibitory at the 50% level. Other compounds showing inhibition of esterase activity were alpha-naphthol, Tabutrex, lauryl sulfate, sodium fluoride, manganese chloride, cobalt chloride, and tributyrin. No inhibition was shown by NaCl, acetylcholine chloride, Trifluralin, and IPC. An acetone precipitate from a sonified isolated rumen bacteria degraded FDA, alpha- naphthyl acetate, and Mobam. The degradation of Mobam with the acetone precipitate appears to be enzymatic and specific. Snake venom 'esterase' did not degrade Mobam. Trifluralin, a herbicide, has been shown to be degraded by rumen microflora. The bacterium Selenomonas ruminantium has been shown to degrade Trifluralin to similar products. Methallibure, an estrous control agent, is not degraded by rumen digesta when incubated in the dark. Methallibure was shown, however, to be unstable to fluorescent light, with the resultant formation of a thiadiazole by the loss of H(2)S to form a ring-structured compound.

SUPPORTED BY U.S. Dept. of Agriculture

4.1100, METABOLIC FATE OF PESTICIDES IN ANIMALS

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OBJECTIVE: Determine metabolic fate of pesticides in terms of quantitative distribution of compound and metabolites in animal tissues, milk and excreta.

APPROACH: Administer in a single oral dose radiolabeled pesticides to rats, sheep, and lactating goats and cows. Collect and analyze respired CO(2), urine, feces, milk, organs, and tissues for distribution of radioactivity. The radiolabel will be generally C with, if necessary, both the ring-and the side-chain-labeled compound used. Experiments will employ at least 14 rats and 2 sheep, goats, and/or cows. CO(2), urine, feces, and milk will be collected at periodic intervals over a period of 72 hours. Tissue samples will be taken from liver, heart, blood, muscle, kidney and omental fat, kidney, spleen, lung and brain. Metabolic fate of triazine herbicides is currently being determined.

PROGRESS: A series of sheep have been dosed with the C ring- labeled and C side-chain labeled sheep defleecing chemical, cyclophosphamide (2- bis(2-chloroethyl)amino tetrahydro-2H-1,3,2- oxazophosphorine-2-oxide). Seventy-two hours after dosing with the ring-labeled, chemical, 99% of the radioactivity was recovered with the urine containing 84%, feces 6%, and expiratory CO(2) 9%. With the side- chain labeled compound, 96% of the radioactivity was recovered in the urine, 4% in the feces, and 1.8% in the expiratory CO(2) 72 hours after dosing. Residual radioactivity was determined in various organs and tissues of sheep 24, 48, and 72 hours after dosing with radiolabeled cyclophosphamide. Calculations of the time required to reduce tissue residues by one-half gave values of approximately 24 hours. This suggested that residues of cyclophosphamide equivalents would be reduced to levels of 0.01 ppm in 10 days or less. Determination of residues in tissues of sheep slaughtered 7 days after dosing did not verify this calculation. Examination of the data indicated that cyclophosphamide had been metabolized to the extent that a portion of its radioactive carbon had joined the anabolic carbon pool of the body. Cyclophosphamide was metabolized to at least six urinary metabolites. Tentatively, the major metabolite has been identified as oxidized cyclophosphamide.

SUPPORTED BY U.S. Dept. of Agriculture

4.1101, PHOTOLYSIS OF PESTICIDES

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The objectives of this proposal are: 1. To evaluate photolysis coupled with gas chromatography as an analytical method for the identification of certain pesticide residues in foods. 2. To identify photolytic products of certain pesticides irradiated with ultraviolet light under laboratory and field conditions. 3. To investigate the parameters influencing the photolysis of certain pesticides.

Photolysis of pesticides will be carried out in model systems and in selected food systems following clean-up procedures. The degradation pattern as detected by gas chromatography will be evaluated as a means of confirming the identity of each pesticide. Identification of hitherto unidentified products of photolysis will be made by mass spectrometry, infrared spectroscopy and other means. The parameters influencing degradation will be investigated, and mechanisms of degradation will be elucidated when possible. Photolysis under both laboratory and field conditions will be studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.1102, PESTICIDE RESIDUES IN FOOD PRODUCTS

L.C. TERRIERE, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00085)

OBJECTIVE: The development of suitable methods for the measurement of pesticide residues on or in food products entering market channels. Use of these methods in cooperation with pest control specialists to develop control measures with minimum pesticide residue hazards. The study of the metabolic fate of pesticides in plants and animals.

APPROACH: Projects will be planned and executed in cooperation with other scientists, such as entomologists or engineers, so that both field and laboratory phases of the work are covered. In the case of the basic studies the experiment will involve intact plants or experimental animals or they will use in vitro systems prepared from plant or animal tissues. In the case of research aimed at the establishment of tolerances or label registrations the final step will be the preparation of an adequate technical report describing the experiments and the results.

PROGRESS: The development of methods for measuring pesticide residues in hops and in peppermint hay and oil received major emphasis during the year. Two phosphate insecticides, phorate and disulfoton, were applied to hops in Oregon and Washington and samples collected at intervals up to and including harvest. The analyses which have been completed show that the soil or foliage treatment of hops results in total residues, for parent compound and all metabolites, of less than 0.2 ppm on dry hops. This information supplements that gathered last year and will support registration requests for these pesticides. Similar tests with azodrin have not been completed. Phorate and azodrin were applied to peppermint in Washington and Oregon and samples collected during the season are being analyzed. Results to date show that peppermint oil from fields treated with phorate contain up to 2 ppm combined phorate and metabolites. The work on azodrin has not been completed. The loss of insecticides during and immediately after their application to the soil was studied with the insecticides dyfonate and zinophos. The application process was monitored at several points by analysis of appropriate samples. The data show that approximately 25% of the insecticides are lost during application. Root tissue of seedling bean, pea, and corn has been compared as a source of the enzyme system which converts aldrin to dieldrin. Conversions of up to 12% of the substrate have been achieved.

SUPPORTED BY U.S. Dept. of Agriculture

4.1103, ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS

C.D. ERCEGOVICH, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01527)

OBJECTIVE: Development of improved analytical methods for residues of pesticides and their degradation products.

APPROACH: Existing methods for the determination of pesticide residues and degradation products will be critically examined for sensitivity, accuracy, reproducibility and simplicity. Special emphasis will be placed on pesticides in common use, and on pesticide degradation products, soil, water, and other media.

PROGRESS: Compounds possessing nitro groups are reduced to the corresponding amino group, then diazotized with nitrous acid and coupled to fibrinogen. Antibodies of the azoprotein are developed in rabbits over a 30-day period. Ring precipitation and passive hemagglutination tests demonstrate that the antibodies yield a high degree of specificity to dilutions of 1:10 parts of azoprotein antigen, but that impurities in the antigen cause undesirable cross reactions. Improved methods for removal of impurities from azoprotein and changes in injection schedule may increase specificity, sensitivity and reduce cross reactions. Present methods for analysis of CIPC residues in alfalfa and clover are unsatisfactory. A more efficient method has been developed using the Bleidner apparatus for hydrolysis and recovery of CIPC and cellulose column chromatography for removal of interfering plant materials after color development. The procedure is sensitive to .04 ppm. Work indicates possibility of detecting less than 1 ng of chlortriazines by electron capture GLC. Method is based on reacting the herbicide with HFBI and using an OV-210 column. Search for proper reaction conditions for soil and plant samples is necessary to achieve same sensitivity attainable with in vitro samples. Separation of chlorotriazines from their metabolites in ethanolic plant extracts by ion-exchange chromatography has been restudied.

SUPPORTED BY U.S. Dept. of Agriculture

4.1104, FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS

D.E. FREAR, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01532)

OBJECTIVE: Follow the disappearance of pesticide residues in media other than raw agricultural commodities. Qualitatively and quantitatively identify the degradation products resulting from the breakdown of pesticide residues in media other than raw agricultural commodities.

APPROACH: Measure quantitatively pesticide residues remaining at known time intervals following application in various types of soils, water, plant by-products, silage, dairy products, feed stuffs. By gas chromatographic methods. Identify and measure any pesticide degradation products which may result from hydrolysis or decomposition caused by heat or processing or other physical or chemical forces. These will be separated by thin layer, column or gas chromatographic means and identified by infrared or other spectral analyses and the use of labelled compounds.

PROGRESS: The disappearance of total chlorphenamidine and its metabolites during the growing season and the residue of these materials at harvest on six fruit crops and Hagerstown silt loam soil has been studied. Of three identified metabolites only N-formyl-2-methyl-4- chloroaniline and the parent compound were found at harvest. Neither chemical nor enzymatic degradation appear to occur in any of these crops. Environmental factors and growth dilution seem most responsible for its disappearance from fruit. The half-life of total chlorphenamidine residues in soil of 20% moisture at 20 C is about 20 weeks. Microbial activity seems to be primarily responsible for its disappearance from soil. Trace amounts of 4,4'-dichloro-2,2'- dimethylazobenzene (DDAB) were detected after six months in non-sterile but not in sterile soil treated with 2000 ppm of chlorphenamidine. The formation of DDAB under field conditions through the practical use of chlorphenamidine appears to be of little significance. The uptake of DDAB in cabbage and corn plants grown in soil containing 50 and 500 ppm was detected at 14 days, but not at 50 days. Evidence of DDAB degradation in corn and cabbage plants has been observed by thin layer chromatography. The persistence of aminotriazole, dalapon, diuron, paraquat and simazine in orchard soils has been investigated and long term studies of Lovozal have been initiated.

SUPPORTED BY U.S. Dept. of Agriculture

4.1105, DEVELOP MICROANALYSES FOR DETECTION OF HERBICIDES AND METABOLITES IN PLANT TISSUE

C.R. SWANSON, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (0750-09-07-(GR))

OBJECTIVE: Develop new methods and adapt existing methods for the detection of herbicides and determine the sites of accumulation of herbicides and their metabolites in plant tissues and cells.

APPROACH: Representative major herbicides will be tritium labeled and used to treat experimental plants. The harvested plants will be radioautographed by macro and micro methods in order to localize the herbicide and its metabolites. Biochemical separation techniques will also be employed. Other procedures to be explored as possible means of micro detection and assay include microspectrophotometry, specific staining, fluorescence tagging, electron probe detection, and mass spectrometry of gas chromatography effluents.

PROGRESS: A major metabolite of (2,4-dichlorophenoxy)acetic acid (2,4-D) in bean plants was shown to be 2,5-dichloro-4- hydroxyphenoxyacetic acid. A minor metabolite was 2,3-dichloro-4- hydroxyphenoxyacetic acid. Both products existed primarily in plant as glycosides. These metabolites also occurred in wheat and oat plants, but in these species the major metabolite was the glucose ester of 2,4- D. The other major research project, in which the data are not yet fully evaluated, consisted of cytological studies with soybean leaf or callus tissue cells treated with tritiated 2,4-D, atrazine, or diuron to determine sites of localization within the cell. A major metabolite of atrazine in sorghum plants contained both hydroxyatrazine and amino acid residues.

SUPPORTED BY U.S. Dept. of Agriculture

4.1106, AEROBIC AND ANAEROBIC BIODEGRADATION OF DETERGENTS

A.J. STIRTON, U.S. Dept. of Agriculture, Eastern Utilization Res. Div., *Wyndmoor, Pennsylvania* 19118 (E6-3-92)

OBJECTIVE: Develop new uses for inedible animal fats through studies on the mechanism of aerobic and anaerobic biodegradation of fat- based detergents and surface active agents.

APPROACH: The mechanism of biodegradation will be investigated by a method which permits automated analyses for chemical oxidation demand, methylene blue active substance and sulfate ion. Anaerobic biodegradation will be studied by a method based on the volume of methane evolved. Other methods for measuring biodegradation will also be explored. Results will direct the development of improved detergents and help solve present water pollution problems.

PROGRESS: A method for following the course of aerobic biodegradation of anionic detergents by automated analysis for C, MBAS (Methylene Blue active substance) and sulfate ion showed tallow alcohol sulfates, ether alcohol sulfates, alpha-sulfo esters and linear alkylbenzenesulfonate (LAS) to decrease in ease of biodegradation in that order. Completely anaerobic conditions for biodegradation are seldom realized but are approximated by relatively common microaerophilic conditions under which biodegradation occurs at a low oxygen level of about 1 ppm or less. A method based on the river water test was developed for simultaneous measurement under both aerobic and microaerophilic conditions. Tallow alcohol sulfates, sulfated alkanolamides, ether alcohol sulfates, alpha-sulfo esters and LAS were examined. Tests were carried out in river water containing 5 or 10 ppm of the detergent at 25 or 35 C. Aerobic and microaerophilic experiments were stirred by a continuous stream of air or nitrogen, respectively. Biodegradation was followed by analysis for MBAS using an autoanalyzer. Tallow alcohol sulfates and tallow-based sulfated alkanolamides were the most easily degraded under either condition and LAS the most resistant.

SUPPORTED BY U.S. Dept. of Agriculture

4.1107, AGRICULTURAL CHEMICAL RESIDUES IN PLANT AND ANIMAL PRODUCTS

J. SINGMASTER, Univ. of Puerto Rico, Agricultural Experiment Sta., *Mayaguez, Puerto Rico* (PR00104)

OBJECTIVE: Development, of chemical, instrumental and biological methods of residue analysis. Behavior of chemicals as related to residues in agricultural commodities. Residues and their metabolites in agricultural commodities and in their environment.

4. PESTICIDES

APPROACH: Gas chromatography with an electron capture detector will be used for analysis of pesticides especially Di-Syston. Studies on adaptation of existing methods of pesticide residue analysis will be made on such tropical crops as sugarcane, pineapple, coffee, pigeon peas, plantains, yautia (tanier Xanthosoma Caracu) and yuca (cassava, Manihot Esculenta). Studies of the residues of Di-Syston in leaves of coffee, pineapple and sugarcane from soil applications under different conditions will be made. The discovery that 'green coffee' beans have almost undetectable residues from recommended Di-Syston applications while the pulp from same treatment has up to 3 ppm will be examined, possibly with radioactive Di-Syston, to see if Di-Syston or its metabolites ever enter the bean. Determination of residues and their metabolites will be done in the following crops: for Di-Syston: in tomatoes, lettuce, peppers, and cabbage; for DDT: papaya and pigeon peas; for Diazinon: in pangola grass and sugarcane; for Parathion: in coffee; for Sevin: in pangola grass; for Dieldrin: in yams, yautia, yuca, coffee, and plantains.

PROGRESS: A new extraction procedure for residue analysis in various fruit pastes was successfully developed, as well as an analytical method for Ametryne in tuber crops and pigeonpeas. The latter method, slightly modified, may also be applied to coffee. Analysis of DDT in pigeon peas revealed residues up to 3 ppm in peas from plants treated 15 to 23 days before harvest using several spray schedules. Several small samples that had to be hand shelled had considerably less (ca. 1/3) residue than other replicates with the same treatment, which were machine-shelled. Studies were conducted on a U.V. method for analysis of toxaphene residues without success so far. A new method for urea herbicide analysis was tested, but results were unpromising.

SUPPORTED BY U.S. Dept. of Agriculture

4.1108, DEVELOPMENT & APPLICATION OF QUANTITATIVE TISSUE CULTURE METHODS TO ENVIRONMENTAL PROBLEMS IN CHEMICAL TOXICOLOGY

B.H. PRINGLE, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

The development of a sensitive, reliable system for general toxicological studies involving chemical pollutants. The methods of quantitative tissue culture have been successfully applied to investigate nearly every conceivable process at the level of the cell. It is possible that such a system could be adapted for our needs, which would include the study of both fresh water and marine organisms.

A program was designed to evaluate the possible usefulness of quantitative cell culture for this particular purpose. The overall objectives include an evaluation of comparative toxicity, determination of the presence or absence of genetic effects, and the development of methods permitting the identification of 'no-threshold' chemicals.

Accomplishments of 1970: Initial efforts were started with a study of cadmium early in FY-1970. Full-time studies were initiated in January, 1970. Within this time, a titration end point for the toxicity of divalent cadmium to cultured mammalian cells has been established, and kinetic studies using four different concentrations of this metal are well underway. A reliable technique has been established for conducting kinetic studies and these are currently in progress.

Objectives for 1971: A. The immediate objectives for FY-1971 will include completion of the kinetic studies and the establishment of the kinetic curves. A quantitative model will then be constructed to describe these curves, and the model parameters interpreted in terms of cell structure and/or cell transport processes. B. Autoradiography techniques using electron microscopy will be investigated in an attempt to determine the amount of cadmium taken up by mammalian cells at 'threshold' doses. It is hoped that such studies will be instrumental in clarifying the physical meaning of the 'thresholds' observed in the kinetic studies. The feasibility of autoradiographic techniques with cadmium depends upon the availability of a suitable cadmium isotope, and to a lesser extent, the amount of cadmium taken up by the cells at 'threshold' doses. C. The toxicity of NTA and one additional trace element (mercury or arsenic) will be studied in the cell system and compared with data already available for rotenone and cadmium. It seems clear that comparative data for several classes of chemicals will be required before any evaluation of the technique can be made.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

4.1109, BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

B.J. GOSSETT, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00756)

OBJECTIVE: Determine the effects of climatic and edaphic factors on movement, persistence, and toxicity of herbicides in the soil.

APPROACH: The effects of edaphic and climatic conditions on the movement, persistence, and degradation of prometryne (2,4-bis(iso propylamino)-6-methylthio-s-triazine) and C-2059 (3-(n- trifluoromethylphenyl)-1,1-dimethylurea) will be investigated. Such factors as sunlight, soil moisture, temperature, pH, and organic matter content on the persistence and activity of these herbicides will be determined. Undisturbed soil profiles will be obtained by forcing a hollow cylinder into the soil to a depth of 3 feet. These soil columns treated with the two herbicides will be exposed to varying amounts and intensity of simulated rainfall. Bioassays will be conducted to determine the depth to which the herbicides moved in phytotoxic concentrations. Under field conditions, studies will be conducted on various soil types to determine the effect of soil incorporation and depth of incorporation on the performance of these herbicides.

PROGRESS: Under field conditions the performance of trifluralin and fluometuron was investigated as influenced by various spray volumes and incorporation into the soil at maximum uniformity and controlled depths. The rate of each herbicide used was 1/3x, 2/3x, and 1x of the suggested rate. With both herbicides, spray volumes near concentrate levels gave poorer weed control than conventional spray volumes. However, spray volumes as low as 2 gallons per acre gave weed control equal to that of conventional spray volumes. Better weed control was obtained with both herbicides when incorporated at maximum uniformity to a depth of 2 inches than at the 1- or 4-inch depths of incorporation. Incorporation of fluometuron at the 2-inch depth provided better weed control than when applied to the soil surface in the conventional manner and followed by irrigation. The response of cotton did not appear to be significantly influenced by any treatment, but statistical analysis are not complete.

SUPPORTED BY U.S. Dept. of Agriculture

4.1110, ECONOMIC EFFECTS OF PESTICIDE RESIDUES ON FOOD AND FEED PRODUCTS

L.D. MALPHRUS, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00749)

OBJECTIVE: Study food and feed products with respect to the development of commercial marketing and processing techniques for the detection, removal and/or neutralization of pesticide residue effects. Estimate costs of alternative techniques for the commercial reduction of pesticide residues in food and feed products.

APPROACH: Reduce levels of toxaphene, guthion and parathion residues on harvested coastal bermuda grass and collards. Analyze sample data collected by Federal and State regulatory agencies of pesticide residues in selected food and feed products. Estimates would be made of the variability among lots of a product in the level of pesticide residues and the amount which would have to be removed from the market to comply with residue tolerances. Removal cost estimates would also be made. A cost analysis could be made of marketing or processing techniques identified or discovered under Objective 1 for the identification, reduction or neutralization of pesticide residues in food and feed products.

PROGRESS: No pesticide residue in excess of tolerances was found in 238 samples of cabbage collected in South Carolina retail stores during three seasons of 1966 in 8 cities. Fifty-four percent of the samples had measurable quantities of residues. Sixty three percent of 97 sweet potato samples collected in fall of 1966 had measurable quantities of pesticide residues within established tolerances and three samples had BHC for which no tolerance was established. Some breakdown and some loss of

parathion was noted when flour and bread containing it were heated to bread-baking temperatures. Fourteen to 17 percent of the parathion was unchanged by baking. Results were confirmed by a bioassay with German cockroaches in which toxicity was not increased but remaining parathion was accounted for.

SUPPORTED BY U.S. Dept. of Agriculture

4.1111, PESTICIDE RESIDUES IN PLANT AND ANIMAL PRODUCTS

J.K. REED, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00827)

OBJECTIVE: Development, adaptation and standardization of chemical, instrumental and biological methods of residue analysis. (Methodology). Investigations on the behavior of chemicals as related to residues in agricultural commodities. (Behavior). Determination of residues and their metabolites in agricultural commodities and in their environment.

APPROACH: Biological assay, using Daphnia pulex in water, is used to verify analyses of pesticide residues in animal products, crops, soil, water, etc. Improvements are sought in methods of chemical analysis, chiefly in extraction, clean-up, and detection of the pesticides. Gas-liquid chromatography is being used extensively. The metabolism of trifluralin in fish is being studied in conjunction with the over-all area of retention, breakdown, and movement of pesticides in plants, soil, and water. The movement of DDT and trifluralin from soil into tobacco and soybean plants during growth is being followed to evaluate residues to be expected from growing crops on contaminated soil. Analyses of residues in samples of forage crops, vegetable crops, etc. are determined to facilitate securing labels for products used on minor crops where the volume of pesticide to be sold would not justify the cost to the responsible company.

PROGRESS: In a laboratory study fish accumulated DDT to a much higher level from water than from food even though the level in the food was much higher than in the water. DDT and malathion at sublethal levels caused a decrease in the total hemolymph protein and an increase in the number of non-protein amino acids found in the hemolymph of the crayfish, Cambarus bartoni Fabr. This may indicate interference with protein synthesis in some way. Monitoring of pesticide levels in wild deer populations has been continued for another year. To date only DDT and its metabolites have been positively identified in deer tissues but other unidentified chemicals are present at low levels. The level of DDT in turkeys penned on soil contaminated with DDT up to 40 lbs per acre is being followed to establish expected levels in turkeys reared on abandoned cotton fields where DDT has been heavily used.

SUPPORTED BY U.S. Dept. of Agriculture

4.1112, USE OF INSECTICIDES LABELLED WITH PHOSPHORUS-32 AND TRITIUM FOR THE DETERMINATION OF PESTICIDE RESIDUES

M. ANGOSO, Junta De Energia Nuclear, *Madrid, Spain*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

4.1113, QUAIL MANAGEMENT ON FOREST AND ASSOCIATED LANDS IN WEST TENNESSEE

R.W. DIMMICK, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00003)

OBJECTIVE: Determine quail population levels in selected forest and associated land habitats. Determine timber and quail production with various land-management practices. Evaluate the economics of quail production systems.

APPROACH: Selected replicated sites will be described. Quail censuses will be taken. Populations will be related to site characteristics. Effects of selected management practices, such as burning and thinning, will be determined and related to quail and timber production. Economic analysis of timber and quail production will be performed.

PROGRESS: On the 2100-acre research area quail density was 83 coveys (1033 quail) in March 1969, and 73 coveys (1007 quail) in December 1969. These data indicate that a marked decline in quail density occurred during the summer period, the first decline in numbers since the study originated in 1966. A total of 177 nests were located during the 1969 nesting season. Success of nests was determined for 93 which contained eggs or egg fragments when found. Thirty-four (36.6%) were successful, 45 (48.4%) were destroyed, and 14 (15.0%) were deserted. Mean clutch size for 44 complete clutches was 12.6 eggs; however, only 75% of the eggs in 20 successful nests hatched. A total of 614 crops from quail collected on the research areas from December 1966 through March 1969 were examined. Identification of foods was completed, data were processed for IBM analysis, and analysis was completed. A thesis describing the food habits of quail is in final stages. A study of the behavior of wild quail in winter is in progress. Birds are now being trapped, marked with visible wing markers and/or radio transmitters, and released for observation. A total of 31 quail were collected during September 3 & 4 for analysis of pesticide residues.

SUPPORTED BY U.S. Dept. of Agriculture

4.1114, AGRICULTURAL CHEMICAL RESIDUES IN PLANT AND ANIMAL PRODUCTS

W.A. KRUEGER, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00049)

OBJECTIVE: Development, adaptation and standardization of chemical, instrumental and biological methods of residue analysis. (Methodology) Determination of residues and their metabolites in agricultural commodities and in their environment. (Dissipation)

APPROACH: Work will include development and adaptation of methods for the extraction and clean-up of samples of hay and animal products for the determination of heptachlor, heptachlor epoxide, DDT and other residues by means of the gas chromatograph. The fate of various residues during food processing, such as washing, cooking, and canning will be studied. Also, residues will be determined in agricultural products, including forage crops, vegetable crops, animal products and fruit crops to establish recommendations for safe usage, disappearance rates, and tolerance levels.

PROGRESS: Turnips were grown in control plots and plots treated with DDT and/or heptachlor epoxide. Samples were taken for residue analysis after spraying, at harvest, after washing and after blanching. Washing and blanching of turnip greens reduced TDE and DDT residues but did not affect DDE, heptachlor or heptachlor epoxide content. None of the processing treatments significantly affected root residues. Thermal processing effected a rise in TDE, but had no effect on DDE or DDT. The results of this study indicate that the processing treatments examined do not reduce insecticide residues to acceptable Food and Drug Administration standards.

SUPPORTED BY U.S. Dept. of Agriculture

4.1115, THE BIOLOGY AND CONTROL OF INSECTS AND MITES ATTACKING SMALL GRAINS

N.E. DANIELS, Southwestern Great Plains Ctr., *Bushland, Texas* 79012 (TEX01020)

Objective; Determine ecological and physiological factors which control small grain pests. Determine effectiveness of experimental insecticides on small grain pests. Determine influence of various farm practices on small grain insects and mites. Evaluate inheritance of greenbug resistance in small grains and the basis of resistance.

Approach: Studies of population densities in the oversummering and overwintering source areas of the greenbug and other selected species will be made. Research on the effects of temperature on reproduction, development and survival, development of winged forms and the existence of biotypes will be conducted. New experimental insecticides will be tested. Samples of treated crops will be analyzed for harmful residue. Evaluations on the effect of farm practices. The evaluation of greenbug resistant small grain sources.

4. PESTICIDES

Progress: Greenbugs infested both wheat and grain sorghum in 1966, 67 and 68 and were extremely heavy on grain sorghum during the summer of 1968. They were collected from field grain sorghum and reared alternately in the greenhouse, on wheat and grain sorghum. The adults of greenbugs collected from wheat were heavier than those collected from grain sorghum. Adult greenbugs reared outdoors were also heavier than those reared indoors. Grain sorghum yields were increased 5 percent by controlling, with parathion, a greenbug infestation of 22050 greenbugs per plant (164 greenbugs per gram of plant) while plants were in the boot stage and 31 inches tall. Plants 5 inches tall, that received no chemical treatment, died within 4 days after the population reached 2700 greenbugs per plant (900 greenbugs per gram of plant). Plants 19 inches tall, with no chemical treatment died within 14 days after a population peak of 13500 (337 greenbugs per gram of plant). Of 9 insecticides tested against the greenbug, in wheat, dimethoate and methyl parathion demonstrated the best control. Malathion gave good control of the false chinch bug in wheat and diethyl parathion satisfactorily controlled the insect in sugar beets. Efficient transmission of the virus Maize Dwarf Mosaic was achieved with the greenbug. Of 20 grain sorghum lines tested for greenbugs resistance none were found with significant resistance. After insecticidal soil treatments, endrin was the most prevalent in carrots the first year after treatment and dieldrin the second year.

SUPPORTED BY Texas State Government - Austin

4.1116, DEVELOP METHOD FOR QUANTITATIVELY CHARACTERIZING PESTICIDE DRIFT

L.F. BOUSE, Texas A & M University System, U.S.D.A. Agric. Eng. Res. Div., *College Station, Texas* 77843 (209-056-A126)

OBJECTIVE: Develop a standard method of making quantitative measurement of the driftability of a spray formulation or a spray formulation device.

APPROACH: Experimental measurement of spray driftability in the laboratory is considered the most practical method of quantitatively assessing spray materials and devices. A wind tunnel will be constructed with test section about 2' x 4' x 20'. A blower will provide air movement as desired. Controlled drop sizes will be provided by means of spinning disks. The movement of the droplets will be recorded by means of high speed photography. A device will be developed sufficiently simple and compact that any research agency, manufacturer, or regulatory agency can duplicate it.

PROGRESS: A low speed wind tunnel with controlled environmental facilities was constructed to study spray drift. This equipment permits precise measurements of factors affecting spray drift. The environmental factors controlled were air speed, temperature, humidity, and turbulence. The tunnel procedure will be used to compare the spray drift from the following carriers: 1) water, 2) diesel oil-in-water emulsion, 3) glycerol-water mixture, 4)cetyl alcohol-water mixture, 5) paraffin oil. Methods and techniques were developed for producing homogeneous herbicidal sprays by inducing harmonic disturbances in low- velocity jetstreams. Harmonic disturbances in the audiofrequency range applied to small low-velocity water jets formed by perforated orifice plates produced homogeneous sprays ranging from 100 to 450 microns drop diameter. This technique will be refined for utilization on prototype herbicide sprayers. Instrumentation and techniques were developed to measure electrostatic charges on houseflies. These techniques are being used to determine if insects respond to a pesticide on the basis of electrostatic charge on their bodies. Preliminary results indicate that respiration of an individual fly can be measured and that the amount of charge is related to length of time till death in a gas chamber. Further tests indicate that physical activity, food in the body, and the living versus death process can charge the electrical capacitance of the fly's body.

SUPPORTED BY U.S. Dept. of Agriculture

4.1117, AGRICULTURAL CHEMICAL RESIDUES IN PLANT AND ANIMAL PRODUCTS

H.W. DOROUGH, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX02221)

OBJECTIVE: Development, adaptation and standardization of chemical, instrumental and biological methods of residue analysis. (Methodology) Investigations on the behavior of chemicals as related to residues in agricultural commodities. (Behavior) Determination of residues and their metabolities in agricultural commodities and in their environment. (Dissipation)

APPROACH: Determine and compare the effects of environmental conditions on the reproducibility of biological analysis of pesticide residues utilizing Musca domestica L., Determine methods of activation and detoxification of insecticides plant and animal tissues. Determine residual properties of pesticide.

PROGRESS: Insecticide residues were detected in the forage and seeds of soybeans planted in soils treated with chlordane and heptachlor. Heptachlor applied to soil at 6 lbs./a. 8 days prior to planting resulted in 0.9 ppm residues in the soil at planting time, 0.08 ppm in the plants at pod formation, and 0.11 ppm in mature seeds. Residues of approximately one-half these levels occurred when heptachlor was applied at 3 lbs./a. chlordane applied at 12 lbs/a. resulted in the following residue levels; soil, 0.8 ppm; plants, 0.07 ppm; and seeds, 0.04 ppm. Spraying sunflowers 2 or more times with malathion, methyl parathion, diazinon or endosulfan at a rate of 1 lb/a resulted in very low levels of residues in the seeds at harvest. Even when the last spray was applied 14 days before harvest, residues of endosulfan in the seeds were less than 0.2 ppm; for the other insecticides, the residues were only one-half to one-tenth this magnitude. The data indicate that residue problems would not prevent the use of these chemicals for the control of insect pests of sunflowers. Continued progress was made in defining the metabolic pathways of several carbamate insecticides in plant and animal systems. Temik and Furadan still appear to have excellent potential for becoming commercially available insecticides, although their use in some case may be highly restricted. Ensilage samples were taken from grain sorghum treated with several insecticides, some with ULV and low volume formulations, and some at different rates. Also, samples of seeds were taken from sunflower plants treated with insecticides not included in the residue tests reported above (para. 2).

SUPPORTED BY U.S. Dept. of Agriculture

4.1118, REDUCTION OF ADVERSE EFFECTS OF PESTICIDE RESIDUES ON FOOD PRODUCTS

A.R. HANKS, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX02323)

OBJECTIVE: Study food and feed products with respect to the location and persistance of pesticides residues in market products.

APPROACH: Vegetables (including root, crops, squash, and tomatoes) contaminated with pesticides will be obtained from the Food and Drug District Laboratory in Dallas and from markets in areas where the crops are produced in the State. Penetration and distribution of the residues will be determined by sectioning the vegetables before and following storage under varying conditions of temperature, humidity, and time. Attempts will be made to remove the residues present in the surface of the vegetable by washing with aqueous solutions of surfactants at different temperatures.

PROGRESS: A total of 62 feeds were analyzed by gas chromatography for 14 chlorinated and 4 phosphate insecticides. 90% of the feeds analyzed contained measurable levels of chlorinated residues but no phosphate residues were detected. A total of 21 residues were at the 0.05 ppm level or greater. Contrary to the previous report (1968), the most commonly encountered pesticide was DDT (81% of all residues at or above 0.05 ppm). Dieldrin-previously the most common residue-was the second most commonly encountered residue; however, only one dieldrin residue was above 0.05 ppm. These results support previous findings indicating that there may exist a greater pesticide residue problem in animal feeds than in foods sold for direct human consumption. In view of established FDA residue tolerances and USDA recommended limitations on uses for treated crops (forages and grains), it would appear that a majority of the dairy feeds examined contain unacceptable amounts of pesticides. These residues are contributed, most probably, by the various feed components (corn, oats, sorghum, etc.).

SUPPORTED BY U.S. Dept. of Agriculture

4.1119, COMPARISON OF NUTRIENTS OF PEANUTS FROM SOILS WITHOUT AND WITH LINDANE TREATMENT

C.M. LYMAN, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (HN1-24(C))

OBJECTIVE: Determine whether lindane-treated soil changes amino acid, fatty acid, and B-vitamin content of raw and roasted peanuts as compared with nuts from untreated soil.

APPROACH: Analyze for: lindane residue, total lipids, fatty acids, total N, amino acids, and B-vitamins in raw and roasted peanuts prepared by methods approximating commercial practices. Samples represent crops grown on replicated untreated and lindane-treated soils for 2 years.

PROGRESS: Peanuts grown in experimental plots on soil treated with lindane as compared to those from untreated soil as control were analyzed, raw and roasted, for riboflavin, fatty acids of the lipids, protein, and the individual amino acids. This crop did not show a small increase in protein in peanuts grown on the lindane treated soil as indicated by the previous year. No differences were found in amino acids, fatty acids, and riboflavin of peanuts from treated and untreated soils.

SUPPORTED BY U.S. Dept. of Agriculture

4.1120, HARVEST-AID CHEMICAL RESIDUES IN COTTONSEED

C.S. MILLER, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01332)

OBJECTIVE: Develop suitable methods and techniques for determining amounts of harvest-aid chemicals or their metabolites that remain as residues in cottonseed or other parts of the cotton plant. Study the absorption, translocation and metabolism of defoliants and desiccants and develop suitable methods for identifying their metabolites. Investigate extraction and purification techniques for isolation of residues from large quantities of plant material.

APPROACH: Radioactive isotope-labeled cotton defoliants and desiccants, representing the principal chemical classes now in commercial use, will be applied to plants with bolls of different stages of maturity. The amount of the chemicals or their metabolites, by contact or translocation remaining on the lint, seed coat and in the seed meal oil will be assayed. The absorption, translocation and metabolism of commercial cotton defoliants will be studied by application of radioactive labeled materials to cotton plants, followed by their harvest at different intervals. Radioautograms of entire plants and chromatograms of extracts will be used.

PROGRESS: Arsenic acid residue studies were continued through obtaining 1100 pounds of cottonseed which contained 7 ppm arsenic. The seed were hulled, solvent extracted and the meal desolventized by the Oilseed Products Research Center for subsequent extraction and isolation purposes. About 242 pounds of cottonseed meal was extracted with water, screened, centrifuged, pH adjusted, centrifuged, reduced in volume, acetone precipitated, partitioned, volume reduced and stored in a freezer awaiting further purification. The arsenic was contained principally in two fractions, one of which was composed of 58% protein, was initially of axle-grease consistency and converted to an acetone powder.

SUPPORTED BY Texas State Government - Austin

4.1121, NUTRIENT COMPOSITION OF PEANUTS GROWN ON LINDANE TREATED SOIL

J.M. PRESCOTT, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01616)

OBJECTIVE: Plan and conduct investigations to determine the effects of lindane treatment of the soil on amino acid, fatty acid, and B-vitamin composition of raw and roasted peanuts.

APPROACH: Determine existing lindane level in plots of land to be used for investigations. Apply lindane to one-half of the plots, and leave one-half untreated to be control plots. Plant and produce for at least two successive years at least eight plots of a single variety of peanuts, using usual irrigation methods. Harvest and process peanuts produced, roasting one-half of treated and one-half of untreated peanuts. Conduct laboratory analyses, using chromatographic procedures, to determine lindane content in representative subsamples of all groups of roasted and unroasted peanuts from treated and untreated plots. Conduct laboratory analyses to determine component nutrients in those subsamples. Statistically analyze and evaluate data and results obtained.

PROGRESS: Analytical work on this project is complete and the data have been analyzed statistically. The final report is in preparation after which the project will be open for publication only.

SUPPORTED BY Texas State Government - Austin

4.1122, PESTICIDE ANALYSIS, COLLEGE STATION

R.A. STOKES, Texas A & M University System, U.S.D.A. Entomology Res. Div., *College Station, Texas* 77843 (00ENTM0305460100)

OBJECTIVE: Determine routes and rate of absorption, translocation, and breakdown or dissipation of systemic insecticides in cotton plants and soil.

APPROACH: Obtain information through analysis on rate of release of systemic insecticides from formulations into the soil, rate of adsorption on and desorption from soil, routes and rate of their absorption, translocation, and breakdown or dissipation in cotton plants, and identity and persistence of metabolites in the plants.

PROGRESS: A gas chromatographic procedure was developed for the analysis of dimethoate in aqueous samples and formulations. This method utilized a U-shaped glass column (2.5 ft. x 3 mm. i.d.) packed with 5% QF-1 on 60/80 mesh Gas Chrom Q and a flame photometric detector equipped with a 524-mmu interference filter for detecting phosphorus-containing compounds. A gas chromatographic procedure was developed for analyzing the four monoterpene components in a synthetic preparation of the boll weevil (Anthonomus grandis) sex pheromone with a single injection. The compounds were detected by hydrogen flame ionization after chromatography on a column loaded with 10% fluorosilicone (QF-1).

SUPPORTED BY U.S. Dept. of Agriculture

4.1123, INACTIVATION AND LOSS OF PESTICIDES FROM SOIL

A.R. SWOBODA, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX02621)

OBJECTIVE: Determine inactivation and loss of pesticides from soil by: volatilization; retention and release; microbiological degradation; non-microbiological degradation; movement of water through and over soil for the purpose of identifying primary loss processes, relating these processes to soil properties, and predicting pesticide persistence.

APPROACH: Loss of pesticides from soils will be measured in the laboratory using vapor trapping devices. Retention and release of selected pesticides by soils will be studied using adsorption isotherms and column chromatography. The movement of pesticides through and across the soil will be studied in field experiments. Pesticides will be monitored in leaching and runoff waters.

PROGRESS: Work on the movement of DDT and Toxaphene in watersheds in Central Texas was continued. Due to the lack of runoff causing rainstorms during the past year few water were collected. Work was completed on the toxicity of arsenic to cotton and soybeans in two Texas soils. Arsenic was found to be very toxic to soybeans, especially on Amarillo fine sandy loam soil. Soil tests were investigated to determine toxic levels of arsenic. Arsenic was also found to become very soluble under flowed soil conditions. This reduced soil condition may cause arsenic to become more toxic to plants during rainy period during the growing season.

SUPPORTED BY U.S. Dept. of Agriculture

4.1124, PESTICIDE RESIDUE ANALYSIS, KERRVILLE
H.V. CLABORN, U.S. Dept. of Agriculture, Entomology Research Division, *Kerrville, Texas* 78028 (00ENTM0303461100)

OBJECTIVE: Determine the amount, persistence, and fate of residues of new insect control chemicals and their metabolites in animals, milk, poultry, and eggs.

APPROACH: Obtain information through analysis on rate of deposition, distribution, persistence, and fate in animal and poultry tissues of residues of chemicals applied for insect control and of their metabolites. Determine identity, amount, and fate of residues in milk and eggs. Analyze pesticide formulations to be used in experiments on insect control.

PROGRESS: Studies were made to determine the amount, distribution, and rate of disappearance of Shell Compound 4072 in eggs and the body tissues of chickens confined in houses treated with the insesticide for house fly control; of ronnel and its oxygen analog in the fat of cattle dipped one and two times in a 0.25% emulsion of ronnel, of CIBA 9491 and its oxygen analog in the body tissues of two calves sprayed with 0.25% and 1.0% emulsions of CIBA 9491; and of Dursban and its oxygen analog in the body tissues of cattle following multiple dippings in 0.025% emulsions of Dursban.

SUPPORTED BY U.S. Dept. of Agriculture

4.1125, METHODS OF ANALYSIS FOR PESTICIDES, KERRVILLE
H.V. CLABORN, U.S. Dept. of Agriculture, Livestock Insect Laboratory, *Kerrville, Texas* 78028 (00ENTM1103461100)

OBJECTIVE: Develop sensitive, accurate, specific methods of analysis for new insect control chemicals and for their residues and metabolites in animal and poultry tissues, milk, and eggs.

APPROACH: Study chemical and physical properties and reactions of new insect control chemicals and their metabolites to find specific measurable characteristics; develop quantitative analytical methods based on these characteristics. Develop efficient procedures for extraction and cleanup of residues for animal and poultry tissues, milk, and eggs preliminary to analysis.

PROGRESS: Sensitive methods were developed for determining CIBA 9491 and its oxygen analog in the body tissues of cattle and the oxygen analog of ronnel in the body tissues of cattle. A method was developed for determining the concentration of Dursban in dipping vats.

SUPPORTED BY U.S. Dept. of Agriculture

4.1126, REDUCTION OR ELIMINATION OF PESTICIDE RESIDUES ON FOOD AND FEED PRODUCTS
S.J. RITCHEY, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0626106)

Objective: Study food and feed products with respect to location and persistence of pesticide residues in market products, effects of pesticide residue on quality characteristics.

Approach: The effects of processing techniques, cooking methods and length of storage on the persistence of certain pesticide residues in broilers will be studied. Tissue will be analyzed by recognized procedures of sampling, extraction and cleanup of samples and by gas chromatographic methods for analytical work at the time of slaughter and after periods of storage in the cold and before and after cooking. Muscles of the cooked broilers will be evaluated for flavor, odor, juiciness and tenderness. Chemical measurements of changes in fatty acid content will be done.

Progress: Data have been obtained on the effects of various cooking methods on residues of chlorinated pesticides in muscle tissues of chickens raised to market weight (8 weeks). The feed contained 10 ppm of aldrin, dieldrin, endrin, heptachlor and lindane. The 10 ppm level of endrin resulted in mortality of 75% of the birds. The various cooking methods were baking, frying and pressure cooking. Raw tissue was used as a control. In addition to the above methods, one bird from each pesticide treatment was further tested by baking sections of muscle for 30, 60, or 90 minutes.

SUPPORTED BY U.S. Dept. of Agriculture

4.1127, PREVENTING INSECT DAMAGE TO TOBACCO AND TOBACCO PRODUCTS IN MARKETING CHANNELS
D.P. CHILDS, U.S. Dept. of Agriculture, Market Quality Research Div., *Richmond, Virginia* 23240 (SP16)

OBJECTIVE: Investigate effect of environmental factors on physiology and reproduction of the cigarette beetle; evaluate insecticides for toxicity against adult cigarette beetles and determine residues in tobacco; and develop improved programs for controlling stored-tobacco insects.

APPROACH: Ecological studies to determine influence of environmental factors such as temperature, atmospheric humidity and moisture content of tobacco on the physiology, reproduction and behavior of the cigarette beetle. Compounds to be evaluated for residual, vapor, repellent and attractant action to adult cigarette beetles. Determine performance and nature of insecticide residues remaining in tobacco. Develop improved programs for insect prevention and control where tobacco is stored or processed.

PROGRESS: Movement of late stage larvae of the cigarette beetle from hogsheads of tobacco under semicontrolled warehouse conditions occurred twice. The larvae responded to a temperature gradient in tobacco located near the hogshead perimeter. All stages of the cigarette beetle remaining in the tobacco were killed by low temperatures. Temperatures near the center of tobacco hogsheads were below 40 F. for 90 days. The Bacillus disease of the cigarette beetle remains unidentified. Tests have shown mode of transmission to be mechanical. Gravid cigarette beetles were induced to oviposit on nonfood substances treated with ethanol extracts of attractant food materials. Mean number of eggs deposited on filter paper per female was 30.5 and viability was 91.2%. Efficiency of electric grid traps with BL lamp versus the standard trap to capture the cigarette beetle was approximately 3X in tobacco storages and 10X in a tobacco factory. About the same exposure time was required with 100 p.p.m. phosphine as with 500 p.p.m. to kill all stages of the cigarette beetle. Louvered warehouses were sealed satisfactorily for fumigation with phosphine when draped with tarps of 2-mil polyethylene. Overseas freight containers in sound condition were sufficiently gastight for fumigation of tobacco cases with phosphine. The fumigant was evolved from aluminum phosphide pellets used at 165 per 1,000 cubic feet and exposure was for 72 hours at tobacco temperatures above 60 F., and for 96 hours at tobacco temperatures below 60 F.

SUPPORTED BY U.S. Dept. of Agriculture

4.1128, THE BIOLOGY AND CONTROL OF INSECTS AND MITES ATTACKING STONE FRUITS
E.W. ANTHON, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01090)

OBJECTIVE: Determine the biology of new pests of stone fruits. Determine the most economical control measures of pests attacking stone fruits; also, pests that are resistant to standard insecticides now in use. Spray and collect fruit for residue analysis.

APPROACH: Explore the specific use of insecticides which would promote the use of natural biological agents. Test various insecticides for controlling stone fruit pests and continue biological studies of temperatures in relation to San Jose scale crawler stage.

PROGRESS: The peach twig borer was successfully reared on wheat germ diet through two generations under laboratory conditions. The adding of more alphacel to the diet and a germicidal lamp treatment to the freshly made medium assisted in drying the media enough to allow the larvae to move about freely. Wheast (a yeast cultured on cottage cheese whey) when added to the diet made it more acceptable to the neonatal larvae. The neonatal larvae were induced to eat the medium when confined in tightly lidded plastic jelly cups placed in complete darkness. Integrated mite control studies on prunes indicated that an early prebloom supplemented by a mid-season mite spray provides sound and economical control. Laboratory and field testing in-

dicated that Plictron, omite, TH-467-I Hoc. 2960, Fundal and Humble plus Collier oil plus omite provided good control of mites on stone fruits. The materials most promising for aphid control were Fundal, American Cy. 72613, Stauffer R 15552 - 15792, Baygon and Azodrin.

SUPPORTED BY Washington State Government - Olympia

4.1129, PHYSICAL METHODS OF IDENTIFICATION AND DETERMINATION OF PESTICIDES AND THEIR DEGRADATION PRODUCTS

D.R. COAHRAN, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01793)

Objective: Develop improved methods for the separation, identification and determination of pesticides and their degradation products.

Approach: Initial work will be on gas chromatography, with emphasis on selective detection methods which give qualitative as well as quantitative information on the composition of the material being chromatographed. The use of such detectors will greatly simplify the identification of materials resolved by gas chromatography. The detectors under consideration include electron capture, hydrogen flame, mass spectrometer, and spectrometric glow discharge.

Progress: Preliminary work was done on a radio-frequency glow- discharge gas chromatographic detector utilizing the spectrum of the light produced by the discharge to identify the material detected. Progress was slow, however, and the project was dropped when Cooke published the design of a detector operating on the same principle. Work was done on a swept-voltage electron capture detector for gas chromatography. Such a detector should give information about the structure of the compound being detected. Initial experiments were not successful, due to the very slow response of available electron capture detectors to voltage change. This idea is not being pursued at present, but work will be resumed under another project when fast-responding detectors become available. A phosphorus-sensitive Gas Chromatographic detector of greatly increased stability was developed and the design was published. An improved version is now commercially available. This detector has been of great value in the analysis of organo-phosphate pesticide residues.

SUPPORTED BY U.S. Dept. of Agriculture

4.1130, METHODS OF ANALYSIS FOR PESTICIDES, YAKIMA

L.M. MCDONOUGH, U.S. Dept. of Agriculture, Entomology Research Division, *Yakima, Washington* 98902 (00ENTM1104500809)

OBJECTIVE: Develop sensitive, accurate, specific methods of analysis for new insect control chemicals and for their residues and metabolites or breakdown products in agricultural crops, animal tissues, and soils.

APPROACH: Study chemical and physical properties and reactions of new insect control chemicals and their metabolites to find specific measurable characteristics; develop quantitative analytical methods based on these characteristics. Develop efficient procedures for extraction and cleanup of residues from plant and animal tissues and soils preparatory for analysis.

PROGRESS: An analytical method was developed for the determination of residues of carbofuran, its hydroxy- and its keto-metabolites by the preparation of a trichloroacetate derivative and subsequent analysis by EC-GLC. It has been applied to tomatoes, tomato foliage, soil, potatoes, lettuce, and cucumbers.

SUPPORTED BY U.S. Dept. of Agriculture

4.1131, INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER

C.W. CARLSON, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (SWCW8-BELT-19)

OBJECTIVE: Determine the most effective method for extracting and purifying pesticides from soil types and runoff and drainage waters and develop accurate analytical procedures for estimating pesticide concentrations.

APPROACH: Conduct investigation bases designed to determine accurate analytical procedures for the determination of extremely small concentrations of organic pesticide residues in soils and runoff and drainage water. All soil components which interfere with the final analytical determination will be completely evaluated and the methods and necessity for removal investigated. Analytical procedures which will completely extract pesticides residues from different soil systems and waters will be developed; interferring substances from soil extracts will be identified and methods for effectively removing them developed.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

4.1132, THE BIONOMICS AND CONTROL OF INSECTS ATTACKING VEGETABLE CROPS

J.L. LIBBY, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01605)

OBJECTIVE: Study the bionomics of and develop control programs for vegetable crops insects. Determine insect resistance to control measures and the effects of control materials on the environment.

APPROACH: Determine vegetable crops pest species and populations, their life cycles and habits. Utilize chemical and biological agents to develop control programs for pest species in field studies. Determine insect resistance to control agents in field studies. Analyze plant and soil samples by gas chromatography to determine insecticide residue levels and any environmental contamination.

PROGRESS: Chemical and biological control materials were applied to aid in determining effective controls for cabbage worms, root maggots, leafhoppers and flea beetles on cabbage, beans, rutabaga and potatoes. Phytotoxicity studies were conducted in all these plots. Bacillus thuringiensis Berliner will provide an alternative to chemical control of cabbage looper, Trichoplusia ni Hubner only when used at relatively high dosages at regular weekly intervals. Phytotoxicity studies showed the soil applied systemics phorate and disyston to have an adverse effect upon the production of Norland variety potatoes at 3 lbs. and 6 lbs. active ingredient per acre. Three pounds is the generally recommended dosage for commercial application to potatoes.

SUPPORTED BY U.S. Dept. of Agriculture

4.1133, ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE

E.P. LICHTENSTEIN, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01387)

OBJECTIVE: Devise and improve sampling, extraction, and analytical techniques to facilitate quantitation of pesticide residues and degradation products in soils, plants, and animals. Examine the action, persistence, degradation, and translocation of selected biocides and their metabolites in plants, animals, and microorganisms. Describe the evaluate biocide cycling through the soil and water environments, particularly in reference to food chains.

APPROACH: Strictly controlled laboratory tests, accompanied by field tests at the U.W. farms are being conducted. Generally, attempts will be made to further answer questions as the reasons for observed effects. Studies on a subcellular level will be conducted.

PROGRESS: Polychlorinated biphenyl plasticizers were found to synergize the toxicity of several insecticides. Their interference in analyses of insecticides was also demonstrated. Enzyme systems were isolated from subcellular plant components that epoxidize aldrin to dieldrin. Contrary to animal enzymes, those from plants were specific for aldrin. A ten year field study showed that the 'persistent' insecticides, aldrin and heptachlor, disappeared (although relatively slowly) from soils through metabolism into non-toxic compounds and through volatilization. Effects of various insecticides on soil fungi were studied. Interactions between insecticides and aspirin on human cells in tissue culture were investigated and the effects on synthesis of DNA, RNA and protein were determined. Aspirin showed effects similar to those that were observed with the insecticides. Fate and metabolism of the organophosphorus insecticide Guthion was studied under both field and laboratory conditions.

SUPPORTED BY U.S. Dept. of Agriculture

4.1134, STUDY OF THRIPS TABACI, ITS BIOLOGY AND ECOLOGY, A VIRUS VECTOR ON TOBACCO

B. TODOROVSKI, Inst. of Tobacco, *Prilep, Yugoslavia*
(PL480E30ENT9)

OBJECTIVE: Determine biology and ecology of tobacco thrips, its effect on yield and on virus transmission.

APPROACH: Study life history and development of tobacco thrips; effects of environmental factors on movement and population fluctuations; differences in varietal susceptibility to thrips injury and virus transmission, and characteristics of direct injury and virus- vector relationships. Develop methods for control and determine pesticide residues in tobacco.

PROGRESS: Continuing yellow pan surveys indicated that the highest population of onion thrips appeared late in August 1969 as compared to July 1968. Onion thrips' populations varied considerably on different varieties of tobacco. Certain pesticides control thrips well on some tobacco varieties but not on others. Biochemical research to determine the reason for these differences in pesticide efficiency on certain varieties and not others is being initiated. The LV3 virus was purified by ultracentrifugation, and electron micrographs of the material will be made to determine form and particle size. It was noted that tobacco from LV3 virus infected plants is of low quality. This was attributed to the decrease in soluble carbohydrates and polyphenols in the tobacco leaves which resulted in a weak taste.

SUPPORTED BY U.S. Dept. of Agriculture

4.1135, EXPERT, AD HOC COMMITTEES AS A SOURCE OF TECHNICAL ADVICE - DOCTORAL DISSERTATION RESEARCH

J.E. BLODGETT, Case Western Reserve Univ., Graduate School, *Cleveland, Ohio* 44106

The dissertation will investigate the behaviors of scientists serving on expert, ad hoc committees and ascertain their perceptions of these committees' functions and effectivenesses. Focusing on the area of pesticide regulation for the decade 1960-1970, which gave rise to a considerable number of ad hoc study groups commissioned to evaluate various relevant problems, the dissertation research will examine demographic information, advisory experience, decision making, constraints and the expert/public interface.

SUPPORTED BY U.S. National Science Foundation

DESCRIPTION OF RESEARCH TASKS

5. RADIATION

A. SOURCES Primary Sources of Radiation Detrimental to Human Health, Animal Or Plant Communities, Materials, Or the General Environment. Includes Ultraviolet, Radioactive Isotopes, Electromagnetic, and Radiation Sources in General.

5.0001, STRONTIUM-90 LEVELS ON THE DIETS AND BONES OF CHILDREN
D. BENINSON, Comision Nac. De Energia Atom., *Buenos Aires, Argentina* (AT(30-1))

The objective of the project is the determination of parameters governing the contamination of bone as a function of age and the levels of strontium-90 in the diet.

Turnovers of strontium have been determined independently of Sr to Ca discrimination factors by placing emphasis on specific activity measurements.

Radium-226 measurements have been carried out for comparison of its behavior with that of strontium. It is proposed to complete the project with one more year of work at about the same intensity, improving the reliability of the estimates of metabolic parameters.

Results: From determination of Sr-90/Sr specific activity and strontium to calcium ratios in bones and diets, bone turnover rates and strontium to calcium discrimination factors have been estimated for several age groups, but some of the estimates should be qualified by substantial uncertainties.

SUPPORTED BY U.S. Atomic Energy Commission

5.0002, DETERMINATION OF U-235 ENRICHMENT IN UNIRRADIATED URANIUM BEARING STREAMS
N. BACHVAROV, Bulgarian Acad. of Sciences, *Sofia, Bulgaria*

Non-destructive analytical techniques are urgently needed for the accurate determination of the fissile content of process streams, analytical samples and, in particular, for scrap material. The existence of such techniques would make a major contribution in the ability of promptly detecting diversion of fissile material from the fuel cycle.

In anticipating the particular problems of safeguarding enrichment facilities we are trying to develop different methods and techniques to cope with the safeguard task for this part of the fuel cycle. In particular, attention is being focused on development of techniques to determine the enrichment in the flow of UF6.

The objective of present work is to investigate prospective instrument techniques of x-ray fluoresecence and gamma measurement for analysis of U-235 in U-bearing streams, using ratio of intensities of 185 KeV gamma rays from U-235 and K x-rays from total uranium. Spectrometry will utilize semiconductor system with 4000 channel analyzer DIDAC.

The programme of work shall include optimizing the geometry of the detector(s) and assessing a number of possible radiation sources such as Co-57 and Se-75 required for K x-ray fluorescence excitations; and studying the accuracy of the method.

Test will be made initially on UF4 sample. Subsequently, the method will be further developed and tested on UF6 samples.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0003, METEOROLOGY FOR NUCLEAR TESTING
UNKNOWN, Meteorology Research Inc., *Altadena, California* 91001 (011624)

To develop an atmospheric model of diffusion over large distances: (a) Design and execute a cooperative experiment with NASA consisting of a field program measuring relative spread of clusters (2 to 4) of tetrooms as a function of travel time and meteorological conditions; (b) Processing of the data on cluster spread; (c) Preliminary development of an advanced model for large cloud quasi instantaneous source diffusion in simple two dimensional shear flows using results of the field program as input parameters; (d) Recommend for further testing and development of the model.

The field program has been completed in so far as funds have been available and the data are in hand. Interpretation in terms of field parameters and first effort towards developing the model are essentially complete. The model has not been tested and its suitability has not been determined.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

5.0004, THE FATE OF TRITIUM RELEASED BY NATURAL GAS STIMULATION AND STORAGE EXPERIMENTS USING NUCLEAR DETONATIONS
L.R. ANSPAUGH, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

An important area of the Peaceful Uses of Nuclear Explosives program over the next several years will be in the areas of the stimulation of natural gas production and the creation of reservoirs for the storage of natural gas. Both activities will produce large amounts of tritium which will present one of the greatest potential hazards. Two such events, Gasbuggy and Rulison, have already been detonated, and there will possibly be one additional experiment per year over the next five years with the goal of achieving actual commercial usage at the end of the five-year period.

The primary objectives of this program would be to determine the movement of tritium through the biosphere and to assess the ultimate exposure to man from the release of tritium into diverse ecosystems. To accomplish our objectives, we intend to follow the movement of tritium through different trophic levels of exposed ecosystems and to determine at each point the relative partitioning of tritium between organic matter and unbound water. One of the major objectives is to carefully evaluate possible isotopic fractionation mechanisms between trophic levels and between organic matter and unbound water. Such isotopic fractionation mechanisms have been observed for both deuterium and tritium although the possible significance of such mechanisms remains to be adequately evaluated.

Results: This is a proposed new project and no experimental work has been done. An evaluation of the potential biological hazards associated with Project Rulison has been made and published.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0005, STUDIES OF DEPOSITION AND REDISTRIBUTION OF DEBRIS FROM SPECIFIC NUCLEAR EVENTS
L.R. ANSPAUGH, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

The broad objectives of this program are to document the amounts of radioactivity released by specific nuclear events, and to study the transport, the deposition, and the redistribution of the debris. Physical methods of measurement will be used primarily. Biological studies may be done if deemed appropriate, but only when the physical parameters are measured first or simultaneously. Field instrumentation stations have been developed and will be improved upon as the requirements are established. These stations will be used in a network that will furnish radioactivity (specific radionuclides) concentration in the air and ground deposition as a function of time. Appropriate micrometeorology parameters may be measured. Provisions have been made for collecting as a function of time, samples that may be used in establishing fallout particle characteristics. The measurements from these stations will aid the refinement of predictive transport and deposition models.

Field studies were conducted on the Plowshare Cratering experiment, 'Schooner', at the Nevada Test Site. Redistribution over a 1000 hour period following the experiment was documented. This was the first time quantitative studies have been carried out on a Plowshare experiment, with the resultant verification of significant redistribution. Over 20 different radionuclides were studied and quantitated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0006, RADIOECOLOGY OF DEBRIS RADIONUCLIDES AT INTERMEDIATE DISTANCES FROM NUCLEAR CRATERING EVENTS
R.J. GRABSKE, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

The objective of this program is to evaluate the movements in the local ecosystems of radionuclides produced by nuclear cratering events and deposited at distances between 30 and 150 miles from the detonation site. Significant results are to be expected from such a study for two reasons. First, this distance range includes these areas of land outside the Nevada Test Site that are most likely to receive fallout from the test. Second, any debris falling in these areas may more closely resemble in particle size and chemistry the debris that could fall in distant populated areas than debris falling close to the test site.

The measurements proposed include analyses of gamma-emitting radionuclides in the local soils, water, plants, and animals. These materials will be rechecked periodically in areas showing the evidence of fallout for several months after the event or until the radiation levels fall too low for adequate monitoring. These field studies will be supplemented by studies of radionuclide uptake in common food plants grown in the laboratory in radioactive soils collected in Nevada.

Results: Following the Schooner event a survey was made to the north and east of the detonation. Soil, plant, water and wildlife samples were collected. All samples were analyzed for gamma radioactivity. At Livermore a number of species of plants were grown in contaminated Nevada soil to determine the soil-to-plant transfer coefficients for W-181, the major radionuclide.

SUPPORTED BY U.S. Atomic Energy Commission

5.0007, CHARACTERIZATION OF RADIOACTIVE PARTICLES PRODUCED BY NUCLEAR DETONATION
R.E. HEFT, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

Objective; To determine how the individual radionuclides produced by nuclear detonation are distributed according to particle type and particle size.

Reason; The mode of interaction of the radionuclides with the biosphere depends on the physical and chemical properties of the particles population. Thus, a radionuclide which is volume distributed in 500 micron particles has an entirely different biological interaction potential than one which is surface distributed on 10 micron particles. In order to predict the potential biological effects of a given nuclear detonation, it is necessary to be able to predict radionuclide distribution in the particle population.

Procedure; Early time, close-in, aerial filter and fallout samples from a specific nuclear detonation are systematically separated according to particle type and size. The separated fractions are subjected to high resolution gamma spectrometry in order to determine individual radionuclide abundance, and hence radionuclide distribution.

Test Objects and Agents: Close-in particle samples.

Results; Radionuclide distribution for cratering detonations can be understood in terms of a two-stage condensation process. The radioactive plasma produced by the detonation is initially completely contained by a molten rock cavity liner. Depending on a Henry's law interaction, each radionuclide condenses to some extent in the molten liner. When the liner ruptures, venting occurs and the uncondensed radionuclides escape from the temperature cavity and rapidly deposit on the surface of particles produced in the overburden by the shock wave.

SUPPORTED BY U.S. Atomic Energy Commission

5.0008, ECOLOGICAL STUDIES OF RADIONUCLIDES IN ECOSYSTEMS AT NUCLEAR DETONATION SITES
J.J. KORANDA, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

This program is concerned with the distribution and movement of long-lived radionuclides, especially tritium, in ecological and biological systems occurring at nuclear detonation sites. Comparative ecological studies are conducted elsewhere to provide specific information when it is not available. The movement of tritium through soil, plants and animals of a single ecosystem has been studied in the desert environment of the Nevada Test Site, and in the tropical rainforest in Puerto Rico. Current studies are being conducted in other environments, and with agricultural plants as well as natural vegetation.

Continuing studies will be concerned with the half-time of tritium from either a liquid or vaporous exposure in selected plant species, in soils, and in diverse ecosystems. These tracer studies will be conducted at Livermore, NTS, and in other areas of the U.S. Long-term studies will be continued at Sedan crater where the emphasis will be upon half-residence time measurements, and physiological studies in plants and animals.

Results: Research conducted at Sedan crater in the Nevada Test Site has indicated that the half-residence time of tritium in the ejecta or soil around the crater is of the order of 15-18 months. Evaporation, transpiration by plants, and losses to deeper soil water compartments accounts for this loss rate. Comparative data obtained in the tropical rainforest in Puerto Rico show that the half-residence time of tritium in that environment is considerably shorter, and on the order of 77 days for a watershed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0009, ANALYSIS OF RADIONUCLIDE TRANSPORT AND DEPOSITION FOR PREDICTION OF UPTAKE AND DOSES FROM RELEASE OF RADIONUCLIDES
Y.C. NG, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

This analysis of the transport and deposition of radionuclides is a main category of a predictive program designed to provide the following kinds of information: (1) guidance for radiation safety analysis of proposed applications involving nuclear energy, (2) guidance for documentation of the release of radionuclides to the biosphere, and (3) guidance for design in applications involving nuclear energy. This portion of the prediction program deals specifically with the transport of radionuclides from the source of their production estimates and biological uptake relationships to arrive at estimates of the burden and dosage to man. The overall approach is described in a series of reports. The fallout deposition by washout or rainout, provide new information that will be used to update the atmospheric transport phase of our predictive approach.

Results; Fallout depositions that were measured subsequent to Project Schooner of the Plowshare cratering program have been examined and correlated with the radionuclide concentrations that were reported in the milk and feed of dairy cattle following the event, and the implications of these results of a proposed Plowshare cratering experiment have been discussed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0010, THE STUDY OF THE LIFE HISTORY OF RADIONUCLIDES RELEASED INTO A MARINE AND TERRESTRIAL ECOSYSTEM AT THE SITE OF A SMALL BOILING-WATER REACTOR

P.L. PHELPS, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

Primary emphasis will be placed on following the movement of tritium through both the marine and terrestrial environments. The measurement of deposition velocity, residence time in the biota, and quantitative relationships will be studied. These measurements will be related to atmospheric and surface conditions. Transport mechanisms and concentration in biota of other radionuclides will be included in the program. Data derived from these studies will be applicable to model development for future reactor siting.

SUPPORTED BY U.S. Atomic Energy Commission

5.0011, BIOLOGICAL AVAILABILITY TO DAIRY PRODUCTS OF MAN-MADE RADIONUCLIDES

G.D. POTTER, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

This project has been designed to determine the 'biological availability' of metabolism and transport of orally administered radionuclides in the lactating dairy cow and in the calf. Special emphasis has been placed on the secretion of these nuclides in milk and their deposition in tissues. Since a large portion of the diet in this country consists of milk, milk products and beef it is important to determine and understand mechanisms responsible for the secretion of radionuclides into milk and their deposition in tissues as potential pathways in the diet of man. Data obtained from such studies should single out those radionuclides which could present major problems and may also suggest possible countermeasures for the reduction or removal of these radionuclides from the diet of man. The radioisotopes are administered orally to lactating cows or calves as single radioisotopes, as mixtures, or in the form of debris from nuclear events (specifically Plowshare nuclear cratering events). Analysis of the total milk, urine and fecal output of the cows is carried out using sodium iodide detectors for single isotope experiments and lithium-drifted germanium detectors (Ge(Li)) for complex mixtures and debris studies. Similar methods are used for tissue distribution studies in the calves. Uptake and disappearance curves are constructed for individual radionuclides in milk, urine, feces, plasma and erythrocytes. These studies have been extended to Beta-emitting radionuclides including tritium.

Results: Studies on approximately 35 radionuclides have been completed on lactating cows, and about 12 radionuclides have been run in calves. In addition, studies have been completed on cows fed debris from several Plowshare nuclear cratering events. Portions of this material have been submitted and the remainder is being prepared for publication.

SUPPORTED BY U.S. Atomic Energy Commission

5.0012, DISTRIBUTION AND INTERRELATIONSHIP OF ELEMENTS IN BIOLOGICAL SYSTEMS

G.V. ALEXANDER, Univ. of California, Lab. of Nucl. Med. Rad. Biol., *Los Angeles, California* 90024 (AT(04-1)GEN-12)

The primary goal of this project is to determine the distribution and interrelationships of the elements present in biological systems. Of fundamental importance to this goal is the development of efficient analytical methods which will produce accurate results. To meet these requirements an emission spectrometric analytical system has been developed which requires little sample preparation, is simple to operate and is capable of simultaneously determining some 25 elements commonly observed in plant and animal tissues.

Frequently very little is known of the element pattern that would permit a differentiation between a diseased state, radiation damage, ageing and the 'normal' state. The application of multielement analysis and the use of the resulting element interrelationships adds a new and important dimension to this type of differentiation.

Results: During the past year over 11,000 plant samples have been analysed . For the most part these samples are related to the studies of element translocation in desert plants of the Nevada Test Site Region. The cycling of radionuclides and stable elements in areas under study at the Nevada Test Site is being investigated. Related problems such as species variability in accumulation of radionuclides and other elements are also under investigation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0013, INFLUENCE OF SOIL HEATING ON THE GROWTH AND ELEMENTAL COMPOSITION OF BEAN PLANTS

H. NISHITA, Univ. of California, Lab. of Nucl. Med. Rad. Biol., *Los Angeles, California* 90024 (AT(04-1)GEN-12)

The soil in the immediate vicinity of a nuclear detonation may not only be contaminated with radionuclides, but is exposed to heat ranging in temperature well above that causing vaporization down to ambient level. One of the unknown factors arising from these detonations is the influence of soil heating on the availability of the soluble radionuclides in the soil-plant-animal cycle.

Another interesting aspect is the effect of soil heating on the availability of the essential nutrient and the non-essential elements to plants. It is necessary to know the effects of these factors in determining the relationship between ionizing radiation and plant growth in areas exposed to nuclear detonations. Thus, the objective of this project is to determine the growth and elemental composition of plants as a result of soil heating. Experiments are being conducted in the greenhouse using beans as test plants.

Results: The effect of soil heating on the following soil properties were examined: weight loss, particle size distribution, pH, organic matter content, total N, cation exchange capacity, electrical conductivity of saturation extract, and seven NH4OAc extractable cations. The plant leaves were analyzed for 2 radionuclides and 19 stable nuclides in one experiment. The determination of the extractability of different elements in heated soils is in progress.

SUPPORTED BY U.S. Atomic Energy Commission

5.0014, PHYSIOLOGICAL ECOLOGY STUDIES OF DESERT VEGETATION

A. WALLACE, Univ. of California, Lab. of Nucl. Med. Rad. Biol., *Los Angeles, California* 90024 (AT(04-1)GEN-12)

Life histories of major perennial shrub species occurring in the Nevada Test Site are being studied. Phenological records including dates for vegetative growth, flowering, fruiting, leaf fall, dormancy are being kept. Age structure, plant size and weight, and annual productivity are being determined. Annual productivity is also being determined for herbaceous plants. Special studies are being undertaken to determine rates of growth and standing biomass of roots. Mineral nutrients in plant parts are being determined as is similar data for other biotic components and that of the soil for mineral cycling evalution. Special emphasis thus far has been placed on nitrogen and phosphorous. Many of the plant species have been vegetatively propagated and these materials have been used for glass-house studies and effects of environmental variables on those species. Air and soil temperatures have been studied in some detail and important interactions on some shrub species have been determined. Responses of plants to soil pH and salinity are being investigated to explore ecological aspects of the distribution of these species in nature. Effects of these factors and rates of photosynthesis and water use are being studied. It is expected that these studies are to serve as guide lines and integral parts of additional studies concerning effects of radiation on plants and on cycling of radionuclides in desert ecosystems.

Results: After 5 years of gamma irradiation of a plot at the Nevada Test Site wth a 33,000 curie Co60 source to give a cumulative exposure of about 30kR, only one of the plant species, 'Ephedra nevadensis', seems to have been affected. In 1969 this species essentially failed to flower and very few fruits were set relative to plants in non irradiated areas. Progress has been made on all aspects of the project.

SUPPORTED BY U.S. Atomic Energy Commission

5.0015, RESEARCH ON FAULTS AND FAULT ACTIVITY FOR LAND-USE PLANNING

M.G. BONILLA, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

States to which project pertains: Worldwide in scope.

To review and summarize the historic record regarding those aspects of fault activity which are especially important in land-use planning, with particular emphasis on nuclear power reactor siting.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

5.0016, GEOCHEMISTRY STUDIES WITH STABLE AND RADIOACTIVE SPECIES

S. EPSTEIN, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109 (AT(04-3)-767,07)

The evolution of lead influx into our society will be examined by making lead analyses of artifacts and of ores from old civilizations and by examining early metallurgical processes in which lead was involved.

Natural suites of zircons of known crystal radiation damage and of known U-Th-Pb content will be exposed to high temperature and pressure fluids simulating hydrothermal conditions within the earth's crust to permit interpretation of natural hydrothermal conditions to which the zircon has been exposed during its geologic processes.

The problem of interpreting isotope data of lead in feldspars from ancient granites will be attacked by extracting lead from different parts of the feldspars. These techniques should provide information regarding the mobility and redistribution of the lead in the feldspar crystals during modifying geologic processes.

Additional zircon samples from Precambrian basement rocks underlying the Colorado Plateau will be analyzed for the high uranium anomaly to ascertain the history of uranium distribution in the area. Basement rock samples brought up from deep oil wells and by volcanic activity will be the most promising source of samples at this time.

Improved mass spectrometer techniques in measuring small quantities of lead for its isotopic composition permit investigation of single microscopic crystals of U-Th-containing minerals, provided it is possible to eliminate the lead contamination and complex chemistry in preparing the lead for the mass spectrometer.

A survey of the Si30/Si28 ratio of the various natural materials is to be made to establish the possible existence of some systematic pattern in the variations, similar to that observed for the O18/O16 ratio in silicate rocks and minerals.

The establishment of the D/H ratio partition between some hydrous minerals should permit a better understanding of the D/H record in some hydrous minerals. D/H analyses should provide a possible 'temperature' of their formation and an isotopic composition of 'primary igneous water'. The D/H ratio may tell us whether the ocean formed all at once in the early history of the earth or gradually accumulated with continuous degassing of the earth. As a by-product of these investigations, we may be able to learn whether the early forms of life on earth originated in fresh waters or marine waters. (Text Abridged)

SUPPORTED BY U.S. Atomic Energy Commission

5.0017, CHEMICAL REACTIONS INDUCED BY ULTRAVIOLET AND IONIZING RADIATION

G.S. HAMMOND, Calif. Inst. of Technology, Graduate School, *Pasadena, California* 91109

Air Force flight operations involve potential exposure of materials and personnel to harmful radiation. Means are required to inhibit radiation induced damage in order to assure mission completion. This research reveals basic chemical and physical effects of radiation at the molecular level by which energy is dissipated. Specific guidance is afforded design, selection, and synthesis of new materials of increased radiation resistance. Special research emphasis is afforded studies of the detailed kinetics and mechanisms of chemical change induced by high energy radiation - alpha particles, gamma rays, and protons. Prototype studies will be made with chemical systems already well characterized photochemically - using less energetic photons of light radiation. High energy radiation produces many kinds of short-lived chemical species - ions, free radicals, and molecular excited states. These species are precusors of eventual, stable chemical products. Use of systems of well defined photochemistry permits identification of those parts in the radiochemical systems following photochemical reaction pathways. The study of the residual chemistry following other paths is much simplified. Corrollary photochemical studies are designed to reveal systematic relationships between molecular structure and chemical reactivity.

Supporting agency address information: AF Office of Scientific Rsch SRC Arlington, Va. 22209.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0018, VARIATION IN THE ISOTOPIC CONTENT OF PRECIPITATION WITH ALTITUDE

C. SILVA, Univ. De Chile, *Santiago, Chile*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0019, A STUDY OF LASER DAMAGE TO BIOLOGICAL MATERIALS

F.S. BARNES, Univ. of Colorado, School of Engineering, *Boulder, Colorado* 80302

This coming year, it is proposed to do a detailed study of the generation of acoustic waves by means of a Q-switched laser and their damage to biological materials. In particular, we expect to make measurements of a peak pressure and peak pressure gradients of acoustic waves generated by a Q-switched laser as a function of the geometry absorbed laser beam and the power input. Additionally, we expect to measure the characteristics of reflected and transmitted acoustic waves from soft tissue. The objective is to obtain detailed information in the interaction between acoustic waves and biological material including power absorbed, the velocity of propagation, the pressure, and the peak pressure gradients. Additionally, we expect to determine the peak pressure or peak pressure gradients for threshold damage to biological materials.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0020, CENTRAL NEVADA GEOLOGIC INVESTIGATIONS

E.B. EKREN, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

State(s) to which the work listed herein pertains: Nevada.

The first and principal objective of this project was to determine the suitability of Central Nevada as a supplemental test site for underground nuclear testing. Geologic studies, deep drilling, and one nuclear underground test have demonstrated this suitability. Current objectives are to complete mapping eight 15' quadrangles and specific parts of two others, continue to upgrade our knowledge of stratigraphy and structure in order to provide precise data when they are needed by the AEC, AEC contractors and cooperative agencies. As long as the AEC is involved in Central Nevada, we will continue to refine our geologic knowledge. We will publish quadrangle maps at scales of 1:48,000, write intermittent administrative reports for the AEC, and depending on the continuation of the area as a test site, will start a final report in 1971 or 1972.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

5.0021, PLOWSHARE SPECIAL STUDIES
F.W. STEAD, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

Specialized geologic and hydrologic studies by the Geological Survey will provide data for evaluation both of technical feasibility and of public safety of proposed Plowshare nuclear detonations. Recommendations and suggestions to AEC will be made outlining further studies and tests needed to resolve problems in using nuclear explosives effectively and safely in various environments.

Proposed peaceful applications of nuclear explosives are sponsored and primarily funded by industry (Project Sloop--the in situ leaching of an oxidized copper ore body; Project Rio Blanco--stimulation of natural gas production from low permeability reservoir; Project Utah--shattering of oil shale preparatory to in situ retorting), and by government (Project Aquarius--water management in the State of Arizona). Within the next year or so, under the Non-Proliferation Treaty (NPT), Plowshare projects probably will be requested by foreign countries, with coordination through the International Atomic Energy Authority (IAEA).

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

5.0022, INSTRUMENT DEVELOPMENT LABORATORY
W.W. VAUGHN, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: All states.

The purpose of the Instrument Development Laboratory is to originate and develop analytical techniques that are beneficial to geochemical and geologic investigations. A multi-disciplinary approach including electronics, physics, and chemistry is used to economically devise new methods or modify existing techniques to our specific needs. Of general interest are the adaptation and interpretation of the physical characteristics of the electromagnetic spectrum as determined by absorption, interference, reflectance, and fluorescence observations with special interest on the volatile or highly mobile elements.

Current objectives of the project include a two-way development program of simple reliable instrumental techniques using atomic absorpton and nuclear radiadion techniques for volatile or transitory elements occurring naturally. The two techniques will provide analytical data that is unique to each procedure and at the same time serve as correlative measurements to further validify values in the ppb (parts per billion) range of interest in geochemistry.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

5.0023, RADON PROGENY INHALATION EXPOSURES TO URANIUM MINERS
K.J. SCHIAGER, Colorado State University, School of Veterinary Medicine, *Fort Collins, Colorado* 80521

Objectives: This research was initiated as part of an integrated program to determine the effects of inhalation of radon and its daughters upon the induction of bronchogenic carcinoma in uranimum miners. Forty actively working uranium miners were selected from two mines on the Colorado plateau along with ten control subjects residing in the area who had no known occupational exposure to radon progeny or mine environments. The miners were equipped with personal dosimeters consisting of a battery-operated air sampling pump and a thermoluminescent dosimeter (TLD) worn on the miner's hat and designed to sample and measure the radioactivity in the air which the miner actually breathed. Blood and whisker samples were collected on a regular basis for measurement of polonium-210 and lead-210 to determine the correlation between the measured Working Level Month (WLM) exposures to radon progeny and the subsequent deposition of long-lived radioactive decay products in the whiskers. The objective was to develop a reliable bioassay procedure that would indicate cumulative exposures over definite time periods.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0024, A STUDY OF UNSUPPORTED 210 PO ION EXCHANGE IN SOILS, UPTAKE IN VEGETATION AND COMPARISON WITH DIRECT AERIAL DEPOSITION
R.L. WATTERS, Colorado State University, School of Veterinary Medicine, *Fort Collins, Colorado* 80521 (AT(11-1))

It is proposed to continue studies on the distribution coefficients of 210PoO2 in agricultural soils. Uptake in plants will be determined under various soil modification schemes. The chemical forms of the 210Po in soil and soil solution will continue to be investigated. Foliar deposition experiments are designed to determine migration in plant tissues, retention as a function of time and leaf alpha radiation dose effects.

Results: Distribution coefficients have indicated retention in the top soil layers. The distribution coefficients can be predicted from soil pH and silt content. Chemical species of 210Po in soil solution examined by electrophoresis and dialysis experiments indicated positive and negative species existed. Foliar absorption of 210PoO2 is appreciable.

SUPPORTED BY U.S. Atomic Energy Commission

5.0025, FIXATION OF CESIUM 137 BY SOIL CLAYS
B.L. SAWHNEY, Conn. Agric. Expt. Station, *New Haven, Connecticut* 06504 (AT(30-1))

The objectives of the proposed research are to determine the mechanism of Cs fixation by layer silicates and to investigate Cs sorption and fixation by whole soils

To determine the effect of the origin of charge on interlayer collapse and hence the Cs fixation, collapse in two trioctahedral montmorillonites was investigated during the past year. The lack of collapse and regular interstratification in these montmorillonites was similar to dioctahedral montmorillonites. Interlayer collapse will now be determined in dioctahedral vermiculites. Precise estimates of the collapsed layers in interstratified mixtures formed on sorption of Cs and K ions will be made using Fourier synthesis of the x-ray diffraction maxima.

Studies with an electron microprobe of the distribution of sorbed Cs in whole soils during the past year revealed that sand-sized weathered biotite particles in a soil core sorbed almost 8 times as much Cs as the clay. Sorption and distribution of some non-fixing type cation, as Ca, will be determined by the microprobe and compared to Cs distribution. Then, sorption and fixation of Cs by different soils of the region will be studied and related to structural and mineralogical characteristics of the soils.

SUPPORTED BY U.S. Atomic Energy Commission

5.0026, MICROFLORA IN THE SURROUNDINGS OF REACTORS, IRRADIATION PLANTS, & OTHER AREAS WITH A HIGH LEVEL OF IRRADIATION OVER A LONG DURATION (ABBREV)
E.A. CHRISTENSEN, Danske Atomic Energy Comm., *Riso, Denmark*

Summary: dust, water, air, and other samples from the reactors, the irradiation facilities, and the hot cell area at Riso will be investigated for: 1. number of microorganisms 2. kind of organisms 3. radiation resistance of the organisms 4. other characteristics of the microflora in comparison with the flora from similar locations without an abnormal irradiation.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0027, DIAMOND ORDNANCE RADIATION FACILITY OPERATION
W. GEISELER, U.S. Army, Harry Diamond Labs., *Washington, District of Columbia*

The objective of the diamond ordnance radiation facility is to provide a source of neutron and gamma radiation for experimental radiation damage programs conducted at the Harry Diamond Laboratories or by other Federal Government agencies and their contractors. A Triga Mark F nuclear reactor is used as the source of radiation for these programs.

5. RADIATION

SUPPORTED BY U.S. Dept. of Defense - Army

5.0028, NAVY ENVIRONMENT--EPIDEMIOLOGICAL STUDY OF MICROWAVE INJURY IN NAVAL PERSONNEL
C. SILVERMAN, U.S. Dept. of Hlth. Ed. & Wel., *Washington, District of Columbia*

Technical Objective: Determine the risks of deleterious health effects from radar among exposed Naval personnel and their offspring.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0029, REACTOR SITE INVESTIGATIONS
E.H. BALTZ, U.S. Dept. of the Interior, Geological Survey, *Washington, District of Columbia* 20242

States to which project pertains: Various parts of the United States.

The project chief serves as consultant and advisor to the U.S. Atomic Energy Commission concerning the identification and evaluation of the regional and local geologic and seismologic factors and the foundation conditions that are pertinent to the suitability of designated sites and that may have a bearing on the design and construction of nuclear reactors, fuel reprocessing plants, and other nuclear facilities. Consultation includes reviews, as requested by the Commission, of data submitted by applicants as part of the Commission's licensing procedures for commercial nuclear facilities, and reviews of other independently determined geologic data relevant to the designated sites.

Advice and consultation is provided to the Commission for delineating investigations and research on the various geologic and seismologic factors to be considered in the evaluation and licensing of proposed nuclear facilities. Accumulating experience indicates that the knowledge of various regional and local geologic conditions, when applied to evaluations of specific sites, allows the engineering design criteria to be adapted closely to the environment with resulting increases in safety and decreases in cost of design and construction.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

5.0030, RADIOACTIVE FOOD-CHAINS IN THE SUBARCTIC ENVIRONMENT
J.K. MIETTINEN, Helsingin Yli. Helsing. Univ., *Helsinki, Finland* (AT(30-1)-3446)

Whole body counting of Laplanders has revealed about 40 times higher body burdens of Cs-137 in them than in the average for other groups in the northern hemisphere. Environmental studies in Finnish Lapland have elucidated three food chains which cause these elevated body burdens. The most important of these leads from lichens through reindeer meat, another from flooded pastures through horsetails and sedges to cow's milk and the third one from the extremely nutrient- deficient fresh waters through plankton and fish to man.

The purpose of this project is to follow the future trends of the radioactivity in Lapps by the regular counting of the Cs-137 content by a mobile whole body counter and to analyze the radionuclide content in plants and animals to interpret the body burden. Average body burdens of reindeer breeders were maximum in April 1965, 1.5 microcurie with the highest individual values about 3 microcurie. Since then a decrease has taken place, the average value being in March 1970 0.5 microcurie. Sr- 90 and Fe-55 are other artificial fallout nuclides enriched by similar food chains, although not so efficiently as Cs-137. Pb-210 and Po-210 are 'natural fallout nuclides' enriched in Lapps similarly. Body burdens of all these nuclides are estimated from blood, placenta, teeth and urine analyses. They are about 3 to 15 times higher than the average. The food chains causing the elevated levels are being elucidated in detail.

Analyses of Pb-210 and Po-210 in surface waters and fish have revealed hydrospheric food chains efficiently enriching these natural nuclides. The beginning of the food chains at the lowest trophic level will be investigated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0031, INVESTIGATION OF THE UNUSUAL BEHAVIOR OF CESIUM-137 AND OTHER RADIONUCLIDES IN THE FLORIDA ENVIRONMENT
J.F. GAMBLE, Univ. of Florida, School of Engineering, *Gainesville, Florida* 32601 (AT(40-1)4066)

For some time it has been recognized, but unexplained, that for equal fallout deposition, levels of cesium-137 in diet and man in Florida are higher than the U.S. national averages. The objective of this research is to determine the rates and mechanisms of environmental transport of cesium-137 in Florida relative to the human body burden of cesium-137 and to define the extent of unusual radioecological behavior in this location. Results of the program will have significance to power reactor siting, radioactive disposal, and the use of nuclear explosives for engineering applications in sub-tropical climates.

The persistence of cesium-137 in the diet (for example, in milk) during periods of low fallout rate indicates that in Florida the soil- root pathway plays an important part in transferring cesium-137 to the diet. The initial experimental design involves field, laboratory, and greenhouse investigations of cesium-137 behavior in Florida soils, including soil characteristics and soil-plant relationships.

Radioecological studies will be made in highly managed agricultural ecosystems, and to some extent in more natural ecosystems such as a hardwood forest. Concurrently, studies will be carried out to inventory the passage of cesium-137 through important food chains such as the beef and milk food chain to man.

SUPPORTED BY U.S. Atomic Energy Commission

5.0032, FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM
L.R. POMEROY, Univ. of Georgia, School of Arts, *Athens, Georgia* 30332 (AT(40-1))

The salt marshes of Eastern U.S. are well suited for ecological systems analysis, because they are simple, stable, and accessible. On the basis of 15 years of research we have constructed a compartmental model of the flux of phosphorus through the system. Simulation of the flux, using non-linear transfer coefficients, is being performed with an IBM 360-65 computer and a hybrid computer system consisting of a Philbrick analog computer and an RCA-55 digital computer. The model is responding in a stable, realistic way, and its complexity will now be increased.

A program of field research at the University of Georgia Marine Institute runs in parallel with the computer simulation, with as much interaction as possible between them. Emphasis is presently on flux of material through the grass, Spartina alterniflora, and the fiddler crabs, Uca spp.

Results: We have a 20-compartment flux diagram and a 5-compartment mathematical model. The latter is stable in computer simulation and is being used to explore the effects of variations in standing stocks and transfer rates in each compartment. The field program is being used to find and quantify pathways between compartments.

SUPPORTED BY U.S. Atomic Energy Commission

5.0033, RADIOMIMETIC EFFECT OF DRUGS AND FOOD ADDITIVES
K. SAX, Univ. of Georgia, Graduate School, *Athens, Georgia* 30601

The discovery by Levan and Kihlman in Sweden that caffeine is radiomimetic and breaks chromosomes, led us to study the effects of drugs, food additives, home insecticides and carcinogenic agents. We have found that caffeine, alcohol, sucaryl, various antioxidants used in foods, several home insecticides, cycasin which produces cancer in cattle, Veratrum which produces birth defects in sheep, and the carcinostatic drug Vinblastin all break the chromosomes of onion root tips grown in dilute solutions of these agents.

Recent work done in the winter of 1969 indicates that the type of absorbant paper used on which the seeds are grown may

modify the effect of the agent tested, although there is no difference in their effect on the water controls.

We want to continue research on the factors involved in the variation of the effects of radiomimetic agents caused by the various types of paper towelling used for seed germination. Metabolic changes are known to be a factor in the effect of radiomimetic agents ingested by animals.

We would also like to do more work on the synergistic effects of combined radiomimetic agents, such as caffeine and sodium cyclamate (sucaryl).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0034, DETERMINATION OF 18-0/16-0 RATIO IN PRECIPITATIONS (RAIN AND SNOW)

I. OPAUSZKY, Central Res. Inst. of Physics, *Budapest, Hungary*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0035, CONTROLLED ENVIRONMENTAL RELEASE TEST (CERT) PROGRAM

P.G. VOILLEQUE, U.S. Atomic Energy Commission, Health Services Laboratory, *Idaho Falls, Idaho*

The CERT Program has the following broad objectives: (1) define variables which affect the transfer of radionuclides from the point of release to the atmosphere to a human receptor, (2) perform controlled experiments to measure the variables influencing the observed phenomena, and (3) develop and test predictive models of the processes involved. The transport of radioiodine through the milk-food chain has been studied since the inception of the CERT Program. Currently, the emphasis of the Program is shifting to analysis of (1) the air-to- vegetation transfer of radioactive particles and other radioactive gases and (2) mechanisms of removal of radioactivity from vegetation. Field tests involving the release of radioactive gases and aerosols are conducted over the 27-acre pasture of the Laboratory's Experimental Dairy Farm at the NRTS. The pasture is primarily mixed pasture grass but areas of other crops (e.g., alfalfa, sudangrass) are grown as required. Documented field releases will be used to obtain data to relate transfer rates and retention halftimes to variables which define meteorological and pasture conditions. Studies of the influence of specific variables on transfer and retention will be performed in controlled environment chambers in the Laboratory. Results of both types of experiments will be used in the development and testing of models.

Results: The transfer of radioiodine gas (I-2) from air to Manchur Bromegrass has been found to be dependent upon the percent of leaf area composed of open stomata. When the stomata are fully open, about sixty percent of the total transfer to the grass is via the stomata. It was also shown that Bromegrass sorbs only 2 - 5 percent of the I-2 which reaches the plant surfaces.

SUPPORTED BY U.S. Atomic Energy Commission

5.0036, BIO-ENVIRONMENTAL STUDIES

S.S. BRAR, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

The objective is to determine empirically the inventory, particularly of radioactivity, in various segments of the environment, and the flow through the environment from one compartment to another. Considerable emphasis is placed upon man as the ultimate receptor. Segments of the environment examined are air, precipitation, soil, water, and biota. The movement of material (initially nuclear weapon debris, more recently a host of industrial effluents, primarily airborne) through the atomosphere via precipitation to the surface is documented. Further movement in soil, water, and through foodchains is also examined. Gamma-ray emitters among the fallout radionuclides have been of prime interest, and neutron activation is employed in analyzing for stable elements. With the initiation of the Argonne Great Lakes Research Program, much of the effort in this category has been directed at radionuclide and trace element dynamics in Lake Michigan.

Results: A running inventory of gamma-ray emitting fission products has been maintained since the mid-1950's in air, soil, foodstuffs, and water. Levels of environmental radiation from fallout and natural sources has been measured for a number of years. The reconcentration of specific radionuclides in aquatic and terrestrial ecosytems has been identified. More recently, the degree of vertical mixing within Lake Michigan has been determined by using tritium and short-lived fission products as environmental tracers.

SUPPORTED BY U.S. Atomic Energy Commission

5.0037, FOR X-RAY RESEARCH

UNKNOWN, Goshen College, Undergraduate School, *Goshen, Indiana* 46526

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Research Corporation - New York, N.Y.

5.0038, A DETAILED STUDY OF THE ENERGY FLOW THROUGH THE BIOTA OF DOE RUN, MEADE COUNTY, KENTUCKY

L.A. KRUMHOLZ, Univ. of Louisville, Graduate School, *Louisville, Kentucky* 40208 (AT-(40-1)-3540)

The ecosystem of Doe Run, a torrent spring stream in north-central Kentucky, has been under intensive study since 1959 in an attempt to determine the pathways and fates of radioactive fission products within the system. Data gathered just before and after the series of Russian and American nuclear tests that began in September 1961 indicated that there was prompt uptake of fission product fallout from those tests. That accumulation reached a maximum in 1964 and by the summer of 1966 the amounts of radionuclides in the biota had returned essentially to the levels of the summer of 1961.

On the basis of those data it was proposed to inoculate the source of Doe Run with relatively short-lived radioisotopes of the two biologically important fission products, strontium 90 and cesium 137. Accordingly, the stream has been inoculated with cesium 134 on four occasions, in December 1966, in June and December 1967, and in June 1968. Also, it has been inoculated with strontium 85 in December 1968. The discharge at the source of the stream was different on the occasion of each inoculation, and the data on stream flow show that at low discharge (14-18 cfs) the concentration of radionuclide moved relatively slowly downstream, but became linearly dispersed over a relatively great distance, where as at high discharge (85 cfs) the concentration moved quite rapidly and remained compact.

Much of the cesium 134 was adsorbed to the bottom sediments and was rendered unavailable to the biota. Plants in the stream took up the cesium rather rapidly and in relatively high concentrations shortly after the inoculation, but most of that radioactivity had been lost with a month.

A study on the biology of the western blacknose dace, Rhinichthys atratulus meleagris Agassiz, was completed and is being prepared for publication in open literature.

A detailed study of the contribution of riparian leaf fall to the energy budget of Doe Run is underway as is a study of the biology of the white sucker Catostomus commersoni (Lacepede).

SUPPORTED BY U.S. Atomic Energy Commission

5.0039, ACCUMULATION AND MOVEMENT OF FISSION PRODUCTS IN SOILS AND PLANTS - II. MOVEMENT OF RADIONUCLIDE IONS IN SOILS

M.H. FRERE, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Beltsville, Maryland* 20705 (AT)

A large gap exists between knowledge of details of the chemical behavior of individual ion species in soils and the ways in which these interact in controlling their movement to and uptake by plant roots. The use of mathematical simulation of the overall process with the aid of high-speed computers permits the analysis of the systems to identify the dominant factors and to test the validity of various assumptions that can be made to simplify its description.

5. RADIATION

The development of the necessary computer programs describing the movement of calcium, potassium, nitrate, and bicarbonate ions has reached the operational stage. These are the dominant ions in fertile agricultural soils. The effects of water movement and the influence of salt content on the diffusion coefficients and the uptake of these and other ions will be examined for roots of different uptake requirements. The resulting data will provide insight into the treatments necessary to reduce the uptake of exchangeable radionuclide ions from contaminated soils.

Results: Simulations have been made to determine the influence of varying mass flow rates, and exchange capacity using a mathematical model, which takes into account the ion exchange capacity of the soil, mobility of the ions in the system, rate of water flow, and electrical potential. In several simulations it was concluded that the behavior of Sr and Cs can be deduced from the behavior of Ca and K as a first approximation. However, refinements are needed to interpret the effects of intermediate ranges of mass flow and other factors.

SUPPORTED BY U.S. Atomic Energy Commission

5.0040, DEVELOP METHOD OF REMOVING RADIO-ACTIVE CONTAMINANTS FROM AGRICULTURAL LAND

P.E. JAMES, U.S. Dept. of Agriculture, Agricultural Engin. Res. Div., *Beltsville, Maryland* 20705 (901-054-001(AEC))

OBJECTIVE: Develop and evaluate methods of safely producing crops on land contaminated by radioactive fallout.

APPROACH: Develop methods for reducing uptake of radioactive material by plant roots which are not as expensive or as difficult to perform as removal of top soil. Study practical application of punch planting which leaves radioactive material on the surface so tht roots feed primarily in uncontaminated soil. Also study cocooning method whereby top layer of soil is wrapped in a plastic envelope and plowed under. Plastic wrapper theoretically prevents entry of roots and subsequent uptake of radioactive elements.

PROGRESS: Manuscript was prepared for a Technical Bulletin entitled 'An Engineering Appraisal of Radioactive Fallout Decontamination Methods.' This manuscript describes preparation, distribution and measurement, and errors in measurements of radioactive tracers used as contaminants. It describes soil types, surface roughness and vegetation coverage of land decontaminated. Results of decontamination using farm machinery, earth-moving equipment and street sweepers are compared, and contaminant burial by a large plow is discussed. Effects on uptake of radioactive elements by plants grown through the surface of undisturbed land covered by radioactive fallout are compared with planting in soil having radioactive material plowed into it. Exploratory studies indicated corn leaves grown from mercurial treated, Ceresan M. seeds contained from 400 to 450 parts of mercury compared to 25 to 29 parts per billion in leaves from corn having no mercurial treatment.

SUPPORTED BY U.S. Dept. of Agriculture

5.0041, DEVELOP TECHNIQUES FOR DECONTAMINATING SOILS POLLUTED WITH RADIOACTIVE MATERIALS OR HEAVY METALS

W.D. KEMPER, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Beltsville, Maryland* 20705 (SWC-025-AB-4)

OBJECTIVE: Minimize the potential hazard of the accumulation of radioactive fission products or heavy metal elements in soils and plants from either chronic low levels or catastrophic high levels of contamination.

APPROACH: Basic studies are conducted on the soil chemistry of fission products, naturally occurring radioactive materials or heavy metals acting as soil poilutants and their accumulation by plants used as sources of human or animal food. Techniques for the prevention of this accumulation are developed. The uptake of the radioactive or polluting metals is studied in relation to soil management practices, the rooting habits of plants, and radiation damage to plant tissue.

PROGRESS: Studies were conducted with corn to evaluate soil and air as primary sources of Pb in plants. When air was the source, the lead content was higher in the nodes of the upper stalk than in those of the lower ones. When soil was the source, the reverse situation occurred. Corn tassels served as indicators of the particle size distribution of aerial lead. When most of it was in the smaller size fraction, the lead content of the tassels was higher than when most of the lead was in the larger size fraction of the aerosol. Zinc-cadmium interactions were studied. The addition of zinc in concentrations sufficient to suppress the accumulation of cadmium by radishes grown in a nutrient solution caused a considerable decrease in radish yield. The exchange behavior of lead and cadmium in soils with vermiculite- montmorillonite, illite, and kaolinite type clays followed the valency and concentration concepts normal under conditions where specific adsorption effects are absent.

SUPPORTED BY U.S. Dept. of Agriculture

5.0042, ACCUMULATION AND MOVEMENT OF FISSION PRODUCTS IN SOILS AND PLANTS - III. TREATMENT OF SOILS CONTAMINATED WITH RADIOACTIVE STRONTIUM

H M. KUNISHI, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Beltsville, Maryland* 20705 (AT)

Previous work has demonstrated that the addition of large amounts of soluble phosphates to surface soils can reduce the mobility of Sr-90 fallout that has accumulated in surface layers. Considerable phosphate reacts directly with the soil minerals and is not available for precipitation of strontium ions as inactive phosphates. Further examination of the precipitation processes will be undertaken to improve the effectiveness of the immobilization reaction by suppressing the reaction with soil minerals. The net effect of what happens to P will be followed by equilibrating samples in solutions containing different initial levels of P, to characterize the adsorption reactions at different rates of phosphate and lime addition.

The possibility of displacing strontium from soils using calcium in leaching waters will also be investigated since Sr ions and Ca ions adsorbed with approximately equal energy on soil materials.

Results: Alkaline orthophosphate salts can immobilize up to 98% of the divalent ions including radiostrontium in the upper layers of soil. Savings in the total amount of material that must be used for similar immobilization can be obtained by using a mixture of phosphate and fluoride instead of phosphate alone. In soils with exchange capacities no greater than 3meq/100g, the top 60 cm can be cleared of Sr ions by addition of 12 tons or less of gypsum and slow leaching. Enough sandy soils exist to provide adequate vegetable production after leaching following generalized contamination by radioactive strontium.

SUPPORTED BY U.S. Atomic Energy Commission

5.0043, CHEMISTRY, ACCUMULATION, AND MOVEMENT OF RADIOCATIVE MATERIALS

R.G. MENZEL, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Beltsville, Maryland* 20705 (SWCW8-AB-8)

OBJECTIVE: Minimize the potential hazard of fission product accumulation in soils and plants in case of either chronic, low-level contamination or catastrophic, high-level contamination.

APPROACH: Basic principles are studied affecting the accumulation of fission products and naturally occurring radioactive materials in plants that are used as sources of human food. Techniques for the removal of contaminated surface soil are worked out. The uptake of radioactive materials by plants is studied in relation to soil management practices, the rooting habits of plants, and radiation damage to plant tissues.

PROGRESS: Work is continuing on the nature of radiation damage to plants, and factors affecting the movement of radioactive materials in soils and their uptake by plants. Low doses of X-irradiation interfere with the bioelectric potential required for the normal photoreversible response of barley and ming bean roots. Ion movement and availability in soil and soil solution is characterized by equilibrium constants. Calculations for systems involving Na, K, Ca and Mg showed that a variation of any equilibrium constant affects the distribution of all the ions. Further work on methods to immobilize Sr in contaminated soil demonstrated that this can be achieved through the use of calcium hydroxide or

diammonium phosphate but it is impractical to use on a large scale.

SUPPORTED BY U.S. Dept. of Agriculture

5.0044, HEALTH HAZARDS OF URANIUM MINERS OF THE COLORADO PLATEAU
F.E. LUNDIN, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

This project is to study the cause-specific mortality experience of underground uranium miners in relation to standard medical examination findings, cigarette smoking, and airborne radiation exposure data. To determine the quantitative relationship between airborne radiation and the incidence of respiratory cancer. To delineate the role of a number of factors which might influence carcinogenic response to airborne radiation. To develop realistic models for relating environmental exposure to cancer and other chronic diseases.

Study is made of miners and millers of the Colorado Plateau area who volunteered for at least one medical examination performed between 1950 and 1960. These workers are followed annually to ascertain their health status. Deaths are ascertained by review of local newspapers and the Social Security Administration. Death certificates are obtained and classified as to cause of death. Medical information is obtained from hospital and physicians' records.

Approximately 12,000 radon or radon-daughter measurements have been made from 1950 through 1963 and continue to be made with increasing frequency. These are used for quantitating the carcinogenic response to radiation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0045, EXPERIMENTAL RADIONUCLIDE STUDIES
D.F. CAHILL, U.S. Environ. Protection Agcy., Twinbrook Research Laboratory, *Rockville, Maryland* 20852

The objectives of this program element are to determine some of the environmental characteristics and biologic effects of a wide spectrum of important radionuclides such as tritium, krypton, plutonium, strontium, and transuranic elements which are actual or potential environmental contaminants.

Attempts to attain these objectives will be pursued primarily through the definition of the dose-effect relationships of low-levels of environmental radionuclides in a variety of animal species with long- term observation of exposed animals for radiation-induced teratogenesis, carcinogenesis, and mutagenesis.

The Environmental Protection Agency is responsible for the definition of ambient radionuclide levels which strike a proper balance between the benefits and risks entailed. In the past, the NCRP and FRC have made recommendations on this subject but often their decisions on specific radionuclides were, of necessity, based on extrapolations from general dose-effect principles or on 'effects' data from similar radionuclides. This program element would fill some of the data gaps which exist for specific environmental radionuclides.

The results of this program element will be a series of reports on the biological and physico-chemical effects of specific environmental radionuclides on various stages of the ecosystem. Internally, these reports will be relayed to the Division of Criteria and Standards to assist in the formulation or revision of Radiation standards. Externally, reports will be made to the scientific community at large through publication of the experimental results in the open literature.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0046, HIGH TEMPERATURE STUDIES OF RADIOACTIVE FALLOUT PARTICLE FORMATION
C.E. ADAMS, U.S. Navy, Ordnance Laboratory, *Silver Spring, Maryland* 20910 (AT(49-7)3051)

The objective is to determine the rate-determining mechanisms which govern the uptake of radioactive vapors by molten or solid particles formed in the fireball of a nuclear explosion. Data on the actual uptake rates of selected radioactive vapors by various substrate materials will be obtained. This information will be used as input data for a computer-based model designed to predict the areal distribution and intensities of radioactive fallout fields resulting from nuclear explosions.

The laboratory work has utilized a two-temperature, vertical tube furnace in which radioactive vapors are generated in the low-temperature zone and are carried up into the high-temperature zone where they interact with the substrate samples. The vapor uptake rates have been measured as a function of vapor partial pressure, temperature and substrate particle size.

Results: Measurements of the uptake rates of the vapors of MoO3, TeO2, Rb and RbCl on substrates of a clay loam soil and a calcium ferrite have been completed. It was found that the rates of uptake could be described by an expression involving the condensation coefficient of the vapor on the substrate Henry's law constant for the vapor-substrate system and the diffusion constant of the condensed vapor material in the substrate. In cases where the condensation coefficient was less than approximately 10 the minus 3rd power the rate of uptake of the vapor was limited by the rate of diffusion of the vapor molecules through the air.

SUPPORTED BY U.S. Atomic Energy Commission

5.0047, RADIOACTIVE FALLOUT FORMATION
C.E. ADAMS, U.S. Navy, Ordnance Laboratory, *Silver Spring, Maryland* 20910

Technical Objective: Measure the kinetics and discover the rate- determining mechanisms which govern the condensation reactions between certain vaporized radioactive oxides and various molten or solid oxide substrates. This information is put into a physical-chemical model that can predict radiological fallout exposure-rate patterns.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0048, FUNDAMENTAL STUDIES IN FALLOUT FORMATION PROCESSES
I.J. RUSSELL, Boston College, School of Arts, *Chestnut Hill, Massachusetts* 02167 (AT(30-1))

A 9000 joule exploding wire facility is being used to study the incorporation of trace radioelements (fission products) in the condensed products of iron, aluminum and other metals in air and inert atmosphere explosions. Fractionation as a function of particle size can be large and qualitatively is in accord with the condensation behavior of the elements or their oxides in their pure states. Explicit investigation of the importance of the nature of the matrix and the concentration at the tracer level in determining the fractionation behavior of the elements will be studied in argon and air, over a range of specific energies.

Vapor phase uptake of trace fission products by molten oxides of various compositions is also being investigated. Systematizations are shown between uptake factors, the composition of the molten oxide, and the acid or basic character of the trace fission product oxide. For example the relative uptake of molybdenum and cesium vapors by a series of binary and ternary oxide substrates of differing ratios of Na2O, CuO, Al2O3, Fe2O3, and SiO2, exhibits an inverse relationship.

Electrochemical measurements of the oxide ion activity of oxide melts as a function of composition will be correlated with vapor phase uptake factors in forthcoming work.

SUPPORTED BY U.S. Atomic Energy Commission

5.0049, THE METABOLISM OF THE RARE EARTHS FOLLOWING INHALATION - PATHOLOGIC AND BIOCHEMICAL RESPONSE IN THE LUNG AND OTHER ORGANS
H.L. BERKE, Wayne State University, School of Medicine, *Detroit, Michigan* 48207 (AT(11-1))

The increased availability and widespread use of the rare earth poses the problem of their toxicity to the animal, particularly when inhaled. This study is concerned with the individual and comparative distribution and excretion in the Sprague-Dawley rat of scandium, yttrium, europium and ytterbium (and/or thulium) following exposure to aerosols of these isotopes. Modifications in the rate of lung clearance under normal and

varied conditions of intake, short term pathology and diagnostic tests of injury are particularly of interest. Specifically, a study designed to indicate the effects of pulmonary clearance following repetitive exposures using europium 152 and europium 154 is planned.

Results: Most of the distribution data for the various rare earths are now available and will be evaluated. A micro-separation technique for the blood lymphocyte has been developed. Using this technique, morphological changes in the peripheral lymphocyte have been observed following parenteral injections of uranyl nitrate in the rat similar to that after radiation insult. The peritoneal macrophage as transport agent for injected europium chloride as evidenced by blood leucocyte activity has been observed and the data is in preparation. Further investigations on the effects of added carrier, food, etc. on gastrointestinal absorption of europium is in progress.

SUPPORTED BY U.S. Atomic Energy Commission

5.0050, AEC OFF-SITE RADIOLOGICAL SAFETY PROGRAM

M.W. CARTER, U.S. Environ. Protection Agcy., Western Environ. Research Lab., *Las Vegas, Nevada* 89114

This program element will document external exposures to people living in the vicinity of nuclear testing activities and radioactivity levels in all pertinent environment media that occurs from those testing activities.

Nuclear testing activities of the Atomic Energy Commission provide the potential for releases of radioactivity to the environment. A program of continuous off-site radiological surveillance is necessary to document exposures and assure public safety.

A comprehensive off-site radiological safety program for nuclear testing activities including testing of weapons devices, underground engineering applications of nuclear explosives, and testing of experimental nuclear engines for propulsion of spacecraft, will be provided. Major program elements include ground and aerial monitoring, continuous environmental sampling and analysis, cloud and effluent tracking and sampling, public education and community relations, and provisions of medical and veterinary services to individuals claiming radiation injury.

The Western Environmental Research Laboratory maintains 105 air sampling stations in 22 western states for collecting daily air samples. Approximately 250 standby milk stations are activated annually, and about 36 routine milk stations and 95 routine water sources are sampled monthly. Thermoluminescent dosimeters are placed on 60 off-site residents and at 95 stations in the off-site area. Gamma exposure rate recorders are operated continuously at 32 of the air sampling stations. Complete radiological laboratory facilities handle all routine and special sample analyses. Medical direction and support is provided by the WERL Radiation Medicine Office and veterinary services are available from the Radiological Research Program.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0051, PHYSICAL AND CHEMICAL CHARACTERISTICS OF AEROSOLS PRODUCED FROM SOLUTIONS OF POLYVALENT NUCLIDES

G.M. KANAPILLY, Lovelace Fdn. for Med. Ed., *Albuquerque, New Mexico* 87108 (AT(29-2)-1013)

The physical and chemical nature of aerosols produced from solutions of polyvalent metallic nuclides are being determined under various conditions. The physical and chemical nature of radioactive aerosols produced from solutions of nuclides by spills, explosions and fire are poorly understood at present. The specific and general information obtained in this study should provide valuable information in predicting the probable physical and chemical nature of the aerosols produced from solutions of radionuclides and thus enable one to estimate the relative health hazard of an inhalation exposure. The relative effects of various factors on the physical-chemical nature of aerosols is being investigated with solutions of metallic ions (Co, La, Ce, Sb, Ru, Zr, Nb and Mo) in one or more anionic (chloride, lactate, citrate, acetate, EDTA, hydroxide, oxalate, acetyl acetonate and tartrate) forms. Production of aerosols consists of nebulization of the desired solution, drying, degradation at temperatures up to 1100 degrees C and cooling at different rates. Electron microscopic studies, density measurements and determination of aerodynamic properties are being used for physical characterization. The chemical nature of aerosols is studied by tracer techniques, infrared absorption spectrometry, thermal analysis and other methods as applicable for specific cases.

RESULTS: The physical nature of the aerosols is affected by rate of drying, droplet sizes and rate of high temperature heating. Pure solutions of metal organic chelates tend to give hollow particles while micelle containing solutions yield relatively solid particles. The degradation temperature is important in determining the chemical nature of the aerosol particles. However, even at a degradation temperature of 1150 degrees C about 5% oxycarbonate or oxychlorides were found to be present in the aerosol particle produced from organic chelates or chlorides, respectively.

SUPPORTED BY U.S. Atomic Energy Commission

5.0052, BIOLOGICAL RESPONSE TO SMALL, DISCRETE, HIGHLY RADIOACTIVE PARTICLES

W.H. LANGHAM, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Attempts are continuing to create mathematical models and biological data for a probabilistic approach to assessment of population risk from discrete, high specific-activity particles of exotic fuel forms such as those in various SNAP and SNP systems. Based largely on assumptions of biological parameters, computer models are being devised to estimate dose to cells in tissue as a function of residence time of the discrete source and distance from it. The model is extended further to relate probability of biological effect to number of cells at risk from the continuum of doses. Animal experiments are being conducted to observe tissue and cellular response around discrete sources as a function of time and calculated dose in an attempt to provide more experimental data to correlate with and extend the theoretical modeling.

The model developed in the previous year is undergoing continued updating as more data become available. Three of the skin lesions produced on monkey skin by particles of fissioned 235UC2 have been excised for histopathological examination. The examination has revealed no indication of neoplastic transformation, although changes in the germinal layer at the 472,000-rad site are atypical and should be thoroughly investigated. The monkey is being held for continued observation for possible long-term effects at those sites not excised. The period of observation of lesions produced in lungs of rats by particles of 238PuO2 and 239PuO2 has been extended to over 600 days.

SUPPORTED BY U.S. Atomic Energy Commission

5.0053, PHASE II PLANNING STUDY FOR EVALUATION OF RADIOACTIVE CONTAMINATION OF THE FOOD CHAIN

C.L. COMAR, State University of New York, School of Veterinary Medicine, *Ithaca, New York* 14850 (AT(30-1))

Preparation of a comprehensive and interpretive report on Fallout in the Food Chain utilizing data and concepts that have been developed and/or derived from program evaluations, experimental studies and worldwide fallout monitoring networks: Coverage will include: (1) The scope and significance of fallout levels observed throughout the world since regular reporting began following the 1957-58 nuclear test cycle (2) Review of remedial measures available for accidental and intentional releases considering alternatives, feasibility and relative effectiveness and (3) Review of nature and extent that typical dietary adjustments can be utilized or developed to minimize the internal hazard from radiocontaminants.

Appraisal of the needs for continuing an interpretive program dealing with fallout and similar environmental contaminants: Concepts developed under fallout programs should have greater application to peaceful program uses and can greatly assist in developing techniques for a better understanding of long-term behavior studies in other environmental problem areas (pesticides, pollutants, radionuclides in aquatic environments,

etc.) Environmental studies of a proposed nuclear power reactor site have been developed for the local area despite its remoteness from routine reporting networks. Information from previous studies, experimental programs and a ready source of worldwide data and literature have made such an appraisal possible.

SUPPORTED BY U.S. Atomic Energy Commission

5.0054, BIOLOGICAL EFFECTS OF IMPLANTED NUCLEAR ENERGY SOURCES FOR ARTIFICIAL HEART DEVICES (ABBREV)

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This study is designed to determine the biological effects from nuclear power sources which might be used to power artificial hearts in human beings. Continuation is planned of work along the following lines: implantation in Labrador retrievers of simulated sources containing appropriate amounts of californium 252 and strontium 90; clinical observations of implanted animals; further dosimetric studies. It is also planned to initiate preliminary studies using a plutonium 238 source.

Results: Dosimetric procedures have been worked out for the californium 252-strontium 90 sources; surgical procedures have been perfected for the implantation of the radioactive sources in the dog; clinical observations have been made on dogs that have carried these sources for several months. Part 3 of 7.

SUPPORTED BY U.S. Atomic Energy Commission

5.0055, PREDICTION OF TOTAL CONSUMPTION OF FALLOUT RADIONUCLIDES BY HUMANS FROM MILK (ABBREV)

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This phase has as its purpose the development of a model that will allow prediction of the total human intake of radioiodine, -cesium and -strontium from milk following contamination of pastures. The model is intended to apply to various conditions of biospheric contamination and to use a minimum number of samples to assess a nuclear incident. In the coming year we will utilize data developed in this laboratory to develop equations for predicting 90 Sr and 89 Sr intakes and to make error estimates for the predicted total intakes of radiocesium from milk.

Results to date: In the past year the model for prediction of radionuclide intake from milk has been broadened to apply to the situation where deposition of radioactivity takes place over a period of time. Of necessity, the sample requirements are greater; in addition to milk samples there is now a need to measure the rate of deposition of radioactive material in order to apply the models to any particular situation. Part 7 of 11.

SUPPORTED BY U.S. Atomic Energy Commission

5.0056, TISSUE CULTURE RESEARCH AND PLANS FOR ITS EXTENSION

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Projects include the following: a) A measurement of the oxygen enhancement ratio for the mixed gamma-neutron radiation from californium-252, together with a study of the relative biological effectiveness of this radiation compared with radium gamma rays. b) A study of cells arrested at the G1/S interphase as an example of a cell population exhibiting recovery without progression - and the use of this system to study the effect of hypoxia in the recovery of sub-lethal damage.

Other projects that have been started in the past year include the effect of ultra high dose rate on the survival of mammalian cells and ultrasonic radiation damage produced in plant seedlings.

SUPPORTED BY U.S. Atomic Energy Commission

5.0057, RADIOACTIVITY AND TRACE ELEMENTS IN HUMAN BONE AND DIET

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Since the major source of radiation dose from fallout is the ingestion of contaminated food, a systematic program for estimating the dietary intake of selected radionuclides was undertaken in 1960. Quarterly samplings of foods representing 19 categories are carried out in New York City and San Francisco. In addition to Sr-90 which is assayed routinely, measurements have been made of the average daily per capita intake of Cs-137 and Ra-226 and natural strontium, barium and calcium. Since 1961, specimens of human vertebrae from accident victims or from persons whose metabolism could reasonably be assumed to have been normal before death, have been obtained in New York City and in San Francisco, for Sr-90 analyses. The purpose of these measurements has been to see if mechanisms of contamination of the diet and of the human skeleton could be deduced that could then be used to infer diet and bone Sr-90 concentrations at times and places where continuous measurements have not been made.

Results: Average bone and diet concentrations of Sr-90 slightly lower in 1968 compared to 1967. The average per capita intake of Sr-90 by San Francisco residents is less than half of that measured for New York City residents. The Sr-90 to Ca ratios of vertebrae from San Francisco children were correspondingly about one-half as great as those from New York City. There is some evidence that the peak in Sr-90 concentration in bone is shifting to older children. This is to be expected as dietary Sr-90 levels decline.

SUPPORTED BY U.S. Atomic Energy Commission

5.0058, LEVELS OF NATURAL RADIOACTIVITY IN MAN AND HIS ENVIRONMENT

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This program documents the levels of naturally-occurring radionuclides in man and his environment. Special emphasis is placed on diet and subsequent deposition in man.

Uranium is presently being measured in lung, liver, and vertebrae samples from approximately 80 adults from the New York City area who had no occupational exposure to uranium.

Results: The dietary intake of lead-210 in New York City has been documented and is estimated to be 1.2 pCi/day. The highest individual diet category is shellfish (7.6 pCi/kg) but low intake makes this category insignificant in total intake of lead-210.

Additional radium-226 data for the average bone and daily intake levels observed in New York City, Chicago, and San Francisco showed: (pCi/gCa) Bone-Diet: New York City 0.036-1.7, Chicago 0.035-1.1, San Francisco 0.031-0.8.

SUPPORTED BY U.S. Atomic Energy Commission

5.0059, MEASUREMENT OF RADIONUCLIDES IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

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Many scientists have been concerned with the potential effects on marine organisms of low-level radioactive wastes from nuclear reactors on land as well as those on ships and submarines. Additionally, fission products from nuclear weapons are now found in the biosphere. To evaluate the ecological effects of radionuclides on organisms of commercial importance, it is necessary to know the quality, quantity, and form of radionuclides in estuarine and marine environments. These data are needed now so they can be utilized to establish base lines for existing levels of radioactivity in various components of estuarine and marine ecosystems, and so the mechanisms of uptake in the passage of radionuclides through food chains can be investigated.

Large samples of biological materials (1 kg.) are collected for analyses. These samples are either dry ashed or wet ashed to reduce the volume and to provide homogeneous samples. The gamma activity of the samples is then measured with a low background detection system consisting of a multichannel analyzer and a 4 x 4-inch sodium iodide crystal-detector housed in a 7-ton shield. The data for each sample are stored on binary-coded punched tapes which can be used in a computer for comparisons with the radioactivity of future or past samples.

5. RADIATION

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

5.0060, INTERAGENCY REVIEW OF THE HEALTH HAZARDS OF URANIUM MINING - COMPARISON OF EXPERIMENTAL TO EMPIRICAL RESULTS
P.J. WALSH, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

This project is part of a Federal, Interagency Review of the health hazards of uranium mining. Scientists from all the federal agencies are participating in providing information for the review and in reviewing the total body of information available on radiogenic lung cancer. The sub-group dealing with radiogenic lung cancer has identified responsible agencies and due dates for the various parts of the review. The NIEHS is the responsible agency for a comparison of empirical and experimental information on radiogenic lung cancer.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0061, RADIATION PATHWAYS STUDIES
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The object of this study is to investigate through field and laboratory research, the behavior, movement, and fate of radionuclides in the aquatic, terrestrial, and air environments for the purpose of assessing the radiation dose to man resulting through these multiple pathways. Radioactive materials may be discharged into the environment as a result of their use in nuclear power generation, in medical, industrial, and research applications, and in peaceful uses of nuclear energy as exemplified by stimulation of gas from rock formation by nuclear explosion.

Laboratory research studies will investigate pathways by which radionuclides, such as Pu239, Fe55, I129, Zn65, and tritium move through the environment to man. These investigations will deal primarily with metabolic studies concerned with uptake of selected radionuclides by specific environmental media, particularly living organisms. Field studies will also be conducted at selected sites such as at environmental nuclear power stations operating at full power. Boiling water reactor and pressurized water reactor facilities will be of primary concern for investigating the types, amounts, and environmental movement of radioactive materials discharged from them.

Reports on laboratory investigations will document results of uptake studies on certain radionuclides by selected organisms for publication in the open literature. These results will also be offered for use in providing a basis for setting radiation protection guides and standards. Results from field studies, particularly around operating nuclear facilities, will be reported in the literature for identifying and quantifying the radionuclides discharged to the environment and for defining the environmental pathways to man. Recommendations on monitoring and surveillance around such facilities will be developed as indicated by such study.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0062, BIOENVIRONMENTAL AND ECOLOGICAL DATA AND INFORMATION CENTER IN SUPPORT OF BIOENVIRONMENTAL AND RADIOLOGICAL SAFETY FEASIBILITY STUDIES
R.S. DAVIDSON, Battelle Memorial Institute, *Columbus, Ohio* 43201 (W-7405-ENG-92)

The Bioenvironmental and Ecological Information and Data Center (BEDIC) was occasioned by the extensive background information requirements needed for planning and management of Bioenvironmental and Radiological-Safety Feasibility Field Data Collection and Evaluation Studies relating to the nuclear excavation considerations of the Interoceanic Sea Level Canal Study (SLC). The criteria for data collection and evaluation as well as the selection of competent personnel and institutions required the study of the ecological literature and data pertinent to the Central American humid tropics.

BEDIC consists of an information and data storage and retrieval system with computer programs capable of coping with ecological, radioecological, and bioenvironmental research requirements. The capabilities of BEDIC serve the SLC program including a study of the possible ecological impact of interoceanic mixing, a study of the Bioenvironmental and Radiological Safety requirements for the AEC- Supplementary Test Site nuclear testing program, the development of a comprehensive review of the biological implications of tritium and various field survey and feasibility studies of AEC-Plowshare Programs. The cycling and transport of radionuclides in complex ecosystems have received major emphasis. The Center currently consists of approximately 7000 documents and bibliographic citations. BEDIC screens over 150 ecological and bioenvironmental periodicals and approximately 50 secondary publications on a regular basis.

In addition to continuation of the effects listed, the future activities of BEDIC will provide an ecological information and data base for remote inquiry by AEC. Because of extremely limited funding on this program, service to outside research investigators without compensation has not been possible.

SUPPORTED BY U.S. Atomic Energy Commission

5.0063, FISSION PRODUCT-SOIL ORGANIC MATTER COMPLEXES
R.H. MILLER, Ohio State University, Agricultural Experiment Sta., *Columbus, Ohio* 43210 (OHOSS-133)

OBJECTIVE: Separate, identify, and characterize the constituents of soil organic matter which complex fission products and determine the availability of fission products in fission product-organic matter complexes to plants and soil microorganisms.

APPROACH: Fission products will be incubated with several soil types. Organic matter complexes will be extracted, purified, and fractionated into various components. The distribution of fission products in these components will be studied. Attempts will be made to identify the compounds and functional groups which are active in the formation of these complexes. Plant availability of fission product- organic matter complexes will be measured in long term and short term uptake studies. The complexes will be introduced to sand cultures of plants which are allowed to grow to maturity in order to determine the movement of these fission products into edible portions of the plants. In addition the direct effect of the organic colloids on plant uptake will be measured through use of membrane equilibrium systems.

PROGRESS: A study was made of the formation of radiocolloids by Ce and the adsorption of Ce by equilibrated suspensions of humic acid, bentonite clay, and a mixture of these two colloids saturated with either Ca or K and H. The availability of Ce in these suspensions was measured using excised roots. Ionic strength, Ce concentration, and pH were critical factors affecting the equilibrium between radiocolloidal and monomeric Ce. Humic acid adsorbed much greater amounts of Ce and restricted uptake by barley and soybean roots more than did bentonite in the Ca saturated system. However, humic acid and bentonite adsorbed similar amounts of Ce in K-H saturated systems. Mixing bentonite and humic acid produced a synergistic-type effect in regard to Ce adsorption. It was proposed that the strong bonding of Ce by Ca-humic acid and humic acid-bentonite mixtures resulted from a more favorable orientation of the humic acid molecule for chelation of Ce. A multiple regression equation was presented which showed the effects of pH, ionic strength and Ce concentration on the formation of radiocolloidal Ce in salt solutions. Estimates based on the equation suggest that radiocolloidal Ce may not form in soil, but is likely to be present in significant amounts in laboratory studies.

SUPPORTED BY Ohio State Government

5.0064, CHARACTERIZATION OF SOILS & VEGETATION FOR FUTURE EVALUATION OF RADIOACTIVE CONTAMINATION
F. HAGHIRI, Ohio Agric. Res. & Dev. Center, *Wooster, Ohio* 44691 (OHOSS-064-1)

OBJECTIVE: Field, laboratory, and greenhouse investigation of soils and vegetation from selected sites in Ohio to aid in evaluating the role of soil fixation, leaching, run-off, erosion, and possible concentration by plants in the disposition of radioactive contamination.

APPROACH: Soil samples, plant material, and run-off from Sr90 and untreated plots will be analyzed for Sr90 as well as the determination of other soil properties and composition. The soil profiles of the various plots are being characterized and the inorganic and organic fractions of the soil are being studied to determine their influence on the retention or release of Sr90. Soils and vegetation of small watersheds are being analyzed for gamma emitting isotopes. The uptake of Sr90 by various plant species grown under different conditions is underway.

PROGRESS: The movement of Sr in the soil profile and the removal of Sr by runoff, leachate and plant uptake as influenced by soil and crop management practices have been studied. Over a 7 year period, the net rate of Sr loss from 0-4" depth by various processes was maximum under gravel mulch and minimum under grass. The distribution of Sr in the top 12" of soil profile was influenced by cropping system and liming. The concentration of Sr at 8-12" depth under gravel mulch was about 10 times higher than grass. High rates of lime reduced the downward movement of Sr. The % of the initial application of Sr removed by runoff decreased while its loss by leachate increased during the 7 year period. The total % Sr removed by runoff, leachate and plant uptake after a 7 year period was 16.407, 13.655, 12.481, 10.828 and 9.231 for gravel mulch, rotation 'low lime', continuous corn, rotation 'high lime' and grass, respectively. Among various herbicides (fenac, benzac, trifluralin, paraquat, diquat, CIPC and pyramin) studied paraquat and diquat were the most effective in reducing the Sr adsorption by soil. Paraquat and diquat were most effective in replacing Sr in soils with low clay, low organic matter and high pH.

SUPPORTED BY Ohio State Government

5.0065, EFFECTS OF RADIATION ON RESISTANCE TO INFECTION

W. FRIEDBERG, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma* (000613)

Exposure to ionizing radiation is a recognized hazard in civil aviation. Examples of some of the problem areas are a) Unshielded X-ray machines and radioisotopes, employed to locate defects in aircraft components. b) Repair of radio-luminescent aircraft instruments can result in inhalation or ingestion of radioactive materials. c) Shipment of radioisotopes on civil aircraft and military aircraft carrying nuclear weapons at or near civil airports can be hazardous to crash investigators. d) Aircraft flown through fallout from nuclear-weapons testing become contaminated. e) An unshielded klystron tube in a radar installation can produce X-rays of lethal intensity. f) SST passengers and crew will be exposed to ionizing radiation, a large portion of which will be protons and neutrons. g) Neutrons may be encountered in other aviation applications. The immune system is very sensitive to ionizing radiation, a major consequence of radiation exposure is lowered resistance to infection.

1. The radiation dose-immune capacity relationship will be determined for fission neutrons and X-rays. A principal objective is to find the RBE of neutrons at the lowest rad dose at which radiation effects can be detected. 2. The effect on immune capacity of fractionated irradiation with neutrons and X-rays will also be investigated by use of the parasite H. nana. 3. Effects of neutrons and X-rays on acquired immunity will be compared.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

5.0066, UPTAKE OF RADIACTIVE MATERIALS THROUGH FOOD CHAINS

S.R. HUSAIN, Pakistan Atomic Energy Comm., *Dacca, East Pakistan, Pakistan*

In this project the determination of Sr90 and Cs137 in cow's milk and also in crops and vegetation collected from different stations located at various places in East Pakistan will be made. Chemical separation method developed by U.K.A.E.A. (Windscale) P.G. Reports 156(w.) 155(w) and 282 (w) will be used. In some cases method developed by HASL (USAEC) will be applied. The overall chemical yeild of the strontium analysis will be determined with a strontium tracer. Samples of Sr90 will be counted by an automatic sample changer Low beta-II planchet counting equipment (Beckman) having background of less than 1/2 cpm. Final counting will be made by counting the yttrium-90 precipitate from the purified strontium fraction.

For Cs137 gamma-ray spectrometry will be used having a well-type NaI (Tl) crystal integral line asembly, and a 512 pulse height analyser attached to an oscilloscope and computer readout typewriter.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0067, ULTRAVIOLET LIGHT EFFECTS ON NUCLEIC ACID FORMATION AND GENETIC EVENTS IN BACTERIA

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The investigation is concerned with the effect of ultraviolet light in damaging the nucleic acid of the bacterial cell to prevent DNA replication and interfere with RNA formation. It is devoted to studies of the cellular recovery mechanisms which result in resumption of normal macromolecular synthesis and the mistakes made in the process of these repair mechanisms which lead to mutation. It includes studies of the induction of non-photoreversible damage blocking normal semi- conservative DNA replication and presumably leading to a requirement for postirradiation RNA and protein formation in restoration of a new origin for DNA replication. It studies the non-recoverable but photoreversible damage inactivating DNA replication and its relation to cell lethality. It attempts to explore the nature of the mutation induction process and determine its possible relation to the non-conservative DNA replication involved in excision-repair, to recombination processes and to repair mechanisms dependent on initiation of semi-conservative DNA replication.

Results: Results suggest that excision of a pyrimidine dimer followed by recombination-repair is involved in UV-induced mutation. Further, they suggest that inactivation of DNA replication accounts for considerable UV-lethality.

SUPPORTED BY U.S. Atomic Energy Commission

5.0068, DISTRIBUTION & CYCLE OF RADIONUCLIDES & RELATED TRACE ELEMENTS IN MARINE ENVIRONMENT (ABBREV)

V. VOLJIN, Univ. Bucuresti, *Bucharest, Rumania*

The Danube influences the development of benthic organisms, modifying the dynamics of radionuclides in the Romanian coastal region of the Black Sea.

A study is being made of the transfer of 36Cl, 90Sr(90Y)137Cs from the sea and Danube water to the rocks of the continental shelf and to the sediments of the Delta.

The presence of these radionuclides in the Black Sea water was established earlier.

The rock structure and the phase transformations occurring under the effect of hydrostatic pressure and of temperature variation are studied by X-ray and neutron diffraction.

The data on the magnetic properties of the rock containing haematite are used for determining the conditions of formation of the latter and for comparing these conditions with those obtained on land.

The trace elements contained in the rock are determined by spectroscopy.

Conductance is measured in the sea and Danube water and then in the rock and sediment moistened with these waters and having varying grain size.

The diffusion coefficients for the above-mentioned radionuclides are determined by the instantaneous-source method proposed by E.K. Duursma.

The data obtained will make it possible to determine some characteristics of the dynamics of radionuclides under the specific conditions obtained in the Romanian coastal area.

5. RADIATION

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0069, RADIONUCLIDE CYCLING IN AQUATIC ECOSYSTEMS
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The purpose of research on radionuclide cycling in aquatic ecosystems is to provide quantitative data for the interpretation and prediction of radionuclide movement and behavior in aquatic environments. With an understanding of the behavior of radionuclides in aquatic systems, we can also develop new uses and applications for radionuclides in research on fundamental ecological processes. The growing use of nuclear energy and the consequent release of small quantities of radioactive wastes requires information related to the longterm consequences of radionuclides in food chains. These data are needed for radionuclide transport models using the source, pathway, target or sink concept. A synthesis of results obtained from these investigations will help provide the predictive capability required for engineering design of nuclear installations to meet environmental safety criteria. Most of the research is with 90Sr, 137Cs, 106Ru, and 60Co which occur in White Oak Lake. Studies with warm water species of fish and their associated food organisms are carried out in the field and under controlled laboratory conditions. Parameters studied most intensively are assimilation, turnover, and concentration factors.

Results to Date: Bluegills in White Oak have constant K concentrations but 137Cs and Cs cycle seasonally with a peak concentration in February and a minimum in August. The cycling was due to a more rapid excretion rate, a lower level of 137Cs and Cs in the food supply during the summer and a seasonal fluctuation in food consumption rates. The assimilation of 137Cs from food is inversely related to the clay content of food items. Thus, the food chain is important in determining the concentration of 137Cs in different species of fish.

SUPPORTED BY U.S. Atomic Energy Commission

5.0070, CIVIL DEFENSE IMPLICATIONS OF A NUCLEAR POWER REACTOR IN A THERMONUCLEAR TARGET AREA
C.V. CHESTER, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

The object of this program is to determine under what conditions and to what extent the fission product inventory of nuclear power reactors can complicate the problems of Civil Defense during and after nuclear attack. The core of a 1000-megawatt (electrical) power reactor at shutdown before refuelling contains gross radioactivity comparable to that from a 100 kt fission weapon a day after detonation, and a quantity of long lived fission products equal to those produced by about a 30- megaton fission weapon.

The approach to the problem is to determine the increase, if any, in the number of fatalities produced by a weapon due to the presence of a reactor in the target area, and the circumstances under which an increase in fatalities can occur. Reactor structures representative of important reactor types are analyzed (using high explosives on scale models where necessary) to determine the circumstances under which significant quantities of the core fission product inventory can be deposited outside the area depopulated by the weapon.

The effects upon nearby shelters of an uncontained meltdown of a reactor damaged by lower overpressures is being analyzed.

Results to date indicate that prompt ejection of the core from the reactor structure is required, if the core fission product inventory is to be deposited in quantity (due to scavenging by weapon fallout) outside the area depopulated by the weapon. Analysis of a Pressurized Water Reactor and a Liquid Metal Fast Breeder indicates that for prompt core ejection the weapon must burst so close that the reactor will be on the edge of the crater. For megaton weapons, this is beyond current delivery accuracies.

SUPPORTED BY U.S. Atomic Energy Commission

5.0071, AN INVESTIGATION INTO THE RELOCATION OF A PORTION OF THE WHEAT SUPPLY FOR NATIONAL SECURITY CONSIDERATIONS
C.D. GARLAND, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

Considering the maldistribution of the United States food supply in relation to the population and the inherent problems of post-attack transportation, it appears logical to investigate the possibilities of relocating emergency food supplies to provide an adequately distributed emergency food supply.

The redistribution of wheat to areas of greater population concentration would make these supplies available to augment other food supplies and, if necessary, provide adequate nutrition to sustain people until transportation facilities could be restored. This relocation activity would greatly facilitate recovery in the post-attack environment.

The specific objectives of this study are, as follows: first, to identify areas in the continental United States with deficit food supplies and to estimate the cost of transporting wheat from areas of wheat production to areas of deficit food supplies; second, to estimate the cost of storing these wheat supplies in the respective areas; and third, to consider and analyze alternative institutional and administrative arrangements to achieve the program goals. This objective addresses itself to such questions as wheat ownership, release provisions, wheat acquisition practices, storage facilities, and the type and composition of the decision-making group.

Results: The wheat supply areas and the region with a relative food deficit have been identified. Wide variations exist in regional storage cost estimates. The typical food-deficit regions are the areas with normally higher wheat storage charges.

SUPPORTED BY U.S. Atomic Energy Commission

5.0072, ENVIRONMENTAL QUALITY STUDY PROJECT - ENVIRONMENTAL INFORMATION PROCESSING, STORAGE, AND RETRIEVAL.
J.H. GIBBONS, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

We are utilizing the procedures and software of an existing bibliographic information center (NSIC) to abstract, keyword index, and computer-store references useful in work associated with routine discharges from power plants (and their effects). This includes such areas as measurements and controls of releases (radiological, chemical, and thermal); release methods and abatement techniques; movement and effects of release on the biosphere. This information is used internally to assist in the preparation of various state-of-the-art reviews and summaries on areas of interest. It is selectively distributed to interested individuals and groups based on their specific interests and requests. A keyworded abstract file ('PPIF') is also kept of projects being funded by AEC in environmental areas. Contact with the public is encouraged through correspondence and speaking engagements. The Project also attempts to aid the Commission upon request in specific areas of information such as program plan development.

Results: Certain existing, and several new, categories were added in the Nuclear Safety Information Center: (1) radionuclide release and movement in the environment; (2) environmental surveys, monitoring, and radiation exposure in man; (3) meteorological considerations; (4) radiation dose to man from radioactivity released to the environment; (5) effects of thermal modifications of ecological systems; and (6) effects of radionuclides and ionizing radiation on ecological systems. Keywords were developed and over 800 documents were abstracted, key worded, and entered into the computer.

SUPPORTED BY U.S. Atomic Energy Commission

5.0073, ENVIRONMENTAL QUALITY STUDY PROJECT - ENVIRONMENTAL ASPECTS OF RADIOLOGICAL DISCHARGES
J.H. GIBBONS, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

While we know a great deal about radioactivity, its effects are of such consequence in time to man that highly detailed information is required. The object of this work is to develop new data and maintain state-of-art information on production, release, movement, and ultimate fate of radionuclides in the environment. Particular nuclides are chosen for study on the basis of their potential importance in their interaction with living matter, especially man. Our program is closely coordinated with other similar studies at ORNL. Ultimately the characterization of radiological source terms such as power plants will be combined with other radiation sources, followed through release, environmental movement including food chain, and dose (and dose commitment) to man. This will be done for river basin regions including multi-source points. Nuclear and non-nuclear radiation sources will be included. Environmental monitoring techniques and recommended procedures will be one objective. Another is a quantitative understanding of material balance of radionuclides implied by a variety of assumed power plants, reprocessing plants, and the like.

Results: A revision of a state-of-the-art of tritium was largely completed. A state-of-the-art on 85Kr was largely completed as was a review of Pu hazards. Studies of properties of actinide isotopes and their anticipated production rates were performed and a state-of-the-art review was commenced. It was found that there is a serious shortage of information on plant and mammalian uptake of americium and curium (extrapolation from plutonium is subject to large uncertainty).

SUPPORTED BY U.S. Atomic Energy Commission

5.0074, SYSTEMS ECOLOGY

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Systems ecology research is developing methods to further man's understanding of the dynamic interrelations of organisms and the environments in which they live. Most of the research involves simulating natural processes in either stochastic or deterministic ways, so that useful predictions may be derived about environmental interactions. Systems ecology is attempting to perform environmental assessments that will help evaluate anti-pollution practices and devices. Systems engineering and operations research continue to influence some of the basic approaches being tested by ecologists. An immediate objective is to amass the mathematical tools ecologists will need to attack environmental problems at a level of sophistication that reflects the state of the art in other disciplines. Current uses of systems techniques are mostly limited to studying small parts of ecosystems; however, as more work is completed, the subsystems will become the starting point for models of whole ecosystems.

Results: A computer program was written to simulate the dynamic behavior of radionuclides in the environment in order to predict the internal doses resulting from intakes of food and water contaminated by power reactor waste releases. A Monte Carlo simulation approach was used to demonstrate energy budgets for predator-prey relationships in food chain dynamics. Parameter identification techniques, based on random search methods, were used to quantify a process model based on transient behavior data.

SUPPORTED BY U.S. Atomic Energy Commission

5.0075, RADIONUCLIDE CYCLING IN TERRESTRIAL ECOSYSTEM

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Knowledge of the cycling of essential and nonessential elements whose radionuclides are potential terrestrial contaminants is needed for the assessment of impact of nuclear technology on the landscape. These studies are providing data on pathways and fluxes of radionuclides which complements efforts whereby radionuclide tracer techniques are being used to determine fundamental ecological processes occurring in the environment. Research on processes and components of terrestrial ecosystems emphasizes basic ecosystem processes as well as comparative interpretation of the 'unique' and 'common' attributes of the various aspects of the terrestrial landscape. Studies are underway in forest mesic ('Liriodendron tulipifera') and pasture ('Festuca-Andropogon' grasslands) ecosystems. Emphasis has been on the behavior of Cs137 but other tracers utilized include N15, Na22, Ca 45, Ca47, K42, P32 and P33 as well as research on micronutrients such as Mn54, Co60, Fe59 I131 and Ce144. The tracers are used to identify and quantify ecosystem processes such as productivity, soil-plant relations, animal food chains, and microbial decomposition. Analysis at the subsystem and system level is permitting the development of ecosystem models that will have predictive capability for the long-term movement of nutrient elements and fission products in the environment.

Results: Litterfall, standing crop and decomposition data were subjected to analysis and a compartment model developed to describe the mass and mineral element dynamics of the 'Liriodendron' forest floor system. Subsystem models were developed for grass foliage productivity, insect grazing and Cs137 cycling in the forest cryptogams. Similar compartment models were applied to energy flow, Ca, K, and Na fluxes through vegetation and arthropod components of the grassland ecosystem. Hickory and black gum trees are accumulators of Ce144 and Co60, respectively, but turnover of these radionuclides is slow because of strong chemical bonds in the xylem.

SUPPORTED BY U.S. Atomic Energy Commission

5.0076, ENVIRONMENTAL RADIATION STUDIES - EVALUATION OF NUTRIENT AND FISSION PRODUCT DISTRIBUTION AND MOVEMENT IN TERRESTRIAL ENVIRONMENTS

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This research is directed toward (1) defining the movement and mode of retention of nutrients and selected fission products in soils and sediments, (2) characterizing the influence of environmental parameters on the availability and/or exchangeability of these elements, (3) characterizing the forms of these elements in soils and sediments, and (4) relating the observed properties to changes in ecological parameters.

In addition to controlled field plot studies of available nutrients and fission product distribution, samples are collected from the plots, streams, and ponds for laboratory studies. Recently developed density gradient centrifugation techniques are used to segregate mineral and organic fractions. Segregated fractions are analyzed for nutrient and fission product contents using radioisotopic and selective removal techniques. X-ray diffraction and related mineral identification techniques are used to characterize the samples.

Results: Forms and quantities of phosphates in soils, suspended sediment, and bottom sediments were characterized by selective extraction procedures following density separations of mineral components. Samples known to have high calcium phosphates in noncalcareous soils showed similar amounts after segregation in the density gradient solution. This confirms that the density gradient solution does not dissolve and possibly translocate calcium phosphate. The calcium phosphates occur in association with different minerals which further suggests different forms and possibly different availability to plants.

SUPPORTED BY U.S. Atomic Energy Commission

5.0077, FIXATION REACTIONS

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Some soils and clay minerals have the property of retaining certain cations and fission products in a relatively non-exchangeable state, thus affecting their availability for plant uptake. This process is commonly referred to as 'fixation', and is generally believed to be a result of cation entrapment following mineral lattice collapse and/or incorporation of cations into selective sorption sites. The present study is designed to determine: 1) The mechanism responsible for fixation. 2) The effect of different chemical environments on the amount of fixation. 3) The significance of fixation reactions in soils, as they affect the availability of nutrient cations and fission products.

Fixation was measured by the availability of specific cations for rapid isotopic-, or self-exchange in a well-stirred system. Increasing amounts of Cs were added to a Na-saturated vermiculite (less than 1% residual K) and the presence or absence of Na entrapment, along with X- ray diffraction results, helped distinguish between lattice collapse due to the formation of interstratified Cs- and Na-rich layers vs. edge collapse around vermiculite particles.

RESULTS: Cation fixation studies with hydrobiotite and vermiculite have been terminated, and the results are presented in two separate publications: a) Reactions Affecting Cation Exchange Kinetics in Vermiculite. 1967. Soil Sci. Soc. Amer. Proc. 31:744-749. b) Conditions Affecting Ca Fixation and Na Entrapment in Hydrobiotite and Vermiculite. 1970. (Approved for Publication in Soil Sci. Soc. Amer. Proc.) Results cannot be presented in detail, but were pertinent to the aforementioned objective.

SUPPORTED BY U.S. Atomic Energy Commission

5.0078, THE MOVEMENT OF TRITIUM IN SOIL-WATER SYSTEMS

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This program is just being initiated. The objective is to develop standard growth media systems which can be used in extended studies of the distribution and plant uptake of fission products. Specifically, tritium might be used to measure soil moisture movments and uptake by plants. If tracer behavior under particular conditions within the soil is accounted for, a better understanding of soil-water movement and its implications to soil science is achieved.

A study of the movement of radioisotopes within the soil is complicated by the heterogeneous nature of soils and the many environmental factors which affect such movement. However, basic information on the dissipation of radioactive materials as related to soil characteristics, climatic factors, and vegetation can be helpful in resolving many environmental problems. For example, it might povide a better understanding of the contamination problems and soil-water movement processes in the vicinity of various nuclear reactors.

A perfusion system will be used to study tritium availability and distribution in a well-characterized soil. The system will allow precise control of soil moisture content and soil atmospheric composition by regulating the pressure and composition of gases surrounding a perforated soil column within a pressurized chamber.

RESULTS: 1. Initial experiments pertaining to the study of tritium availability and distribution in soils have been outlined. 2. Soil samples have been procured and are being characterized. 3. Soil extraction and liquid scintillation counting techniques are being reviewed. 4. A perfusion system is being constructed for controlling temperature, pressure and moisture conditions in soil columns 12" high and 1" in diameter.

SUPPORTED BY U.S. Atomic Energy Commission

5.0079, RADIATION INJURY ASSOCIATED WITH HIGH ALTITUDE FLIGHTS AND SPACE OPERATIONS

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Technical Objective: Man's ability to perform essential mission tasks will be influenced by his surrounding environment, radiation exposure from nuclear sources and in high altitude or space shuttle operations, i.e. gamma rays, protons, electrons and high Z particles must be considered. Additionally, interactions of other flight stresses combined with radiations must be ascertained. The objectives include evaluation of acute and delayed effects, combined stresses, modes of action and estimations of repair ability in appropriate experimental animals following exposures to these various types of radiation. Comparative data relative to radiation hazards, predictions as to degree of functional impairment and exposure criteria will be developed.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0080, CHROMATOGRAPHIC SEPARATION OF URANIUM AND PLUTONIUM FROM REPROCESSING PLANT LIQUID WASTE

F. MARKOV, Vernadsky Inst. of Geochem., *Moscow, Union of Soviet Soc. Republics*

Chromatographic separation of uranium and plutonium from reprocessing plant liquid waste followed by automatic measurement of plutonium amounts by probe-type alpha detector and the uranium by photometry methods.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0081, ENVIRONMENTAL EFFECTS ON THE CONTENT OF CS137 IN MILK

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We propose to determine the rate of movement and quantity of 90-Sr and 137-Cs transported from mountain watersheds to croplands. Investigations will center about dairy farms on which rapid accretions of fallout nuclides resulting from surface transport have been observed- 'hot-spot farms' which have consistently shown highest level of radionuclides in milk, solids and vegetation over a six year study period. Effects of overgrazing, poor drainage, irrigation methods, deposition of silt in reservoirs and lakes, on the movement of fallout nuclides to lowlands soils will be assessed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0082, THE ANALYSIS OF NATURAL SYSTEMS

L.L. EBERHARDT, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The study is to develop mathematical models for the description and interpretation of ecological data, and to provide the analytical framework for field and laboratory research activities. The problems include experimental design, design of sampling programs, formulation of methods of estimation, hypothesis testing, structuring of computer simulation models, and analysis of ecological data. A further objective is the development of mathematical and computer simulation models of radionuclie transfer from the atmosphere through food chains and to improve understanding of the ecological processes.

Results: Active support to projects has included population estimation, study of home range, plant abundance, and influence of environmental factors on productivity. Development of radionuclide uptake and retention models continued and was extended to pesticides (Cl-36 labelled-DDT). The first order kinetics models appropriate to radionuclide food-chain studies seem also appropriate for pesticides. The model of the Alaskan lichen-caribou-Eskimo food chain was refined and improved.

SUPPORTED BY U.S. Atomic Energy Commission

5.0083, NAVY ENVIRONMENT--EVALUATION OF THE SAFETY EXPOSURE LIMITS OF RADAR USED BY NAVAL PERSONNEL

E.L. HUNT, Battelle Memorial Institute, *Richland, Washington* 99352 (N00014-70-C-0332)

Technical Objective: Shipboard radar sources are increasing in number and power level, entailing a reevaluation of the existent safe level of exposure of 10 mw/sq cm during continuous exposure. This research joins a recent mobilization of effort towards ascertaining acute and chronic effects of microwaves on Naval personnel who operate or are exposed to radar.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0084, IRON-55 AND LEAD IN THE HUMAN POPULATION OF THE WORLD

C.E. JENKINS, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)1830)

The transfer of Fe-55 from fallout into the various phases of the biosphere, with special emphasis on the levels in man and in the food chains leading to human consumption, is being studied. Investigations are being made to determine the overall behavior of Fe-55, including its concentration with depth, its distribution through the food chains, and how much has actually reached the ocean floor and is contained in the sediments. Iron-55 in salmon and the food chains leading to the salmon are extensively studied since salmon contain high levels of Fe-55. These measurements permit the distribution of Fe-55 to be studied as a function of latitude, salmon species, sex, age, and trophic feeding level. The scope of the work includes the use of existing Fe-55 burdens in the general population to study the uptake and retention of iron with different ages, sex, and diet.

Results: The worldwide Fe-55 and iron concentrations measured in men and women's blood samples correlate well with Fe-55 levels in the atmosphere and vary as the yearly rainfall at the collection site. Concentrations of Fe-55 in cattle blood correlate with the expected concentration in vegetation and follow a biological half-life of 1.72 years. Iron-55 in Alaskan fish-eating natives is tenfold higher than in Richland, Washington, residents and the level is declining at a more rapid rate, reflecting the much higher turnover rate for iron in the foods from the marine biosphere.

SUPPORTED BY U.S. Atomic Energy Commission

5.0085, CHARACTERISTICS OF HANFORD PROJECT SOILS

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The emphasis of soils research is on the Arid Land Ecology (ALE) Reserve and serves to characterize and delineate soil units and to correlate them with biotic components of natural ecosystems. Characterizations and delineations involve the definition of physical and chemical soil properties associated with individual organisms or communities and nutrient cycling through soil-plant systems. Detailed studies of fundamental soil processes and transformations are conducted. The fate of soil organic matter, the flow of carbon and energy through soil, and the availability of mineral nutrients from weathering processes have the ultimate goal of defining the role of essential soil properties in ecosystem dynamics.

Results: Measurement of CO2 evolution from soils amended with native grass tissue indicates that (1) rates are temperature and moisture dependent, (2) soil microorganisms are capable of easily degrading higher quantities of organic matter than occurs naturally, and (3) root tissue is more resistant to decay than shoot tissue. The chemical analyses of field collected samples indicate soil-plant community differences.

SUPPORTED BY U.S. Atomic Energy Commission

5.0086, MACRO-NEKTON INVESTIGATIONS OFF THE COLUMBIA RIVER MOUTH

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The purpose of this project is to assess the magnitude and distribution of the dominant pelagic and zooplankton fauna inhabiting the offshore environment adjacent to the Columbia River mouth, and to determine the role that these fish and invertebrate populations may play in the biological transplant of radionuclides originating from the Columbia River - Hanford reactor site. Major pelagic fish resources of the study include Pacific hake, northern anchovy, various smelts and rockfishes, and lantern fishes. Some of these species are now being intensively exploited and most of them feed on zooplankton species which have an affinity for certain radionuclides.

Acoustic surveys and sampling with midwater trawl gear is conducted over a 3,200 square mile contiguous to the Columbia River mouth. All catches are enumerated by species and samples of the selected species are collected for radio-analysis by the University of Washington Laboratory of Radiation Ecology and the Oregon State University Department of Oceanography.

To date, two cruises have been completed; one in February, 1969 and the other in May, 1969. The February cruise was severely restricted because of inclement weather. Two hundred miles of trackline were surveyed in the immediate vicinity of the Columbia River mouth. The most abundant fishes encountered were the yellowtail rockfish ('Sebastodes flavidus'), anchovy ('Engraulis mordax'), and the Columbia River smelt ('Thaleichythys pacificus'). The May cruise provided an opportunity to measure various parameters of the trawl sampling gear. During the cruise 850 miles of trackline were acoustically surveyed. The dominant species present in the study areas was Pacific hake ('Merluccius productus'). Results of the two cruises have been useful primarily in providing a background of information for use in designing future surveys on this project.

SUPPORTED BY U.S. Atomic Energy Commission

5.0087, STUDIES OF THE NATURAL ALPHA-EMITTING RADIOISOTOPES IN MARINE ORGANISMS

T.M. BEASLEY, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105 (AT(45-1)2225014)

The objective of this research is to characterize the levels of the naturally occurring alpha-emitting radionuclides in marine biota. The results will permit an evaluation of the role played by these isotopes in contributing to the natural radiation environment of marine organisms.

SUPPORTED BY U.S. Atomic Energy Commission

5.0088, THE PHOTOBIOLOGY AND PHOTOCHEMISTRY OF RIBONUCLEIC ACIDS

M.P. GORDON, Univ. of Washington, School of Medicine, *Seattle, Washington* 98105 (AT(45-1)2225,015)

These studies have as their goal the nature of the alterations produced in RNA by ultraviolet light and the nature of the photoreactivating systems which can reverse these deleterious alterations. Photoreactivable irradiated tobacco mosaic virus ribonucleic acid (TMV-RNA) contains pyrimidine dimers, while the non- photoreactivable RNA from irradiated whole virus does not. The coat protein of TMV will form hybrid virus particles with potato virus X RNA, and these hybrid particles cannot be photoreactivated. The polyhedral nucleoprotein particle consisting of a hollow shell of cowpea chlorotic mottle virus protein enclosing TMV-RNA does show photoreactivation. These results indicate a possible correlation between photoreactivation and the presence of pyrimidine dimers containing a cyclobutane ring. The ability of assay plants to photoreactivate TMV-RNA is slowly lost upon dark treatment and regained within 10 hours of illumination with white light. Irradiation of assay plants with 253.7 nm radiation blocks photoreactivation of TMV-RNA. This block is removed by illumination with white light for short periods of about 2 hours. An 'in vitro' system has been obtained which appears to carry out the photoreactivation of irradiated TMV-RNA. Methods for the large-scale preparation of chloroplasts and chloroplast tRNA's have been developed. An experimental system consisting of mammalian cells in culture containing tobacco leaf chloroplasts is being developed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0089, EXCHANGE OF LYOTROPIC SERIES CATIONS BY MICACEOUS VERMICULITES IN RELATION TO SURFACE CONFIGURATIONS OBSERVED BY ELECTRON MICROSCOPY

M.L. JACKSON, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin* (AT(11-1)-1515)

Objective: To obtain precise knowledge of lyotropic series cation exchange and fixation mechanisms in micaceous vermiculites, including fission product cations such as 137-Cs ion and 90-Sr ions, as influenced by layer configurations and hydroxy sesquioxide coatings examined by electron microscopy.

Scientific Background for Study: Micaceous vermiculites (a) are ubiquitous in soils and sediments through inheritance from metamorphic rocks, fluvial sediments and aerosolic dusts carrying nuclear fission products in rainfall; (b) undergo exchange with lyotropic series cations and retain (fix) certain fission products. Partial cleavage creates wedges which have steric effects in cation

exchange selectivity, particularly of 137-Cs ion, associated sesquioxide coatings are thought to fix cations such as 90-Sr ions.

Proposed Procedure: Cation exchange and fixation mechanisms involving layer configurations and colloidal sesquioxide coatings of micaceous vermiculites from the sources above will be investigated by radiochemical, high resolution electron microscopy (replica, stereo- scanning, and ultramicrotomy), and chemical extraction techniques. The findings will be correlated with nuclear fallout and waste problems.

Test Objects and Agents: Soils, tropospheric dusts, other sediments, and model exchangers, all containing micaceous vermiculite. Radiochemicals, including 137-Cs ion and 90-Sr ions. Electron microscopes and replicato.

Results: Research thus far has provided basic information on micaceous vermiculites: (1) on the relationship of lyotropic cation exchange and selectivity to the layer charge density and interlayer wedges, by radiochemical and electron microscopic techniques: (2) on the effect of sesquioxide coatings in causing cation exchange capacity (CEC) lowering, pH dependent CEC, and layer lifting; and (3) on identification of tropospheric dusts bearing micaceous vermiculite as additions to soils and sediments (through the oxygen isotopic composition of the 'marker' mineral quartz) and carrying 137-Cs ion and retaining it against replacement by Ca ions of CaCl2.

SUPPORTED BY U.S. Atomic Energy Commission

B. EFFECTS

Physical, Chemical, and Biological Injury. Medical Studies Utilizing Radiation Are Excluded.

5.0090, EFFECTS OF AGING ON SOME ENERGY-LINKED FUNCTIONS OF PLANT MITOCHONDRIA

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OBJECTIVE: Investigate the effects of aging and high energy gamma ray irradiation of seeds, seedlings and isolated mitochondria on several measurable parameters of isolated mitochondria.

APPROACH: Seeds and growing plants will be allowed to age naturally or aging will be simulated by varying the environment. Mitochondria will be isolated from the plant tissues and examined to see what effect the tissue pretreatment has had on a variety of mitochondrial energy-linked functions including conformational change, oxidative phosphorylation and ion accumulation abilities.

PROGRESS. The work so far has only been of a preliminary nature and has concentrated on the effects of radiation on germination and subsequent growth of bean seeds (Phaseolus vulgaris var. Black Valentine). Air-dried seed subjected to 10,000 rads of gamma irradiation showed a slight decrease in germination and a reduction in growth of epicotyl and leaves. Seed given 20,000 rads were largely killed prior to or immediately post germination and showed very little aerial growth. Seed soaked in water prior to irradiation were much more sensitive to radiation damage, the degree of sensitivity being related to hours of soaking prior to irradiation. Generally, the longer the soaking period the lower the seed viability and subsequent seedling growth. Some evidence has been obtained which suggests that seeds soaked for 24 hrs and given low levels of radiation (500-2,000 rads) showed a more rapid rate of germination and increased early growth of the seedlings. Radiation, at the levels used, affects the respiration of embryonic tissue but has no apparent effect on the respiration of the pre-existing cotyledon tissue.

SUPPORTED BY Alabama State Government

5.0091, EFFECT OF RADIATION ON THYROID PROTEIN BIOSYNTHESIS

J.M. HERSHMAN, U.S. Veterans Administration, Hospital, *Birmingham, Alabama* 35233

X-irradiation of microsomal particles prepared from pig thyroid homogenates by conventional methods with 100,000 rads before incubation with radioactive leucine reduced protein synthesis as much as 60% of that of a non-irradiated control. The effect of the radiation was most pronounced at early incubation times (15-30) and at low concentrations of cytoplasmic elements. Beta-mercaptoethanol, which was necessary for protein synthesis, reduced the amount of X-ray damage to protein synthesis considerably when added before X-irradiation but had minimal effect when added after X-irradiation.

SUPPORTED BY U.S. Veterans Administration

5.0092, THE EFFECT OF RADIATION ON DENTAL TISSUES

R.E. MORGAN, Univ. of Alabama, School of Dentistry, *Birmingham, Alabama* 35233

The effect of ionizing radiation on living systems is of vital importance to biology and particularly to dentistry. The present study will investigate the effects of ionizing radiation on the gingival tissue of rabbits with particular reference to both morphologic and biochemical effects. In addition, the mechanisms by which the principal components of the intercellular matrix of gingival tissue, collagen and the glycosaminoglycans, suffer radiation of these components with the products of water radiolysis by means of pulse radiolysis and also to investigate their energy transfer properties.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0093, BEHAVORIAL EFFECTS OF LOW INTENSITY UHF RADIATION

S.F. KORBEL, Univ. of Arkansas, Graduate School, *Fayetteville, Arkansas* 72701

The objectives of the proposed project include investigations of the following variables under low intensity, low frequency (500 MHz) UHF radiation: (a) Behavioral effects; UHF-induced behavioral changes such as activity, emotionality, learning, and stress are being studied; and (b) Parameters: The second objective is the exploration of behavioral changes as a function of the following parameters: (1) Power intensity levels: Evidence indicates that activity is differentially affected by different power levels (.43-.15 mw, 1.75 mw/sq cm, 3.50 mw/sq cm; (2) After effects: One major effect of low intensity UHF radiation, hyoactivity, continues to occur for a short period of time after UHF is terminated; (3) Age of organism: Possible UHF-induced behavioral changes as related to age of organism (78, 18, 138 day old rats at first exposure to UHF fields) will be investigated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0094, THE ROLE OF ENERGY METABOLISM IN REPAIR AND MACROMOLECULE SYNTHESIS AFTER IRRADIATION

G.V. DALRYMPLE, U.S. Veterans Administration, Hospital, *Little Rock, Arkansas* 72206

DNA rejoining by L cells and by rat sarcoma cells was measured by three methods: 1) alkaline sucrose sedimentation, 2) polynucleotide kinase, and 3) DNA polymerase. These studies showed that DNA breaks are produced in a dose-dependent manner and they are rapidly rejoined after irradiation. The rejoining, however, is inhibited by uncoupling concentrations of dinitrophenol. The rejoining of DNA breaks by mouse liver, mouse spleen, and rat sarcoma (as a solid tumor) occurred during the postirradiation period. The results indicated the DNA breaks (as measured by alkaline sucrose sedimentation) were rejoined at the same rate the 5' termini (as measured by polynucleotide kinase) and 3'OH termini (as measured by DNA polymerase) disappeared. We interpret these data to mean that radiation produces a large number of DNA breaks characterized by 5'PO4 - 3'OH termini. Very likely DNA ligase is responsible for this rejoining. Since DNA ligase requires ATP as a co- factor, dinitrophenol treatment would be expected to inhibit the action of this enzyme.

We have found that treating L cells and rat sarcoma cells with a detergent-based lysing solution (2% TIPNS, 1% para-aminosalicylate, 6% butanol, pH 13) produces a most interesting result. Cells were prelabeled with 3HTdR for 2 generations, then suspended in Hank's balanced salts solution without glucose (HBSS). After irradiation (250 - 10,000 rads), the cells were lysed. Within a few minutes of lysis a mucoid precipitate formed

which contained most of the radioactivity. With increasing dose, a decreasing amount of radioactivity appeared in the precipitate. We, tentatively, have interpreted these findings as due to alterations in the DNA-protein interactions which allow greater solubility in the detergent system.

SUPPORTED BY U.S. Veterans Administration

5.0095, EFFECT OF IRRADIATION ON MEMBRANE AND TRANSPORT CHARACTERISTICS OF ISOLATED FROG SKIN

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Purpose: Ionizing radiation causes profound alterations in cellular energetics and metabolism which leads to changes in permeability characteristics and in active transport by the affected cells. The proposed investigation will define time-dose relationships in a well defined, accessible system. The technique introduced by Ussing and Zerahn to study active transport in the isolated frog skin will be used.

Approach: Half of whole, intact frogs (Rana pipiens) will be irradiated and paired experiments will be performed at varying intervals after irradiation. Doses of 0, 1000, and 10,000 rads will be used. The skin from the irradiated and non-irradiated sides will be mounted as flat sheets between lucite chambers containing frog Ringer's solution. Each half chamber will have a volume of 5.0 ml and the area of skin exposed to Ringer's soluton will be 3.14 cm squared.

Following a suitable equilibration period (generally an hour) the skins are short-circuited and the short-circuit current taken as a measure of net sodium flux. When the short-circuit reaches a steady value, radioactive sodium (Na-22) is added to the outside solution of both skins. Sampling of the inside solutions begins immediately after addition of the tracer. A total of 13-14 samples will be taken at intervals over 45 to 50 minutes. This time should be to allow a sufficient steady state tracer flux to occur. A single sample of the outside solution is taken near the end of the experment. At the conclusion of the experiment the skin is removed, blotted, and the area of the skin exposed to the Ringer's solution cut out and counted to assay the amount of radioactive sodium present.

Sodium concentration will be determined by atomic absorption spectrophotometry (at the University of Arkansas Medical Center).

The proposed experimental approach will permit comparison of 'non- irradiated' vs. 'irradiated' skin from the same frog and thereby possibly permit early detection of subtle alterations produced by irradiation. It also allows the calculation of undirectional sodium fluxes across the two faces of the transporting cells and will be used to identify the site(s) upon which irradiation acts to alter sodium transport.

SUPPORTED BY U.S. Veterans Administration

5.0096, STUDIES ON ENZYMIC REPAIR OF RADIATION INJURY IN MAMMALIAN CELLS

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Cultured mammalian cells possess the ability to repair injury sustained from ionizing radiation. Recent investigations have shown that repair can be modified by inhibitors of energy metabolism. Specifically, agents which uncouple aerobic oxidative phosphorylation (dinitrophenol and arsenate) enhance repair. In contrast, chemical inhibitors of the electron transport sytem (azide and cyanide) show no effect. Fluoride, which inhibits anaerobic glycolysis, appears to prevent repair in some cultured mammalian cells. This diversity of effects, resulting from inhibitors with different modes of action, offers us an opportunity to study the role of energy metabolism in the repair of radiation injury.

The proposed research will center around the following points: (1) The radiation survival characteristics of cultured cells being treated with inhibitors of energy metabolism; (2) macromolecular synthesis in irradiated cells undergoing general metabolic inhibition; (3) the response of synchronized cells compared to that of randomly dividing cells; (4) the survival and biochemical responses of cells irradiated under varying degrees of oxygen tension; (5) the behavior of culture cells having different tissue origins. These investigations should give insight into the fundamental mechanism underlying repair of radiation injury in mammalian cells.

Also, these studies have significance in a number of areas concerned with radiation injury, including radiotherapy, mammalian genetics and exobiology.

SUPPORTED BY U.S. Veterans Administration

5.0097, RADIATION INDUCED CHANGES IN NEONATAL NERVOUS SYSTEM

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The purpose of this project is to study the changes induced by exposing a limited portion of the immature spinal cord to ionizing radiation. The animal used in this project is the rat which is irradiated on the third postnatal day. The responses to the irradiation procedure are evaluated by neurologic, light and electron microscopic, histochemical and autoradiographic methods. In contrast to the fetal period during which exposure to radiation drastically alters the neuronal population, exposure during this early postnatal period alters the neuroglial population and, consequently, myelin. Several studies are concerned with this radiation-induced delay in myelinogenesis. Furthermore, exposure to a certain amount of radiation is followed by the development of Schwann cells and peripheral myelin within the spinal cord. Long-term (two year) studies of changes induced by exposure to small amounts of Xrays are under investigation. Although most studies in the initial phase of the project were designed to determine the damage incurred by the spinal cord, some of the current studies are for the purpose of determining the abilities of the immature spinal cord to recover from radiation-induced damage.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0098, CHROMOSOME ABERRATIONS IN PERIPHERAL BLOOD LYMPHOCYTES IN AREAS OF HIGHER ATMOSPHERIC CONCENTRATIONS OF NATURAL RADON-222

J. POHLRULING, Austrian Academy of Sciences, *Innsbruck, Austria*

The question whether continous low-level irradiation or small intermittent exposures cause biological consequences is approached by using chromosome aberrations of the peripheral blood lymphocytes as indication. Blood samples are taken repeatedly from people living or working in the area of the Austrian Spa Badgastein. They are grouped according to their radiation load: A) Thermal Gallery at Bockstein 1) Miners, trainleaders and medical doctors working in the 'Thermal Gallery' a treatment place within a disused gold-mine whose atmosphere contains Rn222 and daughters at high air temperature and humidity (29-95 WLM/a). 2) Attending personnel for the patients in the connected spa house (2-9 WLM/a). B) At Badgastein and Hofgastein 3) watering attendants in spa and treatment houses. 4) Inhabitants of Badgastein- Center where the hot springs containing Rn222 originate. 5) All the other inhabitants living in this region. The blood doses owing to Rn222 and daughters inhalation is about 15; 6 and 3 mrad/a resp. for group 3, 4 and 5.

The radiation doses in the various organs of these people are estimated due to previous experiments from all the measured radioactive omponents of the environments and the duration of stay at the various places.

The blood cultures are set up according to the usual methods. Microscopic scoring showed till now some acentric fragments, very few dicentrics and no rings.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0099, WHOLE BODY COUNTING OF POPULATION LIVING IN AREAS OF HIGH NATURAL RADIOACTIVITY

T.L. CULLEN, Pontificia Univ. Catolica, *Rio De Janeiro, Brazil*

The human population living in an area with gamma radiation levels approximately ten times normal is being studied for possible biological effects.

5. RADIATION

As part of the dosimetric study, a whole body counter was built and improved. Its calibration was renewed and the MDA is 2 nCi.

Of the dozen people thus far measured from the active area approximately half have measurable body burdens.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0100, A STUDY OF NATURAL RADIOACTIVITY IN BRAZIL
T.L. CULLEN, Pontificia Univ. Catolica, *Rio De Janeiro, Brazil* (AT(30-1)-2577)

Brazilian regions of high natural radioactivity are studied to see possible biological effects of chronic low level irradiation. A gas mantle factory was surveyed for intake of thoron products by workers. 1. Guarapari is a town of 6,000 who live in intimate contact with monazite sand. External levels have been measured; food analyzed. Airborne long lived activity is being measured. Whole-body counting of residents will be continued. 2. Araxa is a radioactive farmland. Some poor residents who live off the produce of their own farm will be whole- body counted. 3. Distribution of 212 Pb will be studied in humans and animals in the gas mantle factory.

Results: The population in Guarapari receive an average of 640 in R/yr external dose. Food is clean. Daily intake of dust smaller than 2 microns is about 3 pCi of long lived activity. Rude whole-body counting shows body burdens of order of 1 nCi. Chromosomal aberration in peripherical blood is being studied by Institute of Biophysics.

The gas mantle factory has airborne concentrations of 3.4 pCi of 212 Pb. Whole-body counting, 16 hours later, shows body burden of 2.7 nCi.

SUPPORTED BY U.S. Atomic Energy Commission

5.0101, RADIOCHEMICAL AND RADIOECOLOGICAL STUDIES ON BRAZILIAN AREAS OF HIGH NATURAL RADIATION - CHROMOSOMAL ABERRATIONS SURVEY
M.A. BARCINSKI, Univ. Fed. Do Rio De Janeiro, *Rio De Janeiro, Brazil* (AT(30-1)3273)

Our project concerns chromosomal analysis in population living in Brazilian areas of high natural radiation background. Two of such areas exist in Brazil in which the high level of natural radioactivity is due to the presence of thorium and/or uranium in the soil and rocks thus providing an important material to assess the viability of using chromosomal aberration as a measure of possible biological effect of chronic exposure to relatively high doses of natural radioactivity. People from the areas under survey are selected as blood donors for chromosomal analysis, the sample of choice consisting of those living in the areas for at least 10 years and with less of 50 years of age. The control group comprises people living under normal radiation levels, with the same socio-economical and racial background as those living in the exposed areas. For chromosomal analysis we use the blood lymphocyte technique proposed by Moorhead et al with some modification. Our goal for the following year is to study 120 more cases, including 60 cases from one of the areas (Guarapari) and 60 control samples.

Results: The results until now obtained showed no statistically significant difference between Araxa group (internal irradiation) and the control group, but significant difference between Guarapari group and control. The first results may be considered definitive but the second one not due to the insufficient data available until now.

SUPPORTED BY U.S. Atomic Energy Commission

5.0102, STUDIES ON THE EFFECTS OF NEUTRON IRRADIATION ON SEEDS
M. STOILOV, Bulgarian Acad. of Agri. Sci., *Sofia, Bulgaria*

With a standard neutron irradiation facility (SNIF), which was mounted at a core distance of 46, 4cm to the reactor IRT-2000, the thermal and fast neutron flux was determined. It has been found that the neutron dose in the working volume of the facility is Dn equals 22,4 rad/s, and that one of the gamma-rays - D equals 3,6 rad/s, at a reactor power of 1000 kw.

The results obtained with measurements of the first leaf of the Himalaya barley variety show a linear growth reduction with increasing of irradiation doses (50-55 % growth reduction is observed with a dose of 1000 rad). It deserves to be noted that a certain postirradiation effect after a 30 days storage of the irradiated seeds has been observed in air as well as in nitrogen stored seeds. No significant differences between different temperatures of storage have been observed.

However, in relation to chromosomal aberrations the differences are considerable. Thus when seeds are stored at -5 degrees the percentage of chromosomal aberrations decreases by 4-10 % (as dependent of doses) and at plus 20 degrees it increases by 3-5 %.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0103, RADIOSENSITIVITY OF BIOPOLYMER SYNTHESIS, WITH PARTICULAR EMPHASIS ON THE MITOTIC CYCLE
R. TSANEV, Bulgarian Acad. of Sciences, *Sofia, Bulgaria*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0104, ON THE CORRELATION OF INTERNAL RADIATION DOSES FROM INCORPORATED ISOTOPES AND CHROMOSOME ABERRATIONS
S. TODOROV, Inst. of Radiology & Rad. Hyg., *Sofia, Bulgaria*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0105, REMOVING RADIOACTIVE FALLOUT FROM VEGETABLES AND FRUITS DURING PROCESSING
J.W. RALLS, Natl. Canners Association, *Berkeley, California* 94710 (W3-4-87(C))

OBJECTIVE: Investigate removal of external and internal radioactive materials from vegetables and fruits during processing.

APPROACH: Simulate fallout on growing fruits and vegetables. Differentiate between external and internal radioactive contamination. Evaluate washing, peeling and other processing steps for effectiveness in removing external fallout. Conduct similar studies on vegetables and fruits grown in soils spiked with strontium and cesium. Determine distribution of these elements within edible parts of vegetables and fruits.

PROGRESS: Raw potatoes grown in soil contaminated with radiostrontium were prepared in the form of cubes, shreds, and puree and mixed with water, shaken with ion exchange resin. From 4 to 24 percent of the radioactivity was removed from the solid fraction of the potato. Spray rinsing of strawberries removed only about 30% of external contamination with radiostrontium and 12% of internal contamination. However, when strawberries were blended, diluted with an equal volume of water, and centrifuged, and the supernatant treated with carbonate to precipitate Sr and Ca, 97% of the radioactivity was removed and 43% of the strawberry material was recovered. There was a 27% loss of ascorbic acid. The final product had a salty taste but it should be possible to overcome this by further treatment of the liquid with ion exchange resins.

SUPPORTED BY U.S. Dept. of Agriculture

5.0106, BEHAVIOR AND EFFECTS OF RADIONUCLIDES IN SOILS AND PLANTS (NEW TITLE)
K.L. BABCOCK, Univ. of California, School of Agriculture, *Berkeley, California* 94720 (AT(04-3)34-PROJ.023)

1) Study of the movement of 85Sr, 137Cs and 106Ru in crop plants in the greenhouse. 2) Study of the movement of 89Sr in dwarf pea and the external concentrations which cause radiation damage in the greenhouse. Microscopic examination of damaged tissue. Additional work on damage by 32P. 3) Field studies of beta radiation damage to crop plants by 90Y and associated dosimetry.

Results to date: 1. 89Sr experiments with dwarf pea have not resulted in damage when presented with the same levels of radioactivity as 32P which did produce damage. Microscopic examination of the tissue is in progress. 2. Wheat, lettuce, and corn crops have been contaminated with high levels of 90Y and instrumented with dosimeters in the field. Results are being evaluated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0107, RADIATION STUDIES ON CELL POPULATIONS

H.J. BURKI, Univ. of California, Lawrence Radiation Laboratory, *Berkeley*, *California* 94720 (W-7405-ENG-48)

The purpose of this program is to study the kinetics of normal and tumor cell populations and radiobiological action of ionizing radiations. The results are of potential interest to radiation therapy of cancer and to health protection against radioisotopes.

Several years of studies with lymphoma ascites tumors on the relative biological effectiveness of fast charged particles and of pions were brought to conclusion.

Results: Ascites tumor cells are much more sensitive to high LET radiations than low LET, and the multihit survival curves become single- hit type. Young inocula of ascites cells grow experimentally in the host animal and are well oxygenated. After several days, cell proliferation slows and the cells become anoxic; radiation sensitivity exhibits corresponding changes. The radiation sensitivity of hamster kidney cells in culture shows variation with ploidy. The biological effects of the 900-MeV helium ions were measured along their ionization curve.

SUPPORTED BY U.S. Atomic Energy Commission

5.0108, STUDIES OF TRANSURANIC ELEMENTS AND OTHER RADIOACTIVE BONE-SEEKERS

P.W. DURBIN, Univ. of California, Lawrence Radiation Laboratory, *Berkeley*, *California* 94720 (W-7405-ENG-48)

The aim of this project is the elucidation of the physiological mechanisms of accumulation, translocation, retention, and elimination of the transuranic elements and other radioactive bone-seeking nuclides, the mechanisms of bone resorption and renewal, and the effects of age on these phenomena. This project has some important research by-products in the areas of bone growth and senescence, mineral metabolism, bone physiology, and bone disease.

Results: Data has been collected and some annalysis has been done on metabolic and autoradiographic studies with 241Am and 249Cf; mineral metabolism of the female Charles River-CD rat; 90Sr kinetics in primates; induction of tumors in rats by 211At; growth, maturation, aNd senescence of the female Charles River-CD rat; balance studies with human infants.

SUPPORTED BY U.S. Atomic Energy Commission

5.0109, PROTECTION FROM LONG-TERM EFFECTS OF IRRADIATION

H.B. JONES, Univ. of California, Lawrence Radiation Laboratory, *Berkeley*, *California* 94720 (W-7405-ENG-48)

An evaluation of the long-term effects of radiation and the degree to which they may be influenced by variation of conditions of radiation exposure, such as total exposure, dose rate, age of animals at exposure, etc., and the possible physiologic magnification or attenuation of these long-term effects by metabolic supplements.

An immediate aim of this research is to obtain new dose-cancer (or other pathologic) response data which will aid in the interpretation of radiation effects in the exposure range approaching natural background. Comparison of the dose-response relationship to those of chemical carcinogens is helpful in the study of additive and protective effects in carcinogenesis.

Results: Lung tumors have been induced in mice by administration of various dose schedules of urethane. We found the following: tumor yield is decreased when total dose is fractionated rather than given as one large dose; with a dose of 1.0 mg/g pathogen-free animals get fewer tumors than do those deliberately exposed to Pseudomonas; the effect of thymectomy of the yield of urethane-induced tumors indicates that the immune system plays a considerable role in genesis of tumors.

SUPPORTED BY U.S. Atomic Energy Commission

5.0110, BIOCHEMICAL AND PHYSIOLOGICAL RESPONSE TO IRRADIATION - RETICULOENDOTHELIAL SYSTEM STUDIES

H.B. JONES, Univ. of California, Lawrence Radiation Laboratory, *Berkeley*, *California* 94720 (W-7405-ENG-48)

Studies of the biochemical and physiological nature of radiation damage and of mammalian cell population dynamics and physiological function under normal and abnormal conditions. In our previous studies on the kinetics of phagocytosis, we established the presence in plasma of a clumping factor that causes colloidal carbon to agglomerate. It was suggested that this agglomeration may be an important step in the phagocytic process. Further studies have shown the agglomerating activity to be heightened by the addition of heparin 'in vitro.' This observation is interesting in light of information cited by Filkins and DiLuzio that large doses of heparin can produce marked increases in the rate of clearance of colloidal carbon. Furthermore, we have observed dog plasma to be very much more active in agglomerating the carbon than either mouse or guinea pig plasma (there may be a correspondence between this observation and the difficulty encountered by others in attempting to produce a carbon blockage in the dog). Plasma in all cases was more active than serum; this activity decreased progressively with storage time in the frozen state; and, while plasma activity was always greater than serum, the serum activity was always considerable.

Results: We have investigated the influence of multiple injections of carbon on colloidal gold and colloidal chromic phosphate. When two injections of carbon were given one hour apart and one hour prior to the gold or chromic phosphate, the gold disappearance rate was reduced to one seventh normal and the chromic phosphate to one third of normal, and very profound changes were produced in the distribution of the colloids in the body.

SUPPORTED BY U.S. Atomic Energy Commission

5.0111, BIOCHEMISTRY AND PHYSIOLOGICAL RESPONSE TO IRRADIATION--RADIOSENSITIVITY OF LYMPHOCYTES

H.B. JONES, Univ. of California, Lawrence Radiation Laboratory, *Berkeley*, *California* 94720 (W-7405-ENG-48)

Our interest in the physiology of lymphocytes and especially in their high radio-sensitivity has continued. We observed some time ago that mice treated with actinomycin-D (act-D) suffered a rapid involution of lymphoid tissue. It seemed possible that lymphocytes were especially sensitive to interference with DNA dependent RNA synthesis and that this might be a clue to the biochemical lesion leading to radiation-induced interphase death. The test system has been in vitro suspension of rat thymocytes. Cell viability was determined by eosin exclusion or by the measurement of residual extractable potassium in the cells. In this 'in vitro' system cell survival was affected only by high concentration of act-D. Act-D has been shown by Elkind and others to be a radiation sensitizing agent for tissue culture cells; it has been considered to inhibit repair.

Results: Experiments to date have yielded results that are entirely opposite to our expectations. Thymocytes treated with act-D before exposure to radiation demonstrated a very marked increase in survival compared with other irradiated cells. Radiation protection was proportional to act-D concentration in the range of 0.1 to 5 micrograms per ml. Addition of act-D in the first 4 hours after radiation also resulted in increased survival, the greatest protection being observed when act-D was added immediately after irradiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0112, METABOLIC WARD

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5. RADIATION

The Metabolic Ward is a small hospital unit located at Cowell Memorial Hospital of the University of California containing a maximum of fifteen beds and associated laboratory space. It provides hospitalization facilities for patients, both normal and in various disease states, who because of either illness or the complexity of the studies desired, cannot be studied on an ambulatory basis. In addition to its own clinical laboratory, the Metabolic Ward provides space for those basic investigations which are closely allied to the clinical program.

The Metabolic Ward further provides facilities for reversed isolation designed for use in radiation injury where there might be suppression of bone marrow and immune mechanisms. A principal purpose for the maintenance of this small hospital unit is to keep in a readiness-state, hospital facilities for occupationsl disaster care involving radiation contamination.

Results: A detailed report of the metabolic changes observed before and after heavy-particle therapy in acromegaly was presented at the Royal College of Physician in London. Preliminary studies of the diabetes of acromegaly indicate that hydrocortisone and other glucocorticoids will suppress growth hormone levels, but at doses that are excessive. Comprehensive analysis of excretion of urinary steroids in patients with Cushing's disease who have been selected for heavy- particle pituitary irradiation has demonstrated that the competitive protein-binding assay using C-14 labelled cortisol is more specific than the fluorometric assay in plasma.

SUPPORTED BY U.S. Atomic Energy Commission

5.0113, RADIOLOGICAL PHYSICS

H. MACCABBEE, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

The object of this study is a better understanding of the physical interactions of ionizing radiations and matter, particularly constituents of biological tissue. Types, properties, and distribution of secondary particles and excitations are of special interest. The quantitative relationship of primary physical interactions to eventual biological events is studied by the aid of mathematical models.

We are constructing a heavy-ion microprobe which should give important information on the energy loss of relatively slow heavy particles and on the yield of secondary ions, electrons, and X rays. We have started to develop a new tool. Laminar proton radiography--for diagnostic radiology, based on physical properties of heavy particles.

Results: A theoretical study was completed for estimation of the yield of secondary particles by stripping reactions in ion beams of kinetic energy of up to several hundred MeV. These calculations give upper limits to the contribution of secondaries to dose and LET distributions of a beam of particles, and also yield estimates for exit doses caused by secondaries. The theoretical model was compared to experimental observations in a 900-MeV helium-ion beam, and satisfactory agreement was reached. Both of the above models were utilized to estimate depth-dose characteristics for future heavy-ion beams.

SUPPORTED BY U.S. Atomic Energy Commission

5.0114, ELECTRICAL AND RADIATION STUDIES ON NEURAL ACTIVITIES IN CULTURE AND IN THE INTACT ORGANISM

A.M. MAMOON, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

Radiations have a profound effect on the nervous system which is different from their effect on proliferating cell populations. The complexity of nervous structures, the chronic nature of the effects, and our general ignorance of how the brain functions make this a very important area to study.

Explants and cultures of mammalian nervous tissue allow detailed biophysical studies at the single-cell level, thus allowing quantitative studies of some of the basic properties of neuronal and glial cells. Currently work proceeds on the following problems: dynamics of neuronal cell culture, spontaneous electrical activity in neurons, cell-to-cell communication, morphological and functional effects of radiation, and development and differentiation.

In the intact animal the special methods of study usually involve production of radiation lesions available at the Laboratory. Heavy-ion beams allow production of a variety of local lesions in the nervous system, which are devoid of the trauma that is usually present when surgical lesions are made.

Results: We have maintained cerebellar and midbrain explants from 1 to 5 day old rats routinely for periods of six to eight weeks. A technique was developed which permits detailed studies with active two- dimensional neural nets, in which spontaneous electrical and biochemical activity has been observed. A 3,000-rad dose at the time of explanation nearly completely eliminates new myelinization, a dose-effect curve shows delay and decrease in myelin formation beginning at about 400 rad.

SUPPORTED BY U.S. Atomic Energy Commission

5.0115, CELLULAR AND SUBCELLULAR BIOPHYSICS--HEMATOPOIETIC STUDIES

H.C. MEL, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

Great complexity and heterogeneity is characteristic of biological mixtures. Detailed knowledge of this heterogeneity and eventual control over it are of fundamental importance in problems of cellular change and development (e.g.in erythropoiesis), of immunology (including tissue transplantation), of fertility, of carcinogenesis, and of radiation action. This project is concerned with the physical properties of cells, organelles, and molecules in complex biological mixtures, and the relationship of these properties to the biology of the particles. In continuation of work investigating relationships between bone and regeneration marrow, cells other than endosteal lining cells (previously ruled out by experiment) are being sought as prime initiating cells for marrow regeneration following local surgical depopulation.

Results: In recent rabbit work, a new cell fraction has been obtained which is highly enriched in the large primitive cells normally resident in and confined to the Haversian canals.

SUPPORTED BY U.S. Atomic Energy Commission

5.0116, SEDIMENTATION AND ELECTROPHORETIC STUDIES ON PARTICLE MIXTURES INVOLVED IN SEPARATE BIOLOGICAL AND PHYSICAL STUDIES

H.C. MEL, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7045-ENG-48)

Great complexity and heterogeneity is characteristic of biological mixtures. Detailed knowledge of this heterogeneity and eventual control over it are of fundamental importance in problems of cellular change and development (e.g. in erythropoiesis), of immunology (including tissue transplantation), of fertility, of carcinogenesis, and of radiation action. This project is concerned with the physical properties of cells, organelles, and molecules in complex biological mixtures, and the relationship of these properties to the biology of the particles. Separated fractions of isolated mammalian (Chinese hamster) metaphase chromosomes become available in preparative scale permitting direct chemical and other investigations on subportions of the total karyotype. Following extraction with cold 10% TCA, relative DNA content was measured by the diphenylamine method.

Results: The amount of DNA per average chromosome per fraction follows a pattern generally similar to that for the average size of the chromosome in the fraction but some distinctive differences have been found in 'linear DNA density' between the fractions. Sedimentation coefficients were also measured for the population (and fractions) and found to be in the range Sw, 20 equals 0.05 to 0.48 megasvedbergs.

SUPPORTED BY U.S. Atomic Energy Commission

5.0117, STUDIES ON HAZARDS OF THE TRANSPLUTONIUM ELEMENTS

H.G. PARKER, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

The project is concerned with research on the hazards of transplutonium elements with particular attention to an evalua-

tion of distribution and excretion; and with hazards and therapy in the event of acute exposures to transplutonium elements by inhalation or from wounds. The development of a Si(Li) wound counter and of a routine for actinide wound analysis is almost complete. The animal whole-body counter has been completed and checked out for ordinary gamma counting of animals. The device is presently being adapted for prompt gamma coincidence counting of 252 Cf, for quantitation of Cf in the presence of its daughters and impurities, and for pilot experiments with measurement of prompt gammas from neutron-induced fission of 239 Pu in biology. Pilot studies have been continued with the use of saline aerosols for removal of lung burdens in rats, using a 195 Au colloid.

Results: Standardization of wound counter completed; wound analysis routine checked out. A monkey injected intratracheally with 195 Au colloid has provided a crude movie of time-lapse Anger scintillation camera pictures, that present visually, for the first time, the sequence of elimination of a portion of the lung burden of insoluble particulates, and its travel through the gut.

SUPPORTED BY U.S. Atomic Energy Commission

5.0118, STUDY OF RADIONUCLIDE EFFECTS ON PLANT GROWTH - WITH SPECIAL REGARD TO PLANT DAMAGE CAUSED BY IONIZING RADIATION

R.K. SCHULTZ, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B0-SPN-2408)

OBJECTIVE: Determine the scope and magnitude of the deleterious effects on plants which may be brought about by exposure to ionizing radiation of beta emitting radionuclides. Anatomical changes in plants which may be induced will be investigated at both the macroscopic and microscopic scale.

APPROACH: A properly vented plant growth chamber and facilities for safe handling of highly contaminated soils and plants will be installed at Camp Parks. This laboratory will be used for studying the effect of ionizing radiation on plant growth where this radiation arises from beta emitting radioisotopes. Plants will be exposed to this radiation by way of foliage and soil contamination. The effects of internal emitters and external exposure will be studied.

PROGRESS: Previous work of this project has dealt with effects of beta emitting radionuclides to plants when applied to foliage by immersion in water soluble Y. Dosimetry has been estimated by determination of mu/in on leaf surfaces. All previous experiments have been carried out in controlled environment chambers. The work of the past year has moved into 3 new areas. The plants have been exposed to insoluble Y fused on 88 to 177 micron sand (synthetic radioactive fallout), a new method of beta radiation dosimetry employing thermoluminescent CaF(2):Mn is under development, and a field experiment has been carried out. The first experiments using the synthetic fallout were carried out in a plant growth chamber. The radioactive sand was applied to the foliage of wheat and lettuce plants and the soil surface by entraining this very fine sand in an airstream and dropping the sand (fallout) 10 feet on to the foliage. From this work it was determined that deleterious effects occurred when the Y exceeded 17 millicuries per square foot for the lettuce crop and when the Y exceeded 5 millicuries per square foot in the case of the wheat crop. From these plant growth chamber results field experiments were designed and the new dosimetry methods are to be utilized. Results from the field experiments and new dosimetry techniques are currently under evaluation.

SUPPORTED BY California State Government - Sacramento

5.0119, EFFECTS OF BETA RADIATION ON PLANTS

R.K. SCHULZ, Univ. of California, Graduate School, *Berkeley, Californic* 94720 (DAHC20-71-C-0208)

Technical Objective: To conduct experimental research with the objective of determining the magnitude of the deleterious effects of fallout beta radiation on plant growth and yield.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0120, ELECTROPHYSIOLOGICAL AND BIOCHEMICAL STUDIES OF THE EFFECTS OF RADIATION ON BRAIN ACTIVITY AND DEVELOPMENT

P.S. TIMIRAS, Univ. of California, Graduate School, *Berkeley, California* 94720 (AT(04-3)34,082)

Our most recent research efforts have established that neurotransmission, an important property of CNS functional activity, is markedly altered by X-radiation. Changes in neurotransmission may underlie the changes previously observed in the electrophysiological activity of the brain of irradiated rats. Accordingly, our principal efforts during this year will be directed to the study of the effects of X-radiation on neurotransmitter function, and will attempt to elucidate 1) the mechanisms of specific action of X-radiation on neurotransmission, 2) the age and structural specificity of the effects observed, and dose- age relationships.

As in our previous studies the experimental animal will be the rat at various stages of post-natal development. To elucidate the mechanism of action of X-radiation on neurotransmission, we shall explore the effects of X-radiation in brain synaptosomal preparations. Synaptosomes as well as other subcellular fractions will be studied for their content of ACh and the activity of the enzymes associated with ACh metabolism, as well as the enzyme Na K ATPase. Synaptosomes are useful in studying mechanisms of synthesis, storage and release of neurotransmitters and, therefore, the effects of X-radiation thereon. Dose-age relationships and CNS structural specificity will be investigated primarily with respect to alterations in cholinergic transmission. In addition to establishing the minimum dose required to effect these changes, we will include studies of dose-rate dependence and of acute versus prolonged radiation exposure at various stages of CNS development with a view to the radiation exposures received by human infants.

X-radiation at doses comparable to those known to induce functional alterations in the rat central nervous system also induces alterations in neurotransmission. The cholinergic enzymes, choline acetyltransferase and acetylcholinesterase, and amino acids with putative neurotransmitter function are altered by X-radiation. These alterations vary depending upon the age of the animal and the specific CNS structure under study.

SUPPORTED BY U.S. Atomic Energy Commission

5.0121, MAMMALIAN STUDIES WITH ACCELERATORS: INVESTIGATIONS WITH LARGE ANIMALS

C.A. TOBIAS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

A study on the effects of simulated solar flare radiation on the squirrel monkey was completed and a report is being printed. This study was done in cooperation with the Navel Aerospace Medical Institute at Pensacola, Florida. Twenty-two squirrel monkeys were used. Groups of these animals were exposed to a simulated solar flare spectrum at the Berkeley 184" cyclotron. The primary objective of this study was observation of possible effects of radiation exposure on the vestibular system and the sense of equilibrium of the animals.

Results: There appeared to be two dose related modes of death. Hemotopoietic mode prevails at high dose levels, occurring less than 30 days post-irradiation; another mode of lethality, probably the 'skin' mode occurs at periods beyond 30 days at lower dose levels. The median lethal doses delivered at 0.5 and 1.0 cm depth for 60 day survival are 237 and 185 rads, respectively. Thus, either the simulated solar flare exposure is about twice as effective as uniform dose, or the squirrel monkeys are much more sensitive to radiation than rhesus monkeys.

SUPPORTED BY U.S. Atomic Energy Commission

5.0122, THE EFFECTS OF GRAVITY COMPENSATION, RADIATION AND MAGNETIC FIELDS ON LIVING ORGANISMS

C.A. TOBIAS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

5. RADIATION

These studies aim to measure possible synergistic effects between gravity compensation and radiation on developing organisms. In addition, separate investigations will study relationships between effects of ultrasonic vibrations and radiations. The results are expected to be of value in interpreting biological effects of space environment; for example, the apparent synergism obtained between radiation and weightlessness in Biosatellite II. The results may also be of value in considering the radiobiology of tumor cells.

Results: Engineering and construction of a one-dimensional clinostat has been completed. Gravity compensation is accomplished by uniform, vibration free rotation of the biological test objects, around a horizontal axis, at various angular velocities. The clinostat is housed in a lead shield and can be controllably exposed to a cesium gamma ray source for periods of many days. Air temperature and humidity control is provided, and an aerobic radiation exposure is possible.

SUPPORTED BY U.S. Atomic Energy Commission

5.0123, MAMMALIAN STUDIES WITH ACCELERATORS - RELATIONSHIP OF CELLULAR CONTROL MECHANISMS TO CARCINOGENIC EFFECT OF ACCELERATED IONS

C.A. TOBIAS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

Groups of CD random bred mice have been exposed to whole-skin irradiation by accelerated helium ions at the 88' cyclotron. The penetration of the beam is accurately controlled with definite depth at 120, 220, 310, and 510 microns. In this manner, we hope to obtain some information on the participation of different tissue layers in the tumorogenic process and on the effectiveness of helium ions in inducing tumors. Work has continued in an effort to isolate a tissue specific regulatory substance (i.e., 'chalone') which presumably suppresses mitosis and thereby maintains tissue homeostasis. This study is an extension of the study of heliumn-ion carcinogenic properties in mammalian epidermis.

Results: Crude extracts of mammalian epidermis have been demonstrated to exert a mitotic inhibitory effect on human (foreskin) epidermal cells in culture. When applied complexed with adrenalin, the extract suppresses mitosis for a period of 12 to 16 hours (approximately one generation time). The extract was ineffective when applied alone or on tissue culture cells of non-epidermal origin.

SUPPORTED BY U.S. Atomic Energy Commission

5.0124, MAMMALIAN STUDIES WITH ACCELERATORS: GERMFREE RESEARCH

C.A. TOBIAS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

The response of both germfree and conventional CD strain, random bred mice to a high-energy proton beam (740 MeV) has been investigated. Our initial efforts indicate an RBE of 0.97 and 1.1, respectively, for germfree and conventional mice. An important aspect of this work involves the observation of relative predominance of gastrointestinal vs. hematopoietic injury as expressed by the time distributed mortality response of charged-particle and conventional irradiated animals.

Results: Initial results suggest that, for this particular strain of both conventional and germfree mice, the propensity for gastrointestinal death observed in charged particle-irradiated animals as compared with their conventionally irradiated (Co60) counterparts does not appear to exist. The time course of mortality for both types of radiation in the dose range of about 800 to 1100 rads was essentially identical.

SUPPORTED BY U.S. Atomic Energy Commission

5.0125, THE EFFECTS OF GRAVITY COMPENSATION, RADIATION AND MAGNETIC FIELDS ON LIVING ORGANISM

C.A. TOBIAS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

Our aim is to study the interaction of gravity compensation and radiation on 'Tribolium' pupae in order to obtain ground-level comparison with the results obtained in the spaceflight of Biosatellite II. During the spaceflight the effects of spaceflight factors were in an apparent synergism with radiation effects. Further studies are being made on developing eggs and pupae.

Results: Preliminary results are: the number of wing abnormalities induced in pupae by radiation appears to be slightly greater when gravity is compensated at 8 rpm than when it is not; fertilized eggs are much more radiosensitive than pupae (by a factor of approximately 4); pupae, suspended in water and exposed to ultrasonic vibrations at one megahertz, show marked effects on development, including the induction of wing abnormalities.

SUPPORTED BY U.S. Atomic Energy Commission

5.0126, MAMMALIAN STUDIES WITH ACCELERATORS - WHOLE SKIN HELIUM ION IRRADIATION STUDY

C.A. TOBIAS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

Work has progressed relating the possible predisposition of animals to increased radiosensitivity to whole-body 60Co-irradiation when such exposure has been immediately preceded (in hours) by helium-ion damage limited solely to the whole skin of Swiss-Webster mice. The mortality patterns of the two radiations delivered separately are markedly different. Death from whole-body 60Co-irradiation in the mid-lethal dose region (less than 1,000 rads) occurs mainly from 9 to 17 days and is due to hemotopoietic injury. Animals irradiated with whole- body helium ions die mainly in a 22 to 42 day period post-irradiation.

Results: A helium ion dose of 770 rads to the skin sublethal in itself increases the 20-day cumulative mortality by a factor of 1.5 to 2.0. This means that almost twice as many animals died from 60Co- induced radiation injury when that injury was accompanied by radiation- induced skin damage.

SUPPORTED BY U.S. Atomic Energy Commission

5.0127, ASSESSMENT OF THE HAZARD OF FALLOUT RADIOIODINES

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Technical Objective: To evaluate the radiological hazard posed by fallout fission product radioiodines.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0128, X-IRRADIATION EFFECTS OF ACUTE AND FRACTIONATED EXPOSURE IN BEAGLE DOGS

L.K. BUSTAD, Univ. of California, School of Veterinary Medicine, *Davis, California* 95616 (AT(04-3)-472)

The nature and extent of lifespan shortening, tumor incidence, and diminished reproductive capacity is being determined in beagle dogs following exposure to fractionated or acute doses of X-irradiation. These data are necessary for assessing effects of accidental radiation exposure or the exposure predicted for crews of nuclear-propelled aerospace vehicles.

A total of 360 young adult beagles were exposed to 100 or 300R administered either acutely or in 2 or 4 dose sessions at 7-, 14-, or 28-day intervals.

Exposure to 100R or 300R fractionated or acute X-radiation resulted in a life shortening of about 7% per 100R but failed to reduce reproductive capacity as measured by number and survival of pups in the first 2 litters. Tumors observed in the irradiated dogs were of the same type as those observed in the controls and with a higher frequency.

SUPPORTED BY U.S. Atomic Energy Commission

5.0129, RELATIVE EFFECTIVENESS OF X-IRRADIATION AND RADIOIODINES ON THYROID FUNCTION

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Quantitative data are being obtained on the comparative effects of X-irradiation and radio-iodine on young beagles, to deter-

mine the dose effecting functional changes in the thyroid gland. The study was designed in part to answer questions regarding the dose-effect aspects of thyroid radiation exposure of young children to diagnostic and therapeutic X-ray and to fallout in the Marshall Islands.

Clinical and biochemical studies two years after the initial exposure of beagle pups indicate that radiation-induced damage can be detected only in the animals exposed to 4500 rad. All dogs, however, appear normal.

SUPPORTED BY U.S. Atomic Energy Commission

5.0130, GERONTOLOGIC CHANGES IN BEAGLES
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Physiologic performance and efficiency are being measured to permit qualitative and quantitative evaluation of the nature and effects of radiation (emphasizing internal emitters) on aging. Body temperature, K40 content, radiographic changes, thyroid function, eye changes, skin- fold thickness, cardiovascular and pulmonary function are compared in radiated and control dogs. Response to temperature stress as a function of age will be determined in a selected number of animals. An attempt will be made to delineate the similarities to man, to construct a model for radiation-induced alterations in aging patterns. Support will be sought for a study of the ability of antioxidants to prevent some premature aging changes due to radiation and to prolong the lifespan of beagles.

Mucopolysaccharide content of costal cartilage decreased linearly, and the insoluble protein of the lens increased linearly with increasing age. Reproductive ability waned by 7 years, anestrus was extended, and fewer pups were whelped and weaned in each litter. Ovaries at 7 years manifested surface convolutions, abnormalities in subepithelial tubules, and decreased numbers of follicles, and increased numbers of microadenomas.

SUPPORTED BY U.S. Atomic Energy Commission

5.0131, CELLULAR AND CYTOGENETIC EVALUATION OF RADIATION EFFECT
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The extent of deoxyribonuclear and chromosomal damage is being determined in cells of the hematopoietic system of beagles and Marmosa mitis following X-irradiation or ingestion of 90Sr. Of particular interest is the study of animals that have developed 90Sr-induced myeloproliferative disorders, to determine the nature of the radiation- induced lesion(s) and the extent of repair. Serial bone marrow samples are obtained for determination of endogenous DNA content, RNA content, and base composition and correlation to numbers and kinds of cells present. Efficiencies of intact cells in utilizing various nucleic acid precursors are determined and compared. Priming ability of the DNA is measured in cell-free assay systems. In vitro determinations of DNA- dependent RNA synthesis will be performed.

Assay systems have been defined for measuring cellular and cell- free nucleoside and nucleotide metabolism in dog bone marrow cells. In dogs manifesting a radiation-induced myeloproliferative syndrome, the endogenous DNA per cell was 1.5 greater than that in controls although the DNA synthetic rate per cell was slighdy less and there was an abnormally high deoxypurine content. Methods of culturing and harvesting chromosomes have been adapted for the marmosa lymphocyte system to permit examination of a single specimen by light and electron microscopy.

SUPPORTED BY U.S. Atomic Energy Commission

5.0132, EFFECT OF PROLONGED LOW DOSE RATE CO60 GAMMA RAY EXPOSURE TO BEAGLES
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Whole-body gamma irradiation will be compared to irradiation from deposited Sr90 and Ra220 for effectiveness in inducing changes in the hematopoietic system of beagles. Emphasis will be given to radiation induction of neoplasia. The effect of age at exposure on the incidence of myeloproliferative disease are also important considerations to be evaluated. The study will also provide data on the relative effectiveness of low dose rates compared to equivalent doses given acutely. Beagle dogs of varying ages will be continuously exposed to Co60 gamma radiation in a Co60 field which holds 200 dogs. Dosage rates will range from 0.5R/day to 15R/day and will be compared with doses utilized in an acute radiation study as well as in a long-term study of Sr90 and Ra226 deposited internally.

The radiation exposure field is being completed and measurements have been made in the Co60 field for establishing the desired radiation exposure zones. A pilot study will begin in 1970.

SUPPORTED BY U.S. Atomic Energy Commission

5.0133, EFFECTS OF LOW-LEVEL IRRADIATION ON DEVELOPING OVARIES OF DOGS AND MONKEYS
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The nature and time of the most radiosensitive period of the developing ovary of dogs and subhuman primates is being determined by administering fractioned radiation during gestation and/or the suckling period. In earlier studies, 100R and 300R exposures to young adult female beagles failed to reduce their reproductive capacity. However, when fractioned doses totaling 200R were administered during the suckling period, sterilization occurred. Since reports have appeared indicating that adult subhuman primates are not sterilized by 5000R, it was of practical interest to extend the dog studies to the subhuman primate. Bonnet monkeys are being exposed to low doses of X-ray twice each at various periods of gestation to determine the most sensitive period of development. The data are of importance for the human population if the ovaries of women are as sensitive during early development as those of dogs and monkeys appear to be.

Sterilization and ovarian tumors were induced in female beagles by exposure to 10R X-radiation on alternate days from birth to 42 days of age. Afollicular ovaries appeared in subhuman primates exposed to 10R twice weekly during 2-5 months of gestation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0134, COMPARATIVE TOXICITY OF SR90 AND RA226 IN BEAGLES
L.K. BUSTAD, Univ. of California, School of Veterinary Medicine, *Davis, California* 95616 (AT(04-3)-472)

This long-term study is designed to (a) define the hazards of chronic ingestion of Sr90 in the beagle dog and, by comparing effects to those following Ra226 exposure, permit extrapolation of the results to man, and (b) describe the mechanism and dose-response curve for Sr90 induced granulocytic leukemia and osteogenic sarcoma. Much information is available on the effects of Ra226 in man. By determining the relative toxicity and dose effect relation of Ra226 and Sr90 in the dog, a firm basis for evaluating the hazards of Sr90 to man will be obtained. The data will also be utilized by national and international councils for setting radiation exposure criteria and limits. The Sr90-induced cancers resemble those described in man and are useful models for studying the same diseases in man. Six different levels of Sr90 are fed to female beagles beginning at 21 days following conception. At weaning, the pups are placed on the same Sr90 feeding regimen as their dams until 18 months of age and are observed for their lifespan. Other beagles are injected with comparative levels of Ra226 at 14-18 months of age, simulating Ra226 exposure to young human dial painters who manifested radium toxicity. One thousand beagles are involved in the study.

Results: Strontium-90 radiation effects are seen only at the highest levels of exposure (12 or 36 muCi Sr90/day to 18 months). No granulocytic leukemia has been observed on dogs exposed to less than 1000 rads to bone marrow and no osteogenic sarcomas have been observed in dogs exposed to less than 8000 rads to bone. Following cessation of feeding, Sr90 is lost from cortical bone with a 10-15 yr half period, from trabecular bone with a 1-2 yr half period.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0135, KINETICS OF HEMATOPOIETIC REPOPULATION FOLLOWING IRRADIATION INJURY
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The objective of these studies is to identify variations in hematopoietic recovery patterns in mice given either 1) a LD 100/30 dose of X-ray followed by a 50% protective dose of syngeneic marrow, 2) a LD 50/30 dose of irradiation, or 3) a Ld/100/30 dose of X-ray with sufficient shielding to assure 50% survival of the animals.

It is generally conceded that hematopoietic repopulation begins from stem cells. Yet in the three regimens to be studied the patterns of cellular proliferation differ considerably suggesting that in some of these regimens either the population begins from cells other than stem cells or that factors regulating the repopulation process vary from regimen to regimen. Using the hematopoietic colony technique and employing the three regimens in each experiment, various parameters of hematopoietic recovery will be investigated including the number of stem cells which provide 50% survival of animals, patterns of stem cell differentiation, rates of stem cell renewal, rate of growth of differentiated cells, patterns of recovery of peripheral blood elements, ferrokinetics, and response of recovering marrow to various humoral factors such as erythropoietin and endotoxin. These studies will be performed using CAF sub1 mice of similar sex and age to reduce variation between the experimental animals.

Results: The modal day of death of mice treated with LD 100/30 dose of irradiation followed by a 50% protective dose of syngeneic marrow is 11 days: whereas the modal day of death of mice treated by a LD 50/30 dose of irradiation is 17 days. Splenic hematopoiesis is extensive in the first regimen and nonexistent in the second (LD 50/30). Stem cell renewal in the marrow transplanted animal occurs on the 5th to 6th day and in the animal recovering from sublethal radiation has not occurred by day 7. The pattern of ferrokinetics in the marrow transplanted animals differs considerably from the sub-lethally irradiated mice.

SUPPORTED BY U.S. Atomic Energy Commission

5.0136, A SYSTEMATIC SURVEY OF THE EXCRETION OF RADIONUCLIDES
R.J. CHERTOK, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

The excretion rates of certain radionuclides will be influenced by some of the elements naturally present in the body and by elements added to the diet. This suggests an approach to the exploration of countermeasures.

Stable elements are injected intravenously into beagles and 24-hr urine samples and some serum samples are collected. The samples are analyzed by atomic absorption spectroscopy for the injected and similar elements. In some cases a radionuclide is given in a single oral dose and the rate of loss is determined by whole-body analysis. The urinary and fecal excretion rates are determined. After normal modes and rates of excretion are established, countermeasures are sought for those elements whose excretion rates are so low as to make this radionuclide potentially hazardous to man. A single dose of radionuclide is injected into rats and treatments that might be expected to enhance the excretion rate of the radionuclide are instituted. The rate of loss of the nuclide is determined by daily whole-body analysis. The tissue distribution is then determined.

Results: The study of Group IIA elements revealed only Sr and Be were excreted rapidly with no effect on the other elements and Mg caused a slight elevation in the excretion rates of Ca and Mg. In the elemental survey using radioactive isotopes, the elements studied include in order of decreasing absorption across the gut, Cs-137, Mo-99, Na-22, W-181, Zn-65, Tl-204, Fe-59, Mn-54, Hg-203, Ta-182, Pb-203, and Sn-113. A study of countermeasures for reducing the body burden of Cs- 137 revealed that of Cs, K, Rb, Diamox, Diuril, Lasix, Thyrotropin and Thyroxine, Thyroxine was the most effective.

SUPPORTED BY U.S. Atomic Energy Commission

5.0137, METABOLISM OF NUCLEAR DEBRIS IN THE DOG AND THE PIG
R.J. CHERTOK, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

From compilations of correlated data from many nuclear events there should be an emergence of generalization that will not only broaden and deepen our capabilities for evaluating the biological feasibility of proposed nuclear projects but also enable the identification of all potentially hazardous radionuclides as well as potentially hazardous devices and detonation conditions.

Field studies have been conducted with lactating domestic goats (inhalation) and Yorkshire pigs (inhalation and ingestion) which were placed in the calculated fallout pattern of some cratering events. Tissue distribution of the debris radionuclides was determined. Also nuclear debris collected from cratering events are given orally to peccary pigs (Tayassu tajacu) in a single oral dose. The animals are then analyzed daily on a solid-state detector for all the gamma-emitting radionuclides. Daily urine and feces collections are also analyzed. Tissue distribution is determined after the modes and rates of loss of the various radionuclides are determined. Similar studies have been done with debris given daily over a long period of time. Single oral doses of debris have also been given to beagles and the modes and rates of excretion of the various radionuclides have been determined.

Results: Radionuclides found to be common in several nuclear events have different rates and routes of excretion (Te-132, I-131, Ru- 103, W-187). Some of the radionuclides in the debris have also been found to behave differently biologically when given as a single isotope (Mo-99, W-181). These differences are probably due to the chemical and/or physical state of the radionuclides.

SUPPORTED BY U.S. Atomic Energy Commission

5.0138, RADIATION EFFECTS ON DIFFERENTIATION AND TISSUE CONTROL
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The objective of this research is threefold: First, to identify and compare, in carefully selected contrasting biological systems, the mechanisms by which radiation affects differentiation and tissue organization; second, to relate the radiobiological effects at the molecular, cellular, and tissue levels and to collate them with actions of other comparable agents; third, to elucidate the fundamental links between these mechanisms and the urgent questions that face us in practical human radiation health - carcinogenesis, genetic effects, and derangements of tissue development. Comparative studies involve species representing differing levels of biological organization: bacteria, fungi hydroids, flatworms and vertebrates. Main interest in the long run is in low-level exposure and incorporated radionuclides.

Planarians were selected for initial study because cell differentiation and tissue reorganization are easily elicited in them. It was demonstrated that after x-irradiation animals can regenerate as readily as controls, indicating that new cell formation is not necessary for replacement of parts. The late appearance of a particular head anomaly in animals that had been surgically decapitated after irradiation, as well as in worms left intact, indicated that latent radiation damage persists in non-head cells as they differentiate, becoming manifest only after the new head has been completed. Results: In associated biochemical studies, planarian DNA has been isolated and characterized with regard to buoyant density, melting temperature and base composition. Contrary to published reports, we have found that radioactive thymidine, administered in the water, is very poorly incorporated into planarian DNA, whether the animals are regenerating or not. However, the radioactive label is readily found in association with a non-DNA, carbohydrate component that tends to accompany DNA in separations. This may give the unwary observer an erroneous impression of rapid DNA synthesis.

SUPPORTED BY U.S. Atomic Energy Commission

5.0139, SOMATIC EFFECTS OF LOW DOSE RADIATION: RADIATION, CHROMOSOMES AND HUMAN CANCER

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Objectives of this program are: 1) To characterize quantitatively the chromosome constitution of a significant number of established human cell lines of apparently unlimited life span contrasted with normal human cells; 2) To characterize quantitatively the chromosome constitution of a significant number of cells per cancer and of a significant number of human cancers of several types; 3) To ascertain (if any quantitative chromosome systematics apply to human cancer cells or to established human cell lines), whether or not low dose radiation produces cells with such alterations, and the quantitative aspects of such production. Use of atomic energy for peaceful purposes requires more knowledge of the possible effects upon man of low dose radiation delivered at a low rate. In view of the well known limitations upon direct assessment of somatic effects of low dose radiation in man, it continues to be attractive to approach this problem at the cellular level.

Until technology provides a useful direct computer-microscope interface, projected chromosomes are traced on vellums with black ink. Overlaps and touching arms are separated and idealized. These are photographed on 35mm film, electronically scanned, and the chromosomes are computer analyzed for arm lengths and centromere position. Results are statistically analyzed with a computer program designed to isolate significant numbers and ratios of chromosome groups.

Results: Standard tissue culture techniques are used to provide material for this program. 17 established human cell lines and 11 fresh human cancer specimens have now been karyotyped and all show a marked excess of E16 chromosomes per cell, both absolute and relative to other chromosome classes (1834 normal human control karyotypes have been done). Experiments are currently underway to determine long term effects on chromosomes from acute radiation doses of 500R and chronic doses of 100 mr/hr and less on human fibroblast cultures until persistent viable chromosomal aberrations are observed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0140, EFFECTS OF LOW DOSES OF IONIZING RADIATION ON NUCLEIC ACID STRUCTURE AND FUNCTION

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Objective: To determine, with primarily biochemical and physicochemical techniques, radiation effects on natural nucleic acids in vivo and in vitro and on synthetic polynucleotides in vitro. Particular emphasis is placed on tritium irradiation. Background: DNA is generally believed to be the cellular constituent most sensitive to radiation damage. Phenomena, e.g., chromosome defects, delayed cell division and cell death, have been observed at fairly low doses. Effects on more easily understood biochemical systems, e.g., DNA and enzymes, have generally required much higher doses for demonstration. Procedures: Liver DNA is obtained from kangaroo rats living in a tritiated environment at a low radiation level. Polynucleotides containing tritium-labeled nucleotides are enzymatically synthesized. These products are examined by density gradient centrifugation, ultraviolet spectroscopy and functional enzymatic assays.

Results: The kangaroo rat has two 'satellite' DNA's in density gradients which are more abundant than in any other reported species. Low dose chronic irradiation appears to stimulate an increase in the amounts of these satellites; however, further elucidation of confounding variables is required before drawing firm conclusions. Intramolecular tritium appears more effective than extramolecular (solvent) tritium in damaging the synthetic polynucleotide.

SUPPORTED BY U.S. Atomic Energy Commission

5.0141, METABOLISM OF HYDROGEN ISOTOPES

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This research effort is designed to determine the extent to which tritium is incorporated into various organic components as a result of long-term and short-term environmental exposure which would label foodstuffs as well as water. This information will aid in determining whether or not isotopic concentration mechanisms exist in organic compartments relative to the body water compartment as a result of intake of tritiated organics or tritiated water. It can then be determined whether models based on turnover rates of tritium in water alone are adequate to predict hazards from nuclear releases. Similar data will be obtained for deuterium and it will serve as a reference level for interpreting the tritium data. Certain fractionation mechanisms have been observed for tritium and deuterium. These are very isolated cases and the general effect is very much in question. Tritium and deuterium concentrations will be determined in the free water and combustion water of various organs of humans who have been exposed to natural environmental tritium concentrations. Analysis of available foodstuffs will also be carried out. Samples from sites of elevated tritium exposure involving complex ecosystems will also be analyzed to determine the tritium concentrations in the two compartments. Laboratory experiments involving various animals will also be initiated to determine the tritium distribution as a result of available tritiated organics.

Results: These experiments have just been initiated and only very preliminary data have been obtained.

SUPPORTED BY U.S. Atomic Energy Commission

5.0142, BIOLOGICAL CONTROL PROCESSES AND RADIATION

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Our objective is first to develop mathematical models and related in vivo techniques which will allow determination of the binding constants, reaction rates and reactant concentrations that define the regulation behavior of the lac operon in E. coli. We will then use this methodology to determine the effects of radiation and related perturbations on each of these parameters individually. This approach should permit a precise definition of the susceptibility to radiation of each aspect of transcription level control of protein synthesis in bacteria. It will also provide valuable comparisons with the results of in vitro characterizations of the same system. The value of both aims rests on the great biological importance and ubiquity of protein synthesis control, including its vulnerabilities and pathologies. Our approach primarily involves kinetic studies of the control of beta- galactosidase synthesis in several strains of E. coli possessing both wild type and mutated lac repressors, together with a coordinated theoretical effort to develop mathematical models that can predict, exploit and direct the experimental work. Experiments using a lac transducing phage to manipulate the repressor concentration are in the beginning stages.

Results: Theoretical work, including a simple statistical model to accommodate low average numbers of repressor molecules per cell, is largely complete and our procedures for characterizing the effect of inducer on repressor-operator binding are finished. An experimental system in which all but one of the parameters for the repressor-operator interaction can be separately assayed is under final study and is apparently successful.

SUPPORTED BY U.S. Atomic Energy Commission

5.0143, THE BIOLOGICAL EFFECTS OF LOW DOSAGE RADIATION

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5. RADIATION

The major outstanding question with respect to the peaceful uses of nuclear energy concerns the biological effects of low dosage and low dose rate radiation. Over the past 25 years a very considerable amount of experimental work has been conducted in this area. Moreover, there have been numerous theoretical papers published on this subject. Nevertheless, the problem has remained as a major area of controversy. The purpose of this program is to bring together and analyze the existing worldwide literature pertinent to the somatic and genetic effects of radiation and to integrate this inforation into a cohesive and supportable, practical state-of-the-art ability to predict the biological effects of radiation. The objective would be to pinpoint the areas of major uncertainty and to suggest experimental approach to resolving these uncertainties.

Results: During this fiscal year we have continued our study on the lung hazard associated with highly radioactive particles deposited in the deep respiratory zone. A report on this subject is now in preparation. In addition, during this fiscal year we have brought together and analyzed that data concerning the induction of cancer in man by radiation. We have prepared a number of reports on this subject.

SUPPORTED BY U.S. Atomic Energy Commission

5.0144, PROTEIN SYNTHESIS DURING EARLY DEVELOPMENT OF THE SEA URCHIN EMBRYO

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To determine extent of damage to mechanism of protein synthesis by small doses of radionuclides and by stable ions used to eliminate them. Protein synthesis during the early hours of development of the sea urchin is ideally suited, for there is no dependence on genetic material and any effect can be completely divorced from those on nuclear genome. Protein synthesis in embryos is studied by incorporation of radioactive amino acids into protein and ribosome fractions.

Results: Some of the changes in the egg's capacity for protein synthesis at the time of fertilization have been characterized at subcellular levels. These changes include changes in the activity of ribosomes, the soluble enzymes, and membrane characteristics.

SUPPORTED BY U.S. Atomic Energy Commission

5.0145, NEUROPHYSIOLOGICAL AND BEHAVIORAL EFFECTS ASSOCIATED WITH THE INCIDENTAL IRRADIATION OF NORMAL HUMANS

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The effects of daily Cobalt-60 irradiation on sensory detection of radiation, visual perception, and simple motor performance were investigated in 'normal' human subjects during actual and sham irradiation of the apparently normal brain incidental to radiotherapy. The experiments were carried out in both dark and light adapted persons and it was found that: (a) sensory detection of radiation by humans is not reliable when the phosphene effect is eliminated; (b) visual perception is differentially affected by radiation as a function of the dark-light adaptation state of the retina; and (c) simple motor performance appears to be impaired when central portions of the brain receive about 50 rad.

In addition to these experiments, complex motor performance in multiportal pelvic-irradiated patients was assessed using a modified target gun. The results suggested no reliable post-treatment effects of Cobalt-60 irradiation on complex motor performance under the specified test conditions.

SUPPORTED BY U.S. Veterans Administration

5.0146, RADIATION INDUCED RENAL TUMORS - ELECTRON MICROSCOPE STUDIES

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Since submission of the last report, mice up to 18 months of age have been sacrificed and well formed cystic tubular adenomas are now being studied. In addition, surprising changes in aged intact controls are now being seen and appear to be unrelated to the neoplastic process. In the tumors, a variation in ultrastructure from one cell to another is noted. Some tumor cells show large numbers of mitochondria, others show vesicular cytoplasm with sparse organelles, and most show striking changes in the cell surface with loss of microvilli. In the last sacrifice group (18 months), regressive changes apparently related to ischemia are present. The ischemic alterations are more pronounced in the irradiated uninephrectomized animals which also have a more advanced glomerulosclerosis. Many of these findings are now being reported in a chapter on Radiation Carcinogenesis to be published in the forthcoming year. The material reported here is basically a survey of selected samples. Numerous additional sections must be cut to try and assemble an evolutionary sequence in the development of the tumors. This should require at least one more year of study.

SUPPORTED BY U.S. Veterans Administration

5.0147, EFFECTS OF NUCLEAR TESTING ON VASCULAR PLANT AND RODENT POPULATIONS, NEVADA TEST SITE, NYE COUNTY, NEVADA

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From comparisons of parameters of interest in systems disturbed by nuclear testing (or other origin) at the Nevada Test Site, with the expression of the same parameters in undisturbed systems, certain evaluations of the effects of weapons and other testing on plant species, communities, and rodent populations are in progress. Near completion is a comparison of certain reproductive characters (carpel weight, percent seed germination, and seedling weight under growth chamber conditions) in Larrea divaricata Cav. (Creosote-bush) in 30 sampled irradiated and nonirradiated populations, in relation to environmental variables including gamma radiation, on each of the sampling sites and each of the years 1962-65.

All sampling and data processing are completed, and regression analyses of the variables being compared in the Larrea study are in progress.

SUPPORTED BY U.S. Atomic Energy Commission

5.0148, VASCULAR PLANT AND RODENT PARAMETERS IN 68 MOJAVE AND GREAT BASIN ECOSYSTEMS, NEVADA TEST SITE, SOUTHERN NEVADA, 1962-70

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Toward the ojective of assessment of the effects of nuclear testing on native plant and animal populations of the Nevada Test Site, 68 ecosystems were selected over a 1000 square mile area in the spring of 1962. Definition of certain plant and animal parameters which might enable the distinguishing of changes due to testing from changes due to other causes, have been accomplished in the years since that time, to the extent that manpower has permitted. On all sites, for shrubs (and trees at the higher elevations), herbaceous perennials, winter annuals, and summer annuals, quantitative data have been collected from 1 to 8 consecutive years appropriate to the objectives, and rodent censusing conducted five consecutive seasons. Environmental measuurements were made concurrently on each site (see 'Precipitation, Air Temperatures, Soil Moisture, and Gamma Radiation' project).

SUPPORTED BY U.S. Atomic Energy Commission

5.0149, LATE EFFECTS OF RADIATION IN MAMMALS

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Currently the research of this section is concerned with: (1) The mechanisms, at both the physiological and molecular biological level, of the life shortening process following total body irradiation. This is a gradual change in emphasis from earlier studies which were primarily concerned with the pathology and statistics of life shortening, disease incidence, and clinical course. (2) The consequences of partial body irradiation which have not

been as clearly defined either as to pathology or as to life shortening. The study of partial body irradiation represents an area of growing importance since this type of irradiation results from certain toxicological and industrial exposures as well as improperly administered diagnostic x-ray. This study is of increasing importance in nuclear medicine, radiation therapy, and organ transplantation.

Results: Immuno-supression with I-131 tagged antigen in amounts necessary to protect skin transplants has failed to show life shortening or other deleterious effects.

SUPPORTED BY U.S. Atomic Energy Commission

5.0150, EFFECT OF IONIZING RADIATION ON DIVISION-RELATED MACROMOLECULES

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The overall goal of this investigation is to determine the acute effects of ionizing radiation on the expression of those gene sequences which control cytokinesis. Cytokinesis is used here to define the physical aspects of cell division (i.e., the production of two daughter cells from a single, mature, fully replicated cell). Past research has defined the mechanism by which the ciliated protozoan Tetrahymena pyriformis becomes synchronized following a series of cyclical temperature shifts. The results indicate that the synchronized Tetrahymena population appears almost ideal for an in depth study of the effects of ionizing radiation on the replication and expression of the DNA sequences coding for cell division. Beyond the obvious relevance to radiation biologists of the effects of radiation on cell division, it is noteworthy to point out that the expression of the gene sequences for cell division in Tetrahymena also offers an opportunity to study the effects of radiation on a complete, integrated entity of cellular differentiation. Unlike other cells, ciliates like Tetrahymena begin the process of cell division by the organization of the second oral apparatus. The formation of this large structure follows a regular sequence in time and can be followed accurately by both silver staining and by electron microscopy. Our previous investigations have led to a considerable understanding of the biochemical events controlling this step in cellular differentiation; the additive benefit of having a controllable morphogenetic sequence to follow makes this cell system particularly useful. It is our object over the next two years to initiate an investigation of the effects of radiation on each step in this complex developmental sequence. Eventually, we hope to explore the control of replication of the genes involved, their transcription and translation, and the ultimate formation of the quarternary structures they code for, including the oral apparatus and cleavage furrow.

SUPPORTED BY U.S. Atomic Energy Commission

5.0151, LYMPHOCYTE SIZE AND DENSITY DISTRIBUTIONS

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Accurate determinations of some of the physical properties of viable cells in suspension enables the effects of radiation in vitro and in vivo, the effects of surface active agents and the effects of hormones on these physical properties to be ascertained. We have perfected methods for rapidly determining size distributions by the Coulter aperture principle and for rapidly determining density distributions by equilibrium centrifugation in a precise linear bovine serum albumin gradient. Size distributions can be determined on individual density fractions. These methods have been and are being applied to measurements on human leukocytes, especially lymphocytes, in health and in leukemia. Radiation effects, especially at low doses (100-700 rad) are being determined in rabbit blood. They have been applied to measurements on the size and density of fetal and post natal erythrocytes in maturing mice. These measurements are part of a continuing project.

Results: One important generalization that has appeared to have emerged is that in all series of cells so far studied, the larger cells in an identifiable series are less dense than the smaller cells. Usually a smooth monotonic curve is obtained when density is plotted against size.

SUPPORTED BY U.S. Atomic Energy Commission

5.0152, BIOCHEMICAL EFFECTS OF IONIZING RADIATION ON BRAIN CELLS IN CULTURE

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Neuronal and glial cell lines have been established from brain tumors in culture. The radiation effects on glial and neuronal differentiation previously observed in vivo can now be studied under controlled physical and chemical conditions. The parameters studied include: hormonal induction of glycerolphosphate dehydrogenase and lactate dehydrogenase; synthesis and degradation of DNA, RNA, proteins and myelin lipids (total, fractions, and individual compounds). Changes on nucleic acids are being investigated using polyacrylamide gel electrophoresis and hybridization techniques.

Results: Much higher doses of ionizing radiation were required to obtain inhibition of enzyme inductions in vitro than in vivo. When glial cells were grown in the presence of the radiosensitizer, 5- bromodeoxyuridine, inhibition of protein synthesis was obtained with much lower radiation doses. Greater repair and recovery appears to take place in vitro than in vivo.

SUPPORTED BY U.S. Atomic Energy Commission

5.0153, A SURVEY OF CHEMICAL AND PHYSICAL PROPERTIES OF SOILS AT THE NEVADA TEST SITE

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The objectives of this project are to classify the soils of the Nevada Test Site and to correlate the chemical properties of specific soils with the chemical composition of their associated perennial plants. This is designed to broaden the understanding of the desert plant ecology and to provide background information for the study of radiation effects on the desert plant biome. Soil pits were dug with a back hoe at 75 locations which were selected for diversity of plant growth habit and/or species population. In each pit the soil profile was described according to the system used by USDA Soil Conservation Service and soil horizon samples were taken under a shrub clump and in bare area for laboratory analysis of physical and chemical properties. Perennial vegetation was sampled in the immediate vicinity of each pit for spectrographic analysis. Data will be centered on punch cards to facilitate analysis by computer.

Results: All of the soil profiles have been described and sampled and the spectrographic analysis of the plants has been completed. Soil samples from six of the pit sites (a total of 46 samples) have been completely analyzed for particle size distribution, water retention, soluble cations and anions, and exchangeable cations.

SUPPORTED BY U.S. Atomic Energy Commission

5.0154, FISSION PRODUCT CYCLES IN AN AGRICULTURAL SYSTEM - VALIDATION OF MODEL

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A growth chamber test was made of the effects which different levels of nitrogen fertilizer had upon uptake, distribution within tomato plants, and the concentration of Sr90 in tomato leaves, stems and roots. Soil from the dairy farm being modeled was included with other calcareous soils to obtain a range in free clacium carbonate that decreased from 33% to 0%. Soil science theory, and experimental verification, indicate that uptake of Sr90 by plants is inversely proportional to the level of exchangeable calcium in soil. Calcareous soils, by definition, have high levels of calcium minerals bathed by soil solution. Sr90 competes with dissolved cations for exchange sites in soils, is adsorbed on insoluble calcium minerals, and is concurrently absorbed by plants. No theory exists that gives quantitative predictions for the outcome of the competing probabilities under which Sr90 moves from the soil. This study provides empiric definition of the relative uptake of Sr90 by a test plant under standard conditions, and may give insight into limiting processes controlling Sr90 release from soil, used in the model of the system. The minimum outcome of the experiment is a series of numerical determinations useful in

perturbating the model, evaluating the response, then injecting the farmers fertilizer rates into the model and comparing that outcome to strontium analyses on plants from the farm system.

Results: A manuscript was prepared for publication and summarized the effects of nitrogen applications. Additional stable element analyses are in progress on the plants for calcium, stable strontium and potassium. The concentrations of Sr90 in leaves are independent of the free calcium carbonate % and of nitrogen rates. Stems and roots had higher Sr90 concentrations with increases in nitrogen fertilizer.

SUPPORTED BY U.S. Atomic Energy Commission

5.0155, NUCLIDE METABOLISM

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The objective embraces: study of the behavior of various atomic species normaly present in the human body (Ca, Na, K, Cl, Mg, Fe, etc.,), seeking correlations of abnormal behavior with disease states by using radioactive forms of these materials; study of the metabolism, tissue distribution and excretory patterns of new, radioactive agents being evaluated for clinical usage in nuclear medicine; and finally, investigation of the metabolism of various radionuclides which are either currently or potentially significant contaminants of the human environment such as Cs-137 and Sr-90).

This work is carried on by experiments with laboratory animals and by collaborative investigations with staff physicians at the Hospital of the UCLA Center for Health Sciences. Techniques include radiochemical analyses of body tissues and excreta and repetitive monitoring of radioactivity at various areas of the living animal using external detectors.

A Total Body Counter Facility is operated for detection and identification of extremely small quantities of radioactive materials in living human beings. It is used to measure the gamma radioactivity in children and adults drawn from the local population, to monitor the level of environmental contamination. It is also used in clinical research and diagnostic tests wherein materials labeled with infinitesimal amounts of radioactive tracers are administeted to patients in order to measure the absorption and retention of these materials in their bodies.

Results: Measurements of the oral absorption of iron, manganese and copper were made in patients with iron-storage disease, using traces of Fe-59, Mn-54 and Cu-67 and the Total Body Counter. No significant correlation has yet been found between the absorption and retention of manganese or copper and abnormal iron metabolism. The rates of metabolic synthesis of immune globulins IgG and IgM were shown to be 3 times normal in patients with rheumatoid arthritis, using radioactive iodine- 131 and iodine-125 as labels for these normal blood proteins.

SUPPORTED BY U.S. Atomic Energy Commission

5.0156, RADIATION CHEMISTRY OF NUCLEIC ACIDS AND RELATED COMPOUNDS

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The purpose of this work is to determine the chemical mechanisms of the initial radiation induced reactions which are responsible for the biological effects of radiation, and to develop means of modifying these reactions. Results will provide a rational basis for developing methods of protecting against radiation effects and of using radiation effects in beneficial ways such as in cancer therapy. Reactions of nucleic acids and nucleic acid constituents a) following deposition of energy directly in the organic molecules, and b) with hydrogen atoms, hydroxyl free radicals, and hydrated electrons formed by deposition of energy in water are being investigated. Techniques used include those of conventional radiation chemistry and biochemistry, pulse radiolysis, and electron paramagnetic (or spin) resonance spectroscopy (EPR).

Results: Recent work includes: 1) study of the mechanisms by which substitution of 5-bromouracil for thymine in DNA sensitizes cells to radiation, 2) investigation of rates of formation, reactivity, and structure of free radicals formed by reaction of hydroxyl free radical with pyrimidine bases and with DNA, 3) determination by EPR of the structures of free radicals formed in irradiated single crystals of nucleic acid constituents, and 4) investigation of the radiolysis of thymine in frozen aqueous solutions.

SUPPORTED BY U.S. Atomic Energy Commission

5.0157, RADIATION STUDIES ON ISOLATED CHROMOSOMES

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The objective of these studies is to determine the chemical and physical mechanisms involved in the production and repair of radiation damage in human chromosomes. In particular the connection between chromosome aberrations, the rates of production and repair of DNA strand breaks and other DNA lesions, and the kinetics of unscheduled DNA synthesis will be investigated in human normal and leukemic leukocytes. A comparison of the rates of these various processes among leukocyte populations that differ greatly in content of DNA polymerase and other enzymes together with studies on the production of radiation damage in isolated chromosomes should help elucidate the role of specific enzymes in radiation damage and its repair. In addition it is hoped that these studies will lead to better methods for detecting radiation damage in human populations and to a deeper understanding of the structure of human chromosomes.

A study of the kinetics of unscheduled DNA synthesis in human lymphocytes has permitted the characterization of the rate limiting enzymatic step in terms of activation energy, Michaelis constant, temperature maximum, number of enzymes per cell, nucleotides incorporated per rad into DNA, and lesions per cell per rad.

SUPPORTED BY U.S. Atomic Energy Commission

5.0158, RADIATION DAMAGE AND ITS REPAIR IN HUMAN CHROMOSOMES

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The objective of these continuing studies is to determine the chemical and physical mechanisms involved in the production and repair of radiation damage in human chromosomes. The studies on the kinetics of unscheduled DNA synthesis will be extended to characterize the rate limiting step induced by ultraviolet light and X-rays in human lymphocytes and granulocytes. Studies on the kinetics of strand break repair will be extended to characterize the rate limiting step in both the G sub o and S phases in human lymphocytes. By the use of fluorochromes and a flow fluorimeter measurements will be made of the DNA content, the extent of DNA-histone binding, and other properties of the nuclear chromatin within intact lymphocytes. The effects of irradiation and of PHA activation on these cytochemical properties will be studied and correlated with the studies on DNA breakage and repair, and on other phenomena of importance in the radiation biology of human lymphocytes.

Results: Two sets of experiments have been concluded; one on the temperature dependence of unscheduled DNA synthesis, the other on the kinetics of unscheduled DNA synthesis at low X-ray doses. As a result it has been possible to obtain estimates for a number of parameters characterizing the rate limiting step of the fast process; the number of enzyme molecules per cell, the activation energy, the temperature of maximum rate, the half-life of the rate controlling step, the radiation induced lesions per rad cell, the nucleotides incorporated per lesion, and the Michaelis constant.

SUPPORTED BY U.S. Atomic Energy Commission

5.0159, RADIOECOLOGY OF DESERT VEGETATION AND SOILS

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Research activities aim to a better understanding of (1) radioactive fallout damage to desert vegetation, (2) ecological relationships among plants and soils, and (3) the mineral nutri-

tional characteristics of desert shrubs and their response to the manipulation of environmental factors known to influence plant growth and development. Investigations are conducted in field and laboratory environments in order to bridge the gap between practical and theoretical problems arising from radioactive fallout contamination, and also to increase understanding of some functional and homeostatic factors involved in maintaining the integrity of vegetation in the desert ecosystem. Beta irradiation damage to vegetation from radioactive fallout has been identified and documented. We are continuing to study the recovery of vegetation and the persistence of radionuclides in fallout areas at the Nevada Test Site. Field plots have been established to investigate the response of desert vegetation to supplementary irrigation and fertilization. A marked response in vegetative growth and new seedling establishment has occurred in irrigated plots. A dimensional analysis of an association of desert shrubs in hardpan soil is underway.

Results: A survey of the mineral element composition of desert plants is in progress in conjunction with a survey of chemical and physical properties of pertinent soils in order to help evaluate the influence of edaphic factors on shrub distribution. Laboratory support work in progress includes studies of the effects of soil temperature and moisture on the phenology and growth of desert shrub species, the sensitivity of these shrubs to gamma irradiation, and their mineral nutritional characteristics and peculiarities.

SUPPORTED BY U.S. Atomic Energy Commission

5.0160, CONTINUOUS GAMMA IRRADIATION OF NATURAL POPULATIONS OF DESERT ANIMALS

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This field study examines the effects of gamma radiation on animals, with emphasis on three aspects of the problem difficult to assess in the laboratory. First, we are considering the effects of long exposure to very low (sublethal) dose rates. Second, we are examining the performance and fate of natural populations of interacting animals. Third, we are considering radiation effects within the context of the natural environment, including natural stresses and influences as well as the experimentally imposed radiation. A fenced 20-acre area in southern Nevada is exposed to free-air dose rates of about 5 R/day from a centrally located source of 33,000 Ci of Cs137. The performances of selected animal populations within this area have been followed for six years. The animals occupying three adjoining 20-acre areas have also been followed, and serve as controls. Tissue doses to animals have been measured with implanted or attached lithium fluoride microdosimeters. Annual doses to small rodents and lizards are estimated at around 300- 750 rads, with most of the exposure occurring during the spring and summer.

Results: To date, the irradiated population of the common but short-lived uta (Uta stansburiana) has continued to function in an apparently normal manner. The less common, long-lived, leopard lizard (Crotaphytus wislizenii) has not reproduced in the irradiated area since 1966, although normal reproduction has been observed in the control plots. The failure is attributed to female sterility induced by cumulative gamma doses of less than 2000 rads. The difference in response of these two species is apparently owing to their differing life-spans.

SUPPORTED BY U.S. Atomic Energy Commission

5.0161, BEHAVIOR OF CERTAIN SYNTHETIC CHELATING AGENTS IN BIOLOGICAL AND SOIL SYSTEMS

A. WALLACE, Univ. of California, School of Agriculture, *Los Angeles, California* 90024 (AT(04-3)-34)

A study is in progress of the elucidation of principles involved in the effects of synthetic chelating agents on behavior in plants of heavy metals (including micronutrients) and of radionuclides of heavy metals. The behavior of most concern is the uptake from soil and distribution in plants of some radionuclides. Past studies have indicated that certain chelating agents correct micronutrient deficiencies in plants. Some increase the uptake only of the metal with which the agent is chelated, while others have a great influence on uptake and distribution in plants of other heavy metals and also of some radionuclides which may be in the soil by contamination. Very important findings are indicated for the radionuclides Y90, Am241, and we hope that an elucidation of the principles involved will help to predict what could happen to many other radionuclides. The additions of some iron chelates to soil in high levels induces deficiencies of other micronutrients such as manganese. Progress to date of studies of this behavior is indicating that only some agents have this effect and that it is related very much to levels applied. Other chelating agents even when applied with iron increase the uptake of the very elements that the other agents cause deficiencies for.

We are studying the principles of these reactions so that eventually it will be possible to predict behavior for any agent. As part of a total study of chelating agents in soil and in biological systems, the uptake and metabolism of the agents themselves continue to be studied. Some attention is also directed towards the physiological effects of the metals themselves in plant nutrition. Interactions among metal and chelates, among different metals, and factors regulating the uptake of all are being considered.

Results: Several studies have been made and reported in the literature.

SUPPORTED BY U.S. Atomic Energy Commission

5.0162, XYLEM EXUDATE COMPOSITION AND ITS RELATIONSHIP TO SOLUTE ACCUMULATION AND TRANSPORT

A. WALLACE, Univ. of California, School of Agriculture, *Los Angeles, California* 90024

Intensive study of the root pressure - exudation phenomenon in tobacco roots has identified some areas worthy of continued study among which is diurnal periodicity. Exudation from detopped tobacco follows a marked 24-hour cycle. This cycle is almost completely obliterated by phosphorus deficiency. Irradiation with Co 60 source to give levels of gamma rays which impair various kinds of nucleic acid synthesis (50,000 R) had no apparent effect on exudation but irradiation at levels which have injurious effects on enzyme systems (500,000 R) tended to destroy first the periodicity and then exudation itself. Nitrate nitrogen in the external solution tends to cause large increases in the exudation rate and tends to destroy or mask periodicity. This occurs, however, only at moderate and low temperatures 20 degrees C and lower. At higher temperatures (25 degrees C or higher) distinct periodicity is obtained even for very high nitrate levels. At least some ATPases are reported to have a high temperature optimum and the above observations can be organized into a working hypothesis that exudation periodicity is regulated by an ATPase possibly at the tonoplast as indicated by previous studies here. Salt release from vacuoles has been shown to provide the necessary water potential for the exudation to occur. Various consequences of the working hypothesis are to be tested and include effects of ATP on exudation, of ATPase inhibitors on exudation, of phosphorus level - irradiation interactions on exudation, of phosphorus level - nitrate level interactions on root metabolism. An attempt will also be made to study ATPases. Bicarbonate and CO2 have the opposite effect that nitrate does and the ramifications of this are also being explored.

SUPPORTED BY U.S. National Science Foundation

5.0163, RADIATION EFFECTS ON FORMATION OF PROTEIN AGGREGATES

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This project is a study of the effects of ionizing radiation on the formation of protein complexes in aqueous solution, with particular emphasis on the proteins found in human and animal sera.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0164, ESR STUDIES OF FREE RADICALS IN RELATION TO BIOLOGICAL EFFECTS OF RADIATION

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5. RADIATION

The overall purpose of the present project is to study the ESR characteristics of thiyl and related free radicals, in order to achieve a better understanding of the role of mercapto containing compounds, both in radiation damage and radiation protection processes.

A system has been developed for the study of thiyl and related free radicals in solution, both in a continuous flow and in a stopped-flow mode. For the latter, solenoid valves with closing time of less than 10 milliseconds have been built, and a number of other improvements introduced to facilitate dynamic studies of short lived free radicals.

The oxidation of thiols with ceric ion, in solution, leads to a number of free radical signals, ascribable to at least 6 different species. Some of them, like the RS, have been conclusively identified, while others have been only tentatively assigned (RSO2 and RO). Three other signals defy, at this time, even tentative assignment.

At this time, the ceric ion remains the most versatile oxidizing system; attempts to use other homogeneous or heterogeneous phase one electron transfer agents have been unsuccessful. Attempts are presently underway to build a UV laser, which would be capable of generating a high concentration of free radials directly in the cavity. If this gas laser works as expected, we would be able to produce selected photochemical reactions by varying the wavelength used.

Of particular interest is the hydrogen transfer reaction observed in mercaptoethanol, which might prove to be an interesting model system for the study of radical site migrations. Perhaps the most exciting result this present year is the splitting of the ESR signal arising from the cysteinyl residue in glutathione, suggesting the possiblity of utilizing the thiyl free radical as an internal spin label.

SUPPORTED BY U.S. Atomic Energy Commission

5.0165, PROTRACTED RADIATION EFFECTS
D.C. JONES, Stanford Research Institute, *Menlo Park, California* 94025 (DAHC20-70-C-0219)

Technical Objective: To determine the effects of protracted gamma irradiation on appropriate species of large animals in terms of radiation injury, recovery, and physiological alterations, for the purpose of improving quantitative models of radiation injury and recovery extrapolatable to man.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0166, WEAPONRY--RADIATION DAMAGE BY NUCLEAR BLASTS
C.E. MENNEKEN, U.S. Navy, Postgraduate School, *Monterey, California* 93941

Technical Objective: This research concerns itself mainly with the problems and processes associated with nuclear explosions and the effect of radiation on materials. This is in direct support of studies of shielding against radiation damage to personnel and materials, particularly to semiconductor elements. Included is a study of the photochemical degradation of HMX and related explosives, as well as examination of catalysts such as palladium as required in the synthesis of new fuels and propellants.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0167, GENETICS OF RADIATION AND RADIOMIMETIC AGENTS
J. GREENBERG, Palo Alto Medical Res. Found., *Palo Alto, California*

The objective of this investigation is to discover how cells become resistant to high energy radiations and to certain chemicals resembling radiation in their biological effects. It has already been established in this and other laboratories that there are several different mechanisms responsible for resistance to radiation in bacteria. These mechanisms are under the control of at least four, and probably more different genes. It has also been established that the most sensitive cellular target of both radiation and radiomimetic chemicals is DNA.

Continuing along lines previously established, we shall map as vigorously as possible all genes responsible for radiation resistance. We shall try to establish the function of each gene, and how the different genes interact. We shall at the same time continue to elucidate how radiomimetic chemicals injure DNA and how such injury is prevented, circumvented or repaired in resistant organisms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0168, REAL-TIME SPACE AND NUCLEAR EFFECTS ON SOLAR CELLS
H.E. POLLARD, Philco Ford Corporation, *Palo Alto, California* 94303 (F33615-70-C-1207)

Technical Objective: Determine the real-time effects of space and nuclear environments on conventional and newly developed hardened solar cells.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0169, MODIFICATION OF RADIATION RESPONSE IN VITRO
G.M. HAHN, Stanford University, School of Medicine, *Palo Alto, California* 94305

In mammalian in vitro the monoalkylating agent, Methyl Methane Sulfonate (MMS) induces sublethal damage in DNA which is capable of repair by unscheduled DNA synthesis. This repair can be inhibited by concomitant treatment with hydroxyurea (HU).

Unexpectedly high survival rates have been observed when dense cultures of mammalian cells (hamster ovary) are heavily irradiated in plateau phase. The survival ten to one thousand times greater than could be predicted from conventional dose log survival curves are observed. It appears that the condition of crowding contributed to more efficient repair of sublethal damage similar to the phenomenon of 'neighbor rescue' which has been observed in bacteria. The experiments are in progress to delineate whether or not the above observation is merely another manifestation of 'deoxygen effect'. It is possible that the oxygen consumption in these dense cultures is sufficiently high to deoxygenate the medium, creating a hypoxic environment at the time of the irradiation.

Using diffusion rates of serum from culture medium into cells as a limiting factor for cell division, a model has been formulated for predicting the growth patterns of specific cell lines. Experiments are in progress in order to verify the model by studying the rate of exhaustion of serum and its relationship to the growth patterns of two cell lines, Chinese hamster ovary cells and primary cultures of embryonic rat fibroblasts.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0170, PHOTO- AND RADIOCHEMICAL REACTIONS OF NUCLEIC ACIDS
K.C. SMITH, Stanford University, School of Medicine, *Palo Alto, California* 94305

We wish to continue and extend our studies on the effects of ultraviolet light, of photosensitizing dyes plus visible light, and X-rays upon the nucleic acids in vivo and in vitro. The objectives of this research are to elucidate the nature of the chemical changes produced in the nucleic acids by these radiations (with emphasis on UV); the biochemical consequences of these lesions (e.g., effects on macromolecular synthesis, etc.), and the biochemical mechanisms and genetic control of the repair of radiation damage in bacteria (with emphasis upon the relationship between genetic recombination and the repair of radiation damage).

The following specific problems will be investigated: (1) the radiation induced cross-linking of DNA and protein; its chemical nature, its biological consequences and its possible repair. (2) the effects of radiation on the kinetics of macromolecular synthesis and growth of bacteria. (3) the biochemical mechanisms and genetic control of the repair of radiation damage in bacteria (with emphasis upon the relationship between genetic recombination and the repair of radiation damage).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0171, MOLECULAR BASIS OF RADIATION LETHALITY

K.C. SMITH, Stanford University, School of Medicine, *Palo Alto, California* 94305

Using the polymerase deficient mutant (polA1) that we have shown to be deficient in the fast repair (few minutes in buffer) of the majority of the X-ray-induced chain-breaks produced in the DNA of E. coli, we hope to measure the 'true' number of DNA single- and double-chain breaks produced by a given dose of X-irradiation under aerobic and anoxic conditions. We also plan experiments designed to elucidate the molecular bases of pol repair (fast repair) and rec repair (slow repair) of X-ray damage and for ways in which these repair systems can be inhibited.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0172, SEQUENTIAL STUDY OF ULTRASTRUCTURAL CHANGES IN EXPERIMENTAL RADIATION HEART DISEASE

L. FAJARDO, U.S. Veterans Administration, Hospital, *Palo Alto, California* 94304

It was reported that Radiation-Induced Heart Disease, as seen in humans, could be reproduced in New Zealand white rabbits.

The time-lapse study has revealed 3 SEQUENTIAL STAGES in the evolution of the disease. ACUTE STAGE (6 to 48 hours): acute inflammation of all layers of heart, which subsides. LATENT STAGE (2 to 70 days): no significant changes by light microscopy. LATE STAGE (70 days on): progressive fibrosis of myo and pericardium. The discovery of an ACUTE STAGE during the first two days supports the existence of an Acute Cardiovascular Radiation Syndrome. It may have special application in the management of nuclear accidents. The LATE STAGE is characterized by pericardial and myocardial fibrosis. The pericardial damage is associated with effusion, and 50% of animals living beyond 100 days develop congestive heart failure.

The electron microscopy of the LATENT STAGE has shown severe lesions of blood capillaries resulting in rupture and thromboses. Myo fibers show only minimal changes. These findings support our hypothesis that myocardial radiation disease is mediated through capillary injury.

Comparative radio-autography revealed at 39 days (LATENT STAGE) an increase in the incorporation of H-thymidine, exclusively by endothelial and interstitial cells.

SUPPORTED BY U.S. Veterans Administration

5.0173, THE EFFECT OF LASER ENERGY ON CELLS IN TISSUE CULTURES

D.E. ROUNDS, Pasadena Found. for Med. Res., *Pasadena, California* 91101 (DA)

Technical Objective: To determine if subthreshold levels of laser energy in the green to infrared portion of the spectrum can produce cell (chromosomal, genetic) changes which can persist through several cell generations and to suggest a mechanism of action for producing such changes. These results will indicate whether combat soldiers and other military personnel working with lasers should consider the possibility of basic changes in the cells of their tissues exposed to this energy source.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0174, DIFFERENTIAL RADIOSENSITIVITY IN GERM CELLS OF DROSOPHILA

D.R. PARKER, Univ. of California, School of Letters, *Riverside, California* 95606 (AT(04-3)-34/PA)

The objective is to characterize chromosomal rearrangements induced in primary oocytes and to determine the meiotic properties of the resultant interchange configurations, including effects on metaphase orientation, measurements of preferential segragation of heteromorphicc dyads, and effects on non-homologous pairings and on nondisjunction. The procedures involve the recovery and analysis of half-translocations, usually derived by meiotic interchange involving compound chromosomes (or in some cases supernumerary chromosomes), where the effects of the resultant aneuploidy do not preclude recovery and analysis. These are obtained by X-irradiating mature or immature oocytes of Drosophila melanogaster.

Results: Interchange induced in immature oocytes between chromosomes not involved in chiasmaconjoined bivalents results in the formation of 'quasi-bivalents' that follow the same rules of orientation as do true bivalents. Induced nondisjunction occurs in the ways predicted by this model. Interchange induced in mature oocytes seemingly does not alter already established patterns of segregation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0175, EFFECTS OF FALLOUT ON AGRICULTURAL ECOSYSTEMS

V.M. STERN, Univ. of California, Graduate School, *Riverside, California* 92502 (DAHC20-69-C-0294)

Technical Objective: To conduct a detailed study of the effects of fallout radiation on a highly concentrated agricultural ecosystem, including an analysis of the effects on various food and forager crops and their related insect pests that may be created by imbalances in crop/pest survival and when pesticide use is prevented or restricted.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0176, PULSE RADIOLYSIS STUDIES

L.P. THEARD, General Dynamics Corporation, *San Diego, California* 92112 (AT(04-3)-167,PA36)

The major goal of this research is the elucidation of indirect mechanisms by which ionizing radiation induces chemical transformations in nucleic acids, its components and related compounds, and in aminothiols and radiation sensitizing agents. The plan of the research is to study first the purines, pyrimidines, nucleosides, nucleotides, and nucleic acid in an effort to understand the radiation chemistry of these compounds sufficiently to render them useful as biomolecular models in radiation protection and sensitization studies. In other words, if the radiation chemistry of these systems is understood, effects induced by the presence of aminothiols and other agents may be interpretable in terms of mechanism. The use of the pulse radiolysis technique in this approach is particularly effective since transient free-radical processes are observable directly leading to rate constants and mechanistic details.

Results obtained thus far include the detection of free radical products of the reactions of hydroxyl radicals, hydrated electrons, and hydrogen atoms with nucleic acid and various of its constituents. In many cases the molecular site of free radical addition has been determined. Also determined are absolute reaction rate constants for many of the reactions. From the effects of pH, rate constants for protonation of anions and hydroxylion-induced dissociation of hydroxyl- radical adducts have been determined.

Rate constants for reaction of hydroxyl radicals and hydrated electrons with cysteine have been determined along with absorption spectra of some free-radical products of this protective agent. Other results on pyrimidine bases and nucleic acid containing substituted bromine have revealed details of reaction mechanisms that may pertain to radiation sensitization.

Work in progress and planned for the future includes studies of mixtures of aminothiols with nucleic acid and its constituents, and a study of hydroxyl radical reactivity with a series of aminothiols which vary systematically in molecular structure.

SUPPORTED BY U.S. Atomic Energy Commission

5.0177, X-RAY INDUCED CHANGES IN DROSOPHILA GERM CELLS

R.R. RINEHART, San Diego State University, School of Liberal Arts, *San Diego, California* 92115 (AT(04-3)-590)

Stage 7 and 14 primary oocytes of Drosophila melanogaster were irradiated and egg survival, X- and Y-chromatid in-

terchange, sex- chromosome loss, or sex-linked recessive lethality were used as measures of damage. Modifications of radiation damage included either extended anoxic treatments or exposure fractionations to demonstrate possible repair. The results to date indicate that Stage 7 oocytes repair all of these kinds of damage while Stage 14 oocytes do not.

The radioresponse of oogenic cells earlier than the Stage 7 primary oocyte is being investigated. The approach is to irradiate larvae and pupae with the different oogenic stages as their most mature cell type, allow the cells to mature to eggs, and sample only the first cells from each treated female. Fertility, viability, and number and cytological condition of the ovarioles will aid in determining the cell sample recovered. A comparison of interchange kind and frequency associated with either reversed metacentric or reversed acrocentric attached-X chromosomes may help elucidate possible meiotic configurations, as well as cell types sampled.

SUPPORTED BY U.S. Atomic Energy Commission

5.0178, BASIC STUDIES OF THE IMMUNE RESPONSE AND THE EFFECT OF RADIATION ON THIS RESPONSE

F.J. DIXON, Scripps Clinic Res. Fdn., *San Diego, California* 92037 (AT(04-3)-410)

The Effect of X-Radiation of Macrophage and Lymphocyte functions in the Immune Response - The ability of macrophages to catabolize antigens and to present them in an immunogenic form will be observed after exposure to varying doses of radiation. These two functions are thought to be quite distinct and may be affected differently by radiation. The effects of radiation on Ig bearing lymphocytes and lymphocytes without Ig will be observed in order to determine relative radiosensitivity of these two cell types. Also the radiosensitivity of specific antigen binding lymphocytes will be determined before and after exposure to antigen.

Etiologic Factors in Human Glomerulonephritis - The several isolated non-collagenous glomerular basement membrane protein antigens will be tested for reactivity against anti-GBM antibodies from 15 patients. If one or more of these antigens are particularly involved in this auto-immune response a possible means of their release 'in vivo' will be looked for. The search for virus possibly associated with the etiology of immune complex type glomerulonephritis will be continued with special emphasis on the search for E-B virus antigens in the glomeruli or antibodies in the serum.

Macrophages have been observed to catabolize the antigenic materials they phagocytose and to fix on their surface, apparently in a strongly immunogenic form, non-catabolized antigen. Approximately 50% of mouse spleen lymphocytes have surface Ig. A few % of lymphocytes from previously stimulated mice have specific receptors for the antigen employed. Six non-collagenous protein antigens have been isolated from human GBM.

SUPPORTED BY U.S. Atomic Energy Commission

5.0179, ESTIMATING THE GENETIC HAZARDS OF ENVIRONMENTAL AGENTS

J.A. HEDDLE, Univ. of California, Laboratory of Radiobiology, *San Francisco, California* 94122 (AT(11-1)-GEN)

An attempt is being made to develop a rapid and sensitive test for chromosomal breakage. The criterion is to be the micronuclei produced when chromosomal fragments are not included in the daughter nuclei at cell division. To minimize the extrapolation necessary to estimate risk, mice will be tested in vivo. Furthermore, it may be possible to use meiotic cells which are the important cells insofar as the human population is concerned.

Results: Experiments on broad bean root tips indicate an efficiency of scoring chromosomal damage that is between 10 and 100 times that achieved with metaphase scoring. A significant increase over control in micronuclei after 2.5 R was demonstrated with an hour's scoring. Micronuclei are detectable in mouse bone marrow after irradiation. The relative efficiency of scoring is currently being estimated. No effect of benzpyrene was detected using micronuclei production in bean roots and conventional metaphase scoring of human leucocytes and Chinese hamster cell cultures. This suggests that the well-known correlation between chromosomal breakage and carcinogenesis does not mean that aberrations cause cancer.

SUPPORTED BY U.S. Atomic Energy Commission

5.0180, RADIATION EFFECTS ON CAPILLARIES AND STROMAL ELEMENTS

T.L. PHILLIPS, Univ. of California, Laboratory of Radiobiology, *San Francisco, California* 94122 (AT(11-1)-GEN)

Radiation effects on capillary endothelial cells and stromal cells are being studied in mouse tissue directly by electron microscopy and indirectly by end points such as the LD sub 50/160 days for lung or kidney irradiations. The objective is to discern relationships between radiation dose, exposure pattern, and degree of injury which may be useful in development of procedures for modification of tissue tolerance.

Results: Capillary endothelium is the principal site of injury in lung, muscle and heart after doses of 2000 rads. Kidney damage reflects injury to cells of the convoluted tubules as well as capillaries. The single dose LD sub 50/160 is 1300 rads for lung and 1500 rads for kidney. This parameter for lung irradiation increases with the number of dose fractions (slope of 0.39). Time between fractions is of little importance. The single dose pulmonary LD sub 50/160 is not altered by actinomycin-D or hydroxyurea, but the multiple dose LD sub 50/160 is reduced by repeated treatment with actinomycin-D.

SUPPORTED BY U.S. Atomic Energy Commission

5.0181, ULTRA-HIGH DOSE RATE RADIOBIOLOGY

T.L. PHILLIPS, Univ. of California, Laboratory of Radiobiology, *San Francisco, California* 94122 (AT(11-1)-GEN)

The object of this project is to determine the effect of radiations delivered at dose rates above 10 to the 10th power rads per second on mammalian cells in vivo and in vitro. Alterations in biological effectiveness and in the oxygen effect are possible with these dose rates. A decrease in the oxygen effect would be of use in clinical radiation therapy. Dose response relationsips for mouse bone marrow cells and hamster B14FAF cells are determined at various oxygen concentrations with dose rates of 100 rads per minute and 10 to 10th power rads per minute on an 11 MeV electron linear accelerator. Cell response in vivo has been evaluated by exposure of the skin of mice over the thorax and over the feet to electrons at both dose rates. The lungs of mice have also been irradiated and the response evaluated by the lung LD sub 50/160 technique.

Results: Experiments indicate that 2700 rads delivered at conventional dose rates on the accelerator is equivalent to 4200 rads in a single pulse. Dose response curves for skin reaction were obtained with conventional and ultra high dose rates. There was a decrease in response with the latter at doses above 1500 rads. Similar comparison failed to disclose a difference in the pulmonary LD sub 50/160 for conventional and ultra high dose rates.

SUPPORTED BY U.S. Atomic Energy Commission

5.0182, CHROMOSOME STRUCTURE AS REVEALED BY RADIATION STUDIES

S. WOLFF, Univ. of California, Laboratory of Radiobiology, *San Francisco, California* 94122 (AT(11-1)-GEN)

Although we know that chromosomes consist of proteins and nucleic acids, we still do not know how these components are chemically or physically arranged to form the genetic material of higher organisms. Without this knowledge we cannot understand how radiation interacts with chromosomes to induce mutations, genetic damage, and cell killing. Biophysical and biochemical experiments on the types of chromosome aberrations induced by radiation at different times throughout the cell cycle and on the chemical nature of the repair processes occurring when broken chromosomes reunite can be used to elucidate chromosome structure. To ascertain the chemical species required for linear continuity, the experimental approach is to induce broken chromosomes in cells of higher plants (Vicia, Tradescantia) and animals (Poteroo, hamster, man) and then to see which specific metabolic inhibitors prevent the repair or rejoining of the broken pieces. Other aspects of chromosome structure, such as the number and arrangement of strands within chromatids, are studied by disrupting the arrangement with chemical treatments and then inducing chromosome aberrations with radiation. From the

types of aberrations formed under these circumstances, it is possible to deduce the number of strands involved in the chromosome.

Results: The rejoining of chromosome breaks in human as well as in plant cells requires protein synthesis and not DNA synthesis. Furthermore, chromosome aberration induction is independent of DNA dark repair mechanisms in both plants and animals. The studies on the types of aberrations induced at various times in the cell cycle have led to the conclusion that each chromatid must be at least a two-stranded structure.

SUPPORTED BY U.S. Atomic Energy Commission

5.0183, EFFECTS OF BETA AND GAMMA RADIATION ON DESERT VEGETATION

W.A. RHOADS, E G & G Incorporated, *Santa Barbara, California*
(AT(29-1))

The purpose of this research is to elicit the effects on desert plants attributable to beta and gamma radiation from the particles distributed following nuclear cratering detonations. The fallout pattern is determined, and the beta and gamma doses to the close-in environment are measured at numerous locations. Over the short and long term, effects of the irradiation on naturally occurring desert plants are determined. As controls, one or more non-irradiated areas with histories of gross physical shock will be studied.

The evaluation of the effects of the close-in fallout from the Schooner event was continued. The highest beta dose was 10,500 R and the highest gamma dose 950 R. Artemisia (sage brush) was killed by ionizing radiation except for selected shrubs covered by polyethylene sheets prior to fallout arrival. In the center of the fallout pattern all exposed Artemisia were killed and all plastic covered shrubs survived. For covered shrubs the beta dose was reduced 49 per cent and the gamma dose 16 per cent, sufficient to reduce the total dose below the lethal dose for Artemisia.

SUPPORTED BY U.S. Atomic Energy Commission

5.0184, AGING OF BIOLOGICAL SYSTEMS IN SPACE MISSIONS

H. SOBEL, U.S. Veterans Administration, Hospital, *Sepulveda, California* 91343

Hairless mice were exposed to U.V. light from a Burdick lamp daily for from 10-20 min. as tolerance increased. One-half of the mice were permitted a recovery period of 6 months. After removal of a uniform 'button' from the back of the skin which consisted of the injured area which rendered the greatest amount of U.V., the skins of both groups were analyzed for salt soluble, acid soluble, guanidine soluble and residue collagen, hyaluronic acid, chondroitin sulfate, elastin, fluorescence/collagen, and aldehyde/collagen. There were no consistent differences from the controls except that fluorescence/collagen and aldehyde/collagen seemed to increase in the exposed group. The buttons did not reveal significant changes either in the connective tissue components although keratin was considerably increased.

Pregnant mice at days 3,6,9,12,16, and 18 during gestation were exposed for 72 hours to 27% oxygen at atm (rel). All pregnant mice exhibited an extremely high mortality rate. Animals in the last stages of pregnancy delivered young prior to death which could not be maintained by foster mothers.

Since exposure to high oxygen tension results in the increased fluorescence of collagen and since collagen fluorescence increases with age, acid soluble collagen was exposed to high oxygen tension and the fluorescent product was studied. The activation/emission spectrum of the pronase-digested material suggested certain similarities to oxidation products to tyrosine. This is in accordance with the findings of LaBella. Accordingly several amino acids were exposed to the same conditions and it was observed that certain similarities existed between activation/emission spectrum of oxygen exposed collagen and tyrosine. At the time of my separation from the Veterans Administration we were working with acid soluble collagen which had been labeled with C14 tyrosine.

SUPPORTED BY U.S. Veterans Administration

5.0185, CELLULAR AND MOLECULAR STUDIES OF RADIATION DAMAGE AND REPAIR IN CULTURED MAMMALIAN CELLS

L.D. SKARSGARD, Mcmaster University, *Hamilton, Ontario, Canada*

It has been shown that the organic free radical triacetoneamine N- oxyl (TAN) preferentially sensitizes anoxic Chinese hamster cells to X- ray damage. A dose modifying factor (DMF) of 1.5 was obtained for a concentration of 10-2 Molar TAN compared with a DMF for oxygen of 2.8. The failure of other investigators to obtain sensitization with TAN in mice prompted a series of electron spin resonance studies on the fate of the free radical inside the cell. These measurements showed that the free radical is reduced inside the cell according to zero order kinetics and suggested that no sensitization could be expected unless the dose is delivered within 15 minutes after administration of the drug. We have also shown that synergism exists between the separate effects of the drug and radiation.

Sedimentation studies on mammalian DNA have shown that ionizing radiation damage and repair can be correlated with the molecular integrity of the DNA.

Survival curves have been measured at different stages of the cell cycle using densely ionizing radiations (LET range 20-5600 MeV-cm2/gm. G2 cells, which are sensitive at low LET, become resistant at high LET. This may indicate that some event such as duplication or condensation of the genome renders the cell more resistant to single-hit killing by high LET particles, though it does not appear to do so for lower LET radiations where damage must be accumulated.

SUPPORTED BY Canadian Government - Ottawa

5.0186, COMPARISON OF ULTRA-VIOLET AND X-RAY DAMAGE IN THE PROGENY OF IRRADIATED CELLS - STUDY OF PROTEIN AND RNA SYNTHESIS IN OEDOGONIUM

R.J. HORSLEY, Ontario Cancer Tr. & Res. Fdn., *Hamilton, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Ontario Cancer Treatment & Research Found.

5.0187, EFFECTS OF FRACTIONATED EXPOSURES OF CULTURED MAMMALIAN CELLS TO ULTRA-VIOLET RADIATION

R.J. HORSLEY, Ontario Cancer Tr. & Res. Fdn., *Hamilton, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Ontario Cancer Treatment & Research Found.

5.0188, RADIATION OF FISH DURING SYNCHRONOUS MITOSIS

W. MUIRHEAD, Ontario Cancer Tr. & Res. Fdn., *Hamilton, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Ontario Cancer Treatment & Research Found.

5.0189, FACTORS INFLUENCING THE RADIOSENSITIVITY OF ANIMAL TUMOURS

W.R. INCH, Ontario Cancer Tr. & Res. Fdn., *London, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Ontario Cancer Treatment & Research Found.

5.0190, THE EFFECTS OF LASER IRRADIATION UPON THE VERTEBRATE RETINA
J.W. MCGOWAN, Univ. of Western Ontario, *London, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Research Corporation - New York, N.Y.

5.0191, MECHANISMS INVOLVED IN THE CORRECTION OF RADIATION EFFECTS
G.H. COUSINEAU, Univ. of Montreal, Graduate School, *Montreal, Quebec, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0192, ELECTRON MICROSCOPY STUDY ON THE CELL RESPONSE OF THE CEREBELLAR CORTEX TO IONIZING RADIATION
R. DEESTABLE, Laval University, *Quebec City, Quebec, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Medical Research Council - Ottawa, Canada

5.0193, ETUDE MORPHOLOGIQUE ET CYTOCHIMIQUE ULLRASTRUCTURALE DE L'ACTION DES RADIO PROTECTEURS SUR LE TUBE DIGESTIF ET LE SYSTIME GENITAL
J.S. HUGAN, Univ. De Sherbrooke, *Sherbrooke, Quebec, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0194, STUDY OF THE COMBINED EFFECTS OF THERMAL TRAUMA AND SIMULATED FALLOUT IRRADIATION
G.M. CLARK, Univ. of Toronto, Graduate School, *Toronto, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0195, THE INITIAL PROCESSES OF RADIATION DAMAGE TO BIOLOGICALLY IMPORTANT MOLECULES
J.W. HUNT, Univ. of Toronto, *Toronto, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0196, STUDIES ON REPAIR PROCESSES OCCURRING IN HAEMATOPOIETIC TISSUE FOLLOWING TOTAL-BODY RADIATION
E.A. MCCULLOCH, Univ. of Toronto, *Toronto, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0197, REPAIR OF RADIATION DAMAGE DURING HYPOXIA BY SYNCHRONIZED MAMMALIAN CELLS
J. KRUUV, Univ. of Waterloo, *Waterloo, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0198, BEHAVIORAL RESPONSE OF MAMMALS TO IONIZING RADIATION
M.F. HALASZ, Univ. of Manitoba, *Winnipeg, Manitoba, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0199, THE EARLY EFFECTS OF RADIATION AS OBSERVED IN THE E.E.G. AND BLOOD CLOTTING MECHANISM
J.B. SUTHERLAND, Univ. of Manitoba, School of Medicine, *Winnipeg, Manitoba, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0200, EFFECTS OF WHOLE BODY GAMMA-RADIATION ON THE RESPIRATORY CHAIN OF MITOCHONDRIA AND THE ANAEROBIC GLYCOLYSIS OF NEW BORN CNS
E. EGANA, Univ. De Chile, *Santiago, Chile*

Our Institute has published elsewhere results on the respiration 'in vitro' of all CNS levels; on aerobic and anaerobic glycolysis; ATP content and synthesis and Cr-P synthesis; synthesis and content of ACh in diverse CNS levels; choline-transferase, 5-HT synthesis and content; and, H2O2 and catalase effects in CNS levels respiration. In these studies Beta-internal radiation has been used. Also on mitochondria respiration and conversion of (1-C14) -glucose into free amino acids of encephalon of adult CNS whole body gamma-irradiated.

The growing CNS is more radiosensitive than the adult one. In mitochondria of foetal, new born and impuber whole body gamma-irradiated rat (dose 5,50 and 500 R), the respiratory process will be studied with a special emphasis on the action of substrates (succinate and glutamate as donors of e), of energy sources (ATP and ADP) and carriers of electrons (NAD,FAD, Co6, Co10 and cytochromes); the RCR will be analyzed as also the ADP/O ratio, the oxidative phosphorylation and the anaerobic glycolysis. The study will commence with the new born, to be followed by the analysis of other stages of growing CNS.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0201, BIOLOGICAL TRANSDUCTION OF INFARED RADIATION BY SNAKES
M.W. LUTTGES, Univ. of Colorado, Graduate School, *Boulder, Colorado* 80302

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Research Corporation - New York, N.Y.

5.0202, RADIATION EFFECTS IN CHEMISTRY AND BIOCHEMISTRY
B.M. TOLBERT, Univ. of Colorado, School of Arts, *Boulder, Colorado* 80304 (AT(11-1))

We have proposed that radiation inactivation of solid enzymes proceeds by several chemical mechanisms. These include relatively non- specific alterations of amino acid residues constituting the active site, direct conformational structural changes that may or may not be related to a chemical change, and a few specific chemical changes, for which loss or alteration of -SS- or -SH groups is a good example. In this research we are separating irradiated egg white lysozyme into fractions by salt precipitation followed by column chromatography on Bio-Rex 70 or Bio Gel. These fractions are then analyzed by a variety of physical and chemical techniques. In the next year we propose to continue our work on the fractionation of lysozyme and the comprehensive study of the individual fractions. Analytical methods include UV spectroscopy, denaturation sensitivity, ammonia, -SS-, aldehyde

and -SH group assays, assays for specific amino acid residues, enzymic activity and molecular weight by ultracentrifuge or sodium dodecyl sulfate polyacrylamide gel electrophoresis. In our studies we have been able to relate some of the protein changes to specific chemical changes and to obtain data to confirm some of the mechanisms proposed above.

SUPPORTED BY U.S. Atomic Energy Commission

5.0203, EFFECTS OF RADIATION FROM NUCLEAR EXPLOSIONS ON NATURAL VEGETATION
M.L. CANNON, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: Nevada.

Since 1962, periodic examinations have been made at regular distances from 24 nuclear shot points, of both contained and vented explosions and also from 40 dynamite shots, all of which have been detonated at different depths and with different charges, in order to learn what effects on vegetation should reasonably be expected from various types of nuclear detonations. Little effect on the growth of plants can be observed in the vicinity of contained shots unless there is a gradual escape of gas along fractures. Vented explosions cause widespread radiation damage to the flora over a period of at least 9 years. Deciduous shrubs and trees commonly enter a resting period from which they gradually emerge - time dependent on distance from shot. Conifers gradually die at ever increasing distances with time. These conclusions have been documented by photographs, autoradiographs, analyses, and wood sections.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

5.0204, AMCHITKA GEOLOGIC INVESTIGATIONS
L.M. GARD, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

States to which project pertains: Alaska.

The overall objective of this project is to determine the suitability of Amchitka and Rat Islands, Alaska as a supplemental test site for underground nuclear testing.

Specifically this project: 1. Is determining the stratigraphy and structure of the islands. 2. Is determining the tectonic framework of the island relative to island arc structure. 3. Has determined the physical, hydrologic, and geothermal properties of the rocks at depths to 7,000 feet to provide safe sites relative to construction, containment, contamination, and ground motion for underground tests. 4. Has evaluated the effects of an underground nuclear explosion of about 1 megaton on the geologic and hydrologic environment in order to predict effects of future explosions. 5. Has synthesized available data to develop a plausible tectonic model for the western Aleutian arc.

Objectives for the future are: 1. To continue to refine geologic mapping. 2. To continue studies of the tectonic framework of the Aleutian arc to aid in the investigations of aftershocks and seismic phenomena. 3. To evaluate geologic and hydrologic effects of future underground nuclear explosions.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

5.0205, ABILITY OF ISOLATED KUPFFER CELLS TO POPULATE EXPERIMENTAL GRANULOMAS AND IRRADIATED BONE MARROW
D.M. MILLS, U.S. Veterans Administration, Hospital, *Denver, Colorado* 80210

Hypothesis: Since isolated Kupffer cells resemble blood monocytes morphologically, they may be able to function in experimental situations which require mononuclear macrophages. A. Ability of Kupffer cells to populate granulomas: Foreign body carrageenin and tuberculin granulomas were produced in inbred rats. Donor animals received carbon particles I.V. to label Kupffer cells. The livers of these animals were disaggregated and injected I.V. into animals, with developing granulomas on day 2,4 and 5. On day eight 1 to 3% of the granuloma macrophages contained carbon, verified by electron microscopy. Other animals were then given 700r of total body irradiation 3 days before granuloma induction. Kupffer cells were given as before. The granulomas, although smaller, contained no carbon labelled macrophages. The carbon- containing macrophages in the first granulomas were of bone marrow origin, a result of reutilized carbon label. Carbon I.V. gave the same results. B. Ability of Kupffer cells to protect from radiation death: The median survival after 950r total body radiation is 6 days; Kupffer cells I.V. lengthened this to 9 days. Irradiation with the exteriorized liver shielded gave a median 6 days survival; with sham operation the survival was 6 days. C. Ability of Kupffer cells to repopulate bone marrow after radiation: Adult rats received 4000r to the left tibia. After 100 days the marrow space was reamed out and a suspension of homologous cells replaced. Isolated Kupffer cells, pieces of skeletal muscle, pieces of liver did not restore the marrow. A suspension of isologous bone marrow did lead to normal marrow.

Project continues.

SUPPORTED BY U.S. Veterans Administration

5.0206, BLOOD FORMATION IN THE EMBRYO (NEWBORN) OPOSSUM
M.H. BLOCK, Univ. of Colorado, School of Medicine, *Denver, Colorado* 80220

This animal, born at a 12-day gestation, has reached a stage of development corresponding to an 11-day mouse or 8-week human embryo. The thymus is an epithelial sheet, lymph nodes have not formed, hematopoiesis has begun in the liver and the animal is immunologically imcompetent. Utilizing these characteristics the following are now under investigation: 1) The effect of radiation on the spleen with special reference to feed-in from the stem cell compartment, and upon onset of lymphopoiesis. 2) The inflammatory response prior to formation of lymphocytes, when lymphocytes are formed only in the thymus and when lymphocytes are derived from extrathymic sources. 3) Maturation times of red cells, granulocyte precursors and of megakaryocytes. 4) Effect of erythropoietin on 'embryonic' hematopoiesis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0207, THE CYTOGENETICS OF URANIUM MINERS EXPOSED TO RADON 222
W.F. BRANDOM, Univ. of Denver, School of Arts, *Denver, Colorado* 80210

Uranium miners represent a sizable population of workers occupationally exposed to radiation hazards. The potential and real hazards have been documented by mine radiation dosimetry, lung inhalation studies, epidemiology, bioassay and sputum cell cytology studies. The studies provide data on the amount of Radon 222 in the mines, estimated cumulative radiation exposure to miners, the increased incidence of lung cancer, increased concentration of 210 Pb and Po 210 in the blood, and the relationship between sputum cell cytology and lung cancer. In view of these studies and the recognized association between radiation and chromosome aberrations, it is surprising that no comprehensive cytogenetic study has been done on these men.

The objective of the proposed study is to employ chromosome aberrations as a biological indicator of radiation effects in uranium miners. Peripheral blood leukocytes will be cultured by established methods and chromosome preparations analyzed for aneuploidy, chromatid gaps and breaks, dicentrics, tricentrics, rings, fragments, deletions, translocations and deviations in monocentrics from the Denver system of classification. Appropriate controls will be included in blind-study evaluations. The chromosome findings will be compared with sputum cell cytology and estimated cumulative radiation exposure categories of miners. The chromosome findings should be useful to the clinician for prognostic purposes and for the ascertainment of somatic cell changes in lymphocytes caused by Radon 222 inhalation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0208, CELLULAR RESPONSES TO IRRADIATION
W.C. DEWEY, Colorado State University, School of Veterinary Medicine, *Fort Collins, Colorado* 80521

Sublethal and potentially lethal repair of X-ray damage, as measured by cell lethality and chromosomal aberrations in

synchronized Chinese Hamster cells, appear to be closely related. Further studies are planned to confirm and extend these relationships. Also, agents which sensitize the cells irradiated in various phases of the cell cycle are being studied in terms of effects on repair.

The immediate effects of X-rays measured by delay in progression of cells through the cycle is being investigated in terms of variations in sensitivity during the cycle and the particular periods in the cycle during which the cells are blocked. This delay phenomenon will be studied in relation to any disruption in normal ultrastructural changes which are being determined during the cell cycle and to the synthesis of particular types of RNA and protein.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0209, REPAIR OF RADIATION DAMAGE TO CELLULAR DNA

J.T. LETT, Colorado State University, School of Veterinary Medicine, *Fort Collins, Colorado* 80521

A definitive goal of the radiation biologist in the last three decades has been the detection of radiation damage in cellular macromolecules at doses in the biological range. During the course of the current investigation of the ability of cells to repair X-ray induced strand breaks in their DNA at different stages of the cell cycle a sucrose gradient sedimentation technique has been developed which will permit analysis of the damage induced in mammalian DNA at biological doses. With this method it is proposed to investigate: 1)The relationship between DNA strand breaks and surviving fraction at different stages of the cell cycle. 2) The capacity of different chromosome groups (by size) to rejoin DNA strand breaks. 3) The final expression of chromosomal damage at the level of DNA as chromosome aberrations. 4) The multicomponent DNA structure of the chromosome.

This will represent a logical extension of the present phase of the study with Chinese Hamster Ovary Cells.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0210, EFFECTS OF IRRADIATION ON THE IMMATURE MOUSE

D.J. NASH, Colorado State University, School of Natural Sciences, *Fort Collins, Colorado* 80521

The objectives of the proposed work are to assess the importance of age as a factor governing sensitivity to ionizing radiations. The project is concerned primarily with studying those effects aris..., from radiation administered during the period between birth and sexual maturity. The house mouse will serve as the experimental organism, and special use will be made of different inbred strains and selected marker genes in order to gain understanding of the interaction of genotype with age in conditioning the response to radiation. Both acute and long-term effects of irradiation are being studied. Determination of the LD50/30 values are being made for each of the ages. Recovery rate at each of several ages is being measured through the use of the 'split-dose' technique. Long-term effects of acute irradiation will be studied in the survivors of the LD50/30 studies. Effort is being made to ascertain the pathological changes and causes of death in the long-term survivors of mice that have been irradiated at 0, 2, 4, or 6 weeks of age. Special emphasis is being diRected in studying the changes in the hematopoietic system associated with natural and radiation-induced aging.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0211, RADIOECOLOGY OF SOME NATURAL ORGANISMS AND SYSTEMS IN COLORADO

F.W. WHICKER, Colorado State University, School of Veterinary Medicine, *Fort Collins, Colorado* 80521 (AT(11-1)-1156)

Objectives are to study the behavior of certain radionuclides in, and the effects of radiation on, selected organisms and natural ecosystems in north-central Colorado. This research will provide information useful to the safe development of nuclear energy projects and to the study of natural ecosystems and pollution problems. Currently strontium and calcium metabolism is being investigated in captive mule deer (Odocoileus hemionus) by dosing the animals with Sr85, Sr90, and Ca45 and making subsequent whole body counts. The effects of radiation on pikas (Ochotona princeps) are being investigated in captive colonies in which the degree of social competition can be varied. An 8,750 curie Cs137 source is being used to irradiate (both chronically and semi-acutely) a natural grassland community. The structure of the plant community and the distribution of arthropods are under intensive investigation within the radiation field. The kinetic behavior of cesium in a montane, semi-drainage lake is being investigated through techniques of systems analysis in both laboratory and field studies.

Results: Within the past year, significant progress was made on each subproject. Some items of particular interest are (1) Social competition among pikas appears to significantly increase their response to radiation; (2) The short grass plains plant community appears more resistant to ionizing radiation than previously studied community types, and (3) Certain types of mountain lakes appear to recycle cesium from the sediment which causes prolonged higher levels of the nuclide in the biota.

SUPPORTED BY U.S. Atomic Energy Commission

5.0212, EXPERIMENTAL EMBRYOGENESIS AND HISTOGENESIS IN PINUS LAMBERTIANA

G.P. BERLYN, Yale University, Graduate School, *New Haven, Connecticut* 06520 (AT(30-1)-3444)

Objectives--1. Quantitative cytochemical investigations of radiation effects on nucleic acids, proteins and lignification in relation to senescence and cellular death. 2. Investigation of the radiosensitivity of the transport system of Pinus lambertiana Dougl.

Reason--The proposed studies are designed to integrate the molecular and biochemical levels with the cell and tissue level of organization in a quantitative way and to elucidate some of the effects of radiation as revealed at this dimension.

Procedures--The investigations involve the use of autoradiography, tissue culture, interference microscopy, polarizing microscopy, microspectrophotometry, paper & thin-layer chromatography, electrophoresis, spectrophotometry and electron microscopy.

Test Objectives--Embryo explants, tissue slices, callus cultures, and seedlings of Pinus lambertiana grown in culture on chemically defined media.

Results: 1. In a programmed series of radiations it was demonstrated that radiosensitivity was positively correlated with frequency and distribution of cell division. 2. In embryos cultured from seeds that had been irradiated at 10,000 R the cotyledons showed no radiation damage, the hypocotyls showed slight damage, and the roots showed major effects. 3. Free space with S2 layer of tracheid cells was microspectrophotometrically determined to be about 25%. 4. Polar auxin transport and interaction with sucrose was examined during the course of root regeneration in vitro.

SUPPORTED BY U.S. Atomic Energy Commission

5.0213, STUDIES ON THE EFFECTS OF RADIATIONS ON DNA

F. HUTCHINSON, Yale University, School of Medicine, *New Haven, Connecticut* 06510 (AT(30-1)-2653)

The work on this contract studies various lesions produced in DNA by the action of radiations. The dual purpose is to understand the effects of radiations on cells, and to be able to use the lesions formed to learn more about cell biology. The lesion formed by the action of ultraviolet light on DNA containing the base analog bromouracil is being characterized, and at the moment looks as though it will be possible to describe it completely. Specific properties of this lesion are being exploited to be able to photostain selectively DNA containing bromouracil. This property will be used to follow with the electron microscope the process of genetic recombination in bacterial transformation. In a separate line of work the production of double- strand breaks by gamma rays in bacterial DNA is being studied directly. A method has been evolved of extracting very large DNA from cells, and the

breaks are determined by noting the decrease in sedimentation in the ultracentrifuge with increasing radiation dose.

SUPPORTED BY U.S. Atomic Energy Commission

5.0214, CATECHOLAMINE METABOLISM FOLLOWING X-IRRADIATION OF MAMMALS
M.H. VANWOERT, Yale University, School of Medicine, *New Haven, Connecticut* 06510 (AT(30-1))

Total-body X-irradiation is a stress-inducing agent which activates the sympathetic nervous system and produces changes in tissue and urinary levels of catecholamines. The changes in catecholamine metabolism may be important in the physiological response necessary to the survival and recovery from whole-body X-irradiation.

The purpose of this project is to determine the effect of total-body irradiation on the synthesis, release, storage and metabolism of catecholamines after total body irradiation in man and rats. Specific and sensitive techniques will be applied for (a) the assay of endogenous and administered radioactive catecholamines, (b) the determination of pertinent synthetic and degradative enzymes and, (c) the evaluation of pharmacologic agents that influence amine metabolism. These studies should help define some of the mechanisms by which irradiation affects th sympathetic nervous system. This may result in an improved understanding of several features of the acute radiation syndrome, eg. cardiovascular collapse and the neurologic manifestations. Special emphasis will be placed on relating any changes in catecholamine metabolism to the natural radioprotective action of biogenic amines.

Results: Male albino rats were X-irradiated with 1800R and catecholamine content, tyrosine hydroxylase and dopa decarboxylase were determined in the brain and adrenal gland. In the adrenals the epinephrine and norepinephrine decreased simultaneously with a two-fold increase in tyrosine hydroxylase and a 2 1/2 fold increase in dopa decarboxylase activities. There was no change in brain norepinephrine or tyrosine hydroxylase activity. Between 72 and 84 hours after irradiation the brain dopa decarboxylase decreased to 67 percent of control.

The radioprotective action of dopamine in total-body irradiated rats was also investigated. Dopamine (60mg/kg) produced a 50 percent survival time in 30 days; no irradiated controls survived.

SUPPORTED BY U.S. Atomic Energy Commission

5.0215, SPECIFICITY AND INFORMATION TRANSFER IN SENSITIVITY
B.H. WAKSMAN, Yale University, School of Medicine, *New Haven, Connecticut* 06510

Thymus lymphocytes from normal inbred rats or lethally irradiated rats restored with syngeneic or hemiallogeneic bone marrow, will be fractionated on the basis of size and density. In each subpopulation thus obtained, endo and exonucleases will be measured, the cell membrane content of histocompatibility and thymus-specific antigens will be estimated (by immunofluorescence and blast-transformation techniques), and the presence of immunoglobulin will be sought.

In thymectomized irradiated rats, restored with grafts of hemiallogeneic thymus and syngeneic bone marrow (or vice versa), the role of thymus-derived cells in triggering delayed skin reactions will be evaluated (by immunofluorescent identification of cells coming from the thymus graft). In animals stimulated to form antibody of different immunoglobulin classes, a similar identification of thymus-derived vs. marrow-derived cells making antibody will be attempted. Finally in experiments on adoptive transfer of tolerance, the use of similar rats as donors will permit identification of the relative roles of thymus- derived and marrow-derived cells in the induction and/or maintenance of tolerance.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0216, NAVY ENVIRONMENT - NONTHERMAL HAZARDS OF EXPOSURE TO RADIOFREQUENCY AND MICROWAVE FIELDS
G.H. MICKEY, New England Inst. Med. Res., *Ridgefield, Connecticut* 06877 (N00014-69-C-0176)

Technical Objective: This investigation will ascertain whether physiological/genetic damages to Naval personnel can be caused by microwaves emitted by shipboard radar devices.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0217, TO STUDY BIOLOGICAL HAZARDS OF RADIO FREQUENCY RADIATION
G.H. MICKEY, New England Inst. Med. Res., *Ridgefield, Connecticut* 06877

No summary has been provided to the Science Information Exchange.

SUPPORTED BY John A. Hartford Found. Inc. - New York

5.0218, THE APPLICATION OF NUCLEAR ENERGY TO AGRICULTURE - RADIOSENSITIVITY OF TROPICAL PLANT SPECIES
C.C. MOH, Inter Amer. Inst. of Agr. Sc., *Turrialba, Costa Rica* (AT(30-1)-2043)

This is a continuous study of radiosensitivity of plant species in the American tropics. The objective is to find out the range of radiosensitivity in the plant families which will provide information for predicting the effect of radioactive fallout on plants in the tropical areas. Plants or seedlings are grown radially from the Cesium- 137 source in the gamma field at Turrialba, Costa Rica, and exposed to a range of daily radiation dose up to 540 r. The criteria for determining the plant sensitivity are: (1) for the asexually propagated species, the maximum daily dose at which the plants can survive for a lengthy period; and (2) for the sexually propagated species, the maximum dose at which the plants can produce seed to complete their life cycle. These criteria would give information on the critical dose level at which a plant species could maintain its continuity in a plant community in case of radioactive fallout.

Results: We have completed the study of several species of gymnosperm (pine, sequoia, cypress, cycad and zamia). In general, the gymnosperms are a very radiosemitive group of plants. For the species in the present study, none could survive at a daily dose of greater than 30 r after more than a year of exposure. This year, the sensitivity of 'Leguminosae' is being investigated. More than 20 species of legumes with diversified botanical characters are being tested in the gamma field.

Part 1 of 10.

SUPPORTED BY U.S. Atomic Energy Commission

5.0219, THE APPLICATION OF NUCLEAR ENERGY TO AGRICULTURE: THE MINERALIZATION OF ORGANIC NITROGEN IN SOILS FROM VOLCANIC MATERIAL
C.C. MOH, Inter Amer. Inst. of Agr. Sc., *Turrialba, Costa Rica* (AT(30-1)-2043)

The organic nitrogen mineralization study was concluded. The methods used, Bremner's incubation technique and Jackson's delta value permitted an adequate characterization of the soils studied, which belong to the recent volcanic, lateritic and alluvial groups.

Results: It was observed that soils with over 15% 'crude' allophane present generally a very slow nitrogen mineralization. All but one of the recent volcanic soils belong in this group. Liming reduces mineralization rate while alternate drying and wetting enhances it. The application of organic matter had no clear effect. It is concluded, that total N content can not be used to estimate the N supply in recent volcanic soils.

Part 4 of 10.

SUPPORTED BY U.S. Atomic Energy Commission

5.0220, EFFECT OF RADIATION ON PROTEO-HORMONES ACTIVITY
L. MIKULAJ, Slovak Akademie Ved, *Bratislava, Czechoslovakia*

As is known, hormonal preparations, when used parenterally in medicine for diagnosis or therapy, must satisfy certain requirements as regards sterility. Sterilization by current methods is not always possible because of the change of hormone properties. It is presumed that the use of ionizing radiation for sterilization of hormonal preparations will simplify the working process.

5. RADIATION

The research programme of the Institute of Exper. Endocrinology in Bratislava includes studies on the regulation of endocrine glands function during the processes of adaptation and ontogenesis in experimental animals, of the effect of pituitary trophic hormones on metabolism and hormones biosynthesis in target glands. The role of pituitary hormones and mechanism of their biological action in adaptation to stress is analysed. In these studies the methods for determination of biological activity and bioassay for pituitary hormones, the chromatography, radiochromatography, radioelectrophoresis and radio-immunoassay are employed. All these analytical methods are generally applicable to the study of the effect of radiation on biological and chemical changes of protein hormones. Also included in the work plan for the first year are the following hormones, ACTH, TSH, and STH, which have been selected for the study of the effect of radiation. Their biological and physico-chemical properties will be studied. Electrophoretic and chromatographic purity will be examined too. It is planned to evaluate the co-relation between the changes in biological activity, if these occurred under the action of radiation, and the amount of radiation dose, by the use of statistical-analytical methods.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0221, IDENTIFICATION OF THE RADIOSENSITIVE STAGES DURING THE DIFFERENTIATION OF THE IMMUNOCOMPETENT CELL

J. STERZL, Ceskoslovenska Akademie Ved., *Prague, Czechoslovakia*

The program of the research work is: (a) to irradiate germ-free piglets at various levels to establish the LD/50 and LD/100, (b) to transfer immunocompetent cells to lethally X-irradiated homologous recipients; (c) to determine antibody formation by lymphocytes in culture and by serological techniques; and (d) to study the differentiation of IgM and IgG antibodies at the cellular level and also to determine the differentiation of IgG in situ.

The work will be carried out with the use of sterile piglets, kept on non-antigenic diet, which contain the cells, not yet stimulated by an antigen (immunocompetent X ce'ls). Radioresistance of those animals will be studied before administration of antigen, both in vivo and in isolated cells irradiated in vitro. A similar method will be used for studies of radiosensitivity after a stimulation by antigen, i.e. in the active proliferative phase and in a phase, when the proliferating cells remain prepared for a secondary response as memory cells. Further experiments will follow the effect of irradiation in different time sequences after administration of antigen and the effect of X- irradiation on the ratio of 19S and 7S forming cells (IgM-IgG).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0222, STUDY OF INTERNAL CONTAMINATION WITH STRONTIUM-90 AND RADIUM-226 IN MAN IN RELATION TO CLINICAL FINDINGS

V. KLENER, Inst. of Radiation Hygiene, *Prague, Czechoslovakia*

The study is based on long-term observation of 65 persons with internal Ra-226 and Sr-90 contamination, carried out in cooperation with IAEA in Vienna (Research Contract No 107/RB).

Data on the course of Sr-90 retention in the studied group of persons obtained in the period of 920 to 2600 days after exposure shall be supplemented by whole-body counting of Sr-90 and Ra-226 activity and by determination of SR-90 excretion in urine.

The caryologic studies of selected persons will continue. According to the principles of evaluation stated in UNSCEAR 19 the results of the previous examinations during the period of 1962 till 1968 shall be again critically evaluated for detection of aberrations mainly of the stable type (of symmetrical exchanges). Semiautomatic evaluation of the chromosomal picture is being considered.

Contrary to the expected single case of cancer, studies of the previous period ascertained six malignancies of different localisation. The study under preparation will again pay attention to the incidence of malignant tumors. Questionnaires shall be distributed to all persons of the group. The information thus obtained shall help to get special reports from the respective medical establishments. This material shall serve as data for studies of possible changes in the health state of the studied persons especially in respect of follow up of frequency, localisation and histogenetic classification of malignant tumors. On basis of the thus obtained data further examinations shall be proposed in individual cases.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0223, PRIMARY PROCESSES IN RADIATION CHEMISTRY OF LIQUIDS AND INTERACTION OF RADIATION WITH BIOLOGICALLY IMPORTANT CHEMICAL SYSTEMS

C.N. TRUMBORE, Univ. of Delaware, Graduate School, *Newark, Delaware* 19711 (AT(30-1)-3383)

Continued studies are proposed on the role of excited electronic states present in irradiated aqueous systems of biological interest. The role of the structure of water itself in the transmission of radiation damage is to be paid particular attention. Correlations between aqueous photochemistry and radiation chemistry are to be sought. Pulse radiolysis and flash photolysis studies of aqueous p- nitrosodimethylaniline are to be continued in an effort to explain the many 'non-classical' anomalies found in the system. Computer calculations are to be continued in an attempt to find a reasonable mechanistic model for a very fast electron decay previously found in nanosecond aqueous pulse radiolysis. Preliminary studies are also proposed in radiation energy transfer in membranes. Fundamental chemical studies are also proposed to seek molecular explanations for the wide variation in radiation sensitivity found for various species of blue green algae.

SUPPORTED BY U.S. Atomic Energy Commission

5.0224, THE ROLE OF STRUCTURE AND ENERGY (OR IONIZATION) TRANSFER IN RADIATION CHEMISTRY AND BIOLOGY

C.N. TRUMBORE, Univ. of Delaware, School of Arts, *Newark, Delaware* 19711 (AT(30-1)-3383)

Purpose: To study the primary physical and chemical processes responsible for the interaction of ionizing radiation with living matter. To study both living systems, such as the blue-green algae, and model systems such as aqueous enzyme-polynucleotide complexes by using analytical techniques of modern biochemistry and physical chemistry. In studies on living systems to observe biochemical differences between cellular fractions from radiation-resistant and radiation-sensitive species as well as to observe differences as a function of added chemical protective agents. To utilize in studies of both living and model systems the fastest possible techniques of flash photolysis and pulse radiolysis in determining the sequence of physical and chemical events following absorption of ionizing or near-ionizing radiation. Finally, to more clearly identify the chemical nature and biochemical consequences of the OH radical in radiation studies.

SUPPORTED BY U.S. Atomic Energy Commission

5.0225, VIRUS INDUCED MUTATION AND IRRADIATION

R.C. BAUMILLER, Georgetown University, School of Medicine, *Washington, District of Columbia* 20007 (AT(30-1)-3905)

Objective and Background: The elucidation of the effects of virus on the genetic material is the broad objective of this project. Specifically the objective is to study the changes in radiation induced mutation in the presence of a given virus and its absence. Radiation and new virus is implicated in point mutation, radiation and now virus is implicated in nondisjunction. Radiation and virus are factors in carcinogenesis. Since both factors have a somewhat similar effect, it is reasonable to believe that their combined effect might be greater than additive. The effect of different viruses in different populations may account for epidemiological variation in types of cancer and even in frequency of chromosome abnormalities. The genetic hazards of radiation may be correlated with the viral background present. Procedure: Drosophila melanogaster, infected with sigma virus and 'isogenic' sigma virus free lines is the basic test material. Various types of infection (stable and unstable) and genetic backgrounds are available. Basic

techniques for studying mutation frequency are widely known in this organism. Virus induced x chromosome recessive lethals are found in both the male and female germ line. These mutants are primarily at the distal end of the chromosome (0.0-25 map units). The rate of nondisjunction in the female germ line, as evidenced by the presence of matroclinus females, is significantly higher in virus containing line than in an 'isogenic' virus free line. Results of experiments utilizing X-rays and virus presence are consistent with the hypothesis that their combined effect is greater than additive for point mutants, nondisjunction and sterility.

SUPPORTED BY U.S. Atomic Energy Commission

5.0226, IRRADIATION AND TISSUE-LOCALIZING RESPONSE

R.L. KAHN, Howard University, School of Medicine, *Washington, District of Columbia* 20001

It is a paradox that the very mechanism of the extraordinary local healing effect of radiation therapy in cancer may contain the seed of ultimate morbidity. This possibility is based on our observation that X-irradiation has an antilocalizing or spreading effect on tissue- injected substances. Bacteria, protein or toxin injected in the normal skin of rabbits become localized to a given degree, but if injected in an irradiated area of the skin, they escape from the injected area and reach the blood stream. Might this antilocalizing effect of irradiation permit in certain instances the escape of cancer cells from a cancer- irradiated area and lead to metastasis? Locally, the healing of the irradiated area both in cancer and in infection is so outstanding that physicians speak of irradiation as being anti-inflammatory. Indications are that the reason for the local anti-inflammatory action is that the irradiation exerts an antilocalizing effect. Antilocalization: 1) Permits the spread of injurious substances (bacteria or toxin) from the irradiated area before they can produce local injury, 2) causes a breakthrough of fresh blood supply to the area and 3) enables dead cells and debris to be carried off from the area. Each of these aspects is of an anti-inflammatory nature. To prevent the escape of cancer cells following radiation therapy of cancer is the basic aim of this research project herein proposed. The plan is to investigate the mechanism of antilocalization following irradiation. This plan would embrace also studies of the mechanism of tissue localization in immunity in the absence of irradiation. It is proposed also to combine irradiation of cancer in animals with anticancer drugs as a means to prevent metastasis and to study this problem in conjunction with attempts to combine irradiation of infection in animals with the use of antibiotics.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0227, LATE EFFECTS OF RADIATION ON THE POPULATIONS OF HIROSHIMA AND NAGASAKI - BASIC RADIATION ESTIMATES

UNKNOWN, Natl. Academy of Sciences, *Washington, District of Columbia* 20037 (AT-30-1-72)

This component of the unified program comprises investigation of basic doses of radiation from atomic bombs received by the populations of Hiroshima and Nagasaki, as well as radiation received from diagnostic and therapeutic X-ray procedures or other possible contaminants.

The calculation of radiation dose received by persons exposed to the bombs requires determination of air dose curves, distance from the burst and attenuation factors of shielding materials. In collaboration with the Health Physics Division of the Oak Ridge National Laboratory studies are being made concerning a revised air dose curve (T65D) and new T65D transmission calculation methods while shielding studies describe the shielding environment of persons who were within houses of typical Japanese construction.

Calculation of possible contaminant radiation dosages received outside ABCC comprises several phases, the first being the interrogation of persons in the study population to determine where and how frequently they received medical X-ray. The second phase concerns verification of exposures reported by the subjects and a determination of the technical factors in such exposures. The third phase is determination of individual subject doses received and to evaluate the contribution of this dose to the overall radiation exposure.

SUPPORTED BY U.S. Atomic Energy Commission

5.0228, LATE EFFECTS OF RADIATION ON THE POPULATIONS OF HIROSHIMA AND NAGASAKI - POPULATION STUDIES

UNKNOWN, Natl. Academy of Sciences, *Washington, District of Columbia* 20037 (AT-30-1-72)

This component of the unified program is intended to provide socio- economic and other background material for use in analysis of data. One phase of the program is an epidemiological survey of the Adult Health Study sample to develop a reservoir of environmental data on this selected population. Although the radiation groups are matched for age and sex there are other known differences so that analysis of the morbidity and mortality data will require epidemiological evaluations. This study is therefore designed to compile information concerning residential history, military service, occupational and marital history, smoking and drinking, dietary habits, socio-economic status, religion and education.

A second study is an epidemiologic field study of leukemia in both cities in an attempt to determine if a relationship exists between various types and incidence of the disease and environmental factors such as exposure to X-ray at various stages of growth, various genetic factors such as blood type and ear-wax type or other factors not associated with radiation. A case history probe and study of selected cases from the ABCC leukemia register is the general method of approach.

SUPPORTED BY U.S. Atomic Energy Commission

5.0229, LATE EFFECTS OF RADIATION ON THE POPULATIONS OF HIROSHIMA AND NAGASAKI - GROWTH AND DEVELOPMENT STUDIES

UNKNOWN, Natl. Academy of Sciences, *Washington, District of Columbia* 20037 (AT-30-1-72)

This component of the unified program comprises two main areas. The first is related to experimental evidence that radiation accelerates aging. The following indices are being tested in relation to aging and radiation exposure: a one hour glucose challenge; measurement of the Achilles tendon reflex by Burdick Photomotograph; an investigation of the soluble to insoluble collagen ratio in skin from autopsies and a morphologic evaluation of aging using such indices as amount of lipofuscin in the heart, size of hepatic nuclear, number of PAS-positive spleen cells and other age-related tests.

The second area of study concerns determination of possible differences in growth and development in two distinct groups of children included in other current study samples. These subjects comprise (a) all persons in the Adult Health Study who were age 0 to 10 years at the time of bombing plus (b) all children of the 'in utero' exposed matched sample. Former studies of growth and development have led to uncertain conclusions, in part because of inadequate evaluation of the influence of socio-economic differences and loss of family, therefore data on this factor is being obtained and considered in the analysis together with radiation dose, age at time of exposure and sex.

SUPPORTED BY U.S. Atomic Energy Commission

5.0230, LATE EFFECTS OF RADIATION ON THE POPULATIONS OF HIROSHIMA AND NAGASAKI - MORTALITY STUDIES

UNKNOWN, Natl. Academy of Sciences, *Washington, District of Columbia* 20037 (AT-30-1-72)

This component of the unified program comprises statistical and pathologic investigations of the study population to determine the effects of exposure on life span and to provide through post-mortem examination the identification and evaluation of cause of death. Current statistical studies are: the Life Span Study (ST-100) to determine whether those of the approximately 100,000 persons who were residing in Hiroshima and Nagasaki at the time of the 1950 Japanese National Census who escaped death from acute effects of the bombs continue to live as long as the non-exposed and whether shortening of the life span, if any, is a function of radiation dose; study of children born to survivors comparing mortality rate of children of heavily exposed parents

and suitable controls, study of mortality in children exposed in utero and a study of mortality and socio-demographic characteristics of survivors.

The pathology studies deal with precise diagnosis of disease evident in medical studies, the incidence of various disease processes and with cytologic and histologic changes attributable to radiation. The population sample is the ST-100 sample described above. Post-mortem examinations are performed on as many of the deceased members of the sample as are offered by the families. At present there are approximately 1,000 deaths in the ST-100 sample each year and of these 40% - 50% are autopsied at ABCC.

SUPPORTED BY U.S. Atomic Energy Commission

5.0231, LATE EFFECTS OF RADIATION ON THE POPULATIONS OF HIROSHIMA AND NAGASAKI - MORBIDITY STUDIES

UNKNOWN, Natl. Academy of Sciences, *Washington, District of Columbia* 20037 (AT-30-1-72)

This component of the unified program is concerned with the relation of ionizing radiation to the incidence of disease in the study populations. A major phase of this program is the Adult Health Study which is an intensive search for late effects of single whole body irradiation from the Hiroshima and Nagasaki bombs. Observations are made by means of biennial basic routine medical examinations of the study population which totals approximately 20,000 persons in both cities including non-exposed controls matched by age and sex.

The leukemia detection survey is designed to detect, diagnose and evaluate all cases of leukemia and certain related hematologic disorders in both cities using the broadest possible population and diagnostic bases.

Field studies on the health status of survivors are intended to provide information on significant illnesses which occur in the Adult Health Study sample and provide information on state of health of patients who do not undergo examination at ABCC.

The Tumor Registry provides, through reports of local physicians and medical records of the principal hospitals, data on tumors which can be analyzed within the framework of the ABCC population samples.

SUPPORTED BY U.S. Atomic Energy Commission

5.0232, LATE EFFECTS OF RADIATION ON THE POPULATIONS OF HIROSHIMA AND NAGASAKI - SPECIFIC DISEASES OR DISORDERS STUDIES

UNKNOWN, Natl. Academy of Sciences, *Washington, District of Columbia* 20037 (AT-30-1-72)

This component of the unified program comprises studies of specific diseases or disorders which are observed in the Adult Health Study or the pathology studies and which merit detailed investigations. Current studies are composed of the following subprojects: Arthrologic - Rheumatoid Arthritis and Gout; Cardiovascular - Analysis of Norms for QRS Voltage, Cardiovascular Diseases Study, Predictive Significance of a 'Positive' Master's Exercise ECG Test, Hematologic - Quantitative Serum Protein Electrophoretic Study of Possible Effects of Radiation and Selected Diseases, Aplastic Anemia, Serum Immunoglobulin Levels, The Granulocyte Response to Stress as a Measure of Functional Bone Marrow Reserve in Atomic Bomb Survivors, Hiroshima, Immunologic - Australia Antigen in Atomic Bomb Survivors, Metabolic - Appraisal of Diabetes Mellitus Using Insulin Immunoassay; Neoplastic - Field Study of Leukemia, Blood Group and Haptoglobins in Leukemia, Polyps and Carcinomas of Stomach, Small and Large Intestine, Malignant Lymphoma and Multiple Myeloma, Multiple Neoplasms in Autopsy Series, Carcinoma of Liver, Gallbladder, and Biliary Tree and Their Relationships to Ionizing Radiation, Cirrhosis and Gallstones, Pathology Study of Gastric Carcinoma, Bronchogenic Carcinoma, Pathology Study of Malignant and Benign Breast Diseases and Their Relation to Radiation, Leukemia in Offspring of Atomic Bomb Survivors 1946-68.

SUPPORTED BY U.S. Atomic Energy Commission

5.0233, LATE EFFECTS OF RADIATION ON THE POPULATIONS OF HIROSHIMA AND NAGASAKI - GENETICS STUDIES

UNKNOWN, Natl. Academy of Sciences, *Washington, District of Columbia* 20037 (AT-30-1-72)

This component of the unified program is concerned with genetic effects of radiation on the populations of Hiroshima and Nagasaki. It consists of cytogenetic studies involving cell cultures, analysis by other laboratory methods of genetically connected diseases or aberrations and statistical studies. Current studies are: cytogenetic study of individuals with congenital diseases or malformation by means of tissue culture of peripheral leukocytes; somatic cell chromosome analysis consisting of examination of peripheral leukocyte chromosomes of persons who received heavy exposure (500 to 1000 plus rad); study of patterns of cell division and chromosome replication in human cells consisting of comparison of mitotic capacities and patterns of chromosome replication in cells from normal subjects and from patients with hematologic disorders; a cytogenetic study of the offspring of atomic bomb survivors to detect balanced chromosomal rearrangements in the progeny induced in parental germ cells by radiation; a study of blood groups in Adult Health Study and in utero subjects to determine phenotype frequencies for certain blood group antigens; cytogenetic studies of tissue obtained at autopsy; sex-ratio in offspring of In- Utero exposed and clinical characteristics of A-bomb survivors with chromosomal aberrations.

Results: 1. Aberrant karyotypes and spontaneous abortion in a family. (Kadotani et al) TR 5-69, March, 1969. 2. Familial occurrence of a short arm deletion of a G-group chromosome. (Yoshida, Honda) TR 10- 69, April, 1969. 3. Chromosome aberrations and malignant disease among A-bomb survivors. (Bloom et al) TR 2-70, March 1970.

SUPPORTED BY U.S. Atomic Energy Commission

5.0234, A STUDY OF THE BIOCHEMICAL EFFECTS OF IONIZING AND NONIONZING RADIATION ON PLANT METABOLISM DURING DEVELOPMENT

W.H. KLEIN, Smithsonian Institution, *Washington, District of Columbia* 20560 (AT(30-1)-2373)

Three areas of investigation have been pursued: A) direct effect of light upon phytochrome, B) measurement of daily and seasonal fluctuations in spectral distribution of total sky irradiance and its control of plant growth and development, and C) cytogenetic effects of radiation on plants.

A) Experiments are proposed as follows: 1) determine the amino acid sequence and the protein-chromophore linkages of phytochrome, 2) study disaggregation of phytochrome under controlled conditions and the effect of this disaggregation upon spectrophotometric properties of phytochrome.

B) Experiments are proposed as follows, 1) determine the changes in spectral quality during twilight hours through the implementation of more sensitive detector systems, 2) acquire a full set of solar energy measurements at 2 different latitudes (i.e. Israel and Washington, D.C.).

C) Experiments are proposed as follows; 1) determine the environmental conditions (in newly designed controlled environment chambers) necessary to obtain consistently viable pollen and reproducible chromatid aberration rates, the number of chromatid aberrations and/or the ratio of the chromatid exchange will be used as indices of irradiation effects.

Results. From chromophore degradation studies the bile type chromophore appears identical in the PR form with that of phycocyanin. The structure of the I ring is modified in the PFR form of phytochrome. A scheme for covalent linkage is proposed for both forms of phytochrome bile pigment. A trace-metals analysis has been initiated.

On clear days the ratio of red/far-red remains above 1.5 while on cloudy days (90 per cent reduction in total radiant energy) the ratio shifts toward far red-red and oscillates between 0.5 and 1.5.

SUPPORTED BY U.S. Atomic Energy Commission

5.0235, NUCLEAR WEAPONS EFFECTS ON ARMY MATERIAL/PARAMETRIC STUDIES
D.W. BASSETT, U.S. Army, Harry Diamond Labs., *Washington, District of Columbia*

Technical Objective: By a combination of testing in the laboratory and at radiation simulation facilities, determine the electrical and nuclear radiation characteristics of semiconductor devices for use in computer aided analysis of circuits. Prepare and update device characterization data for circuit analysis codes, such as Circus and Net-2, also determine the response of selected hardware items in radiation environments as required.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0236, PREVENTION OF RADIATION DAMAGE IN BONE
G.C. BATTISTONE, U.S. Army, Institute of Dental Res., *Washington, District of Columbia*

The objective is to confirm a hypothesis that radiation induced radicals in bone crystals can be removed before they cause biological damage. An agent that is a potential scavenger includes tetracycline compounds since these are bound to bone crystals. In vivo applications include any instance of bone exposure to radiation where such an agent may be administered prior to or subsequent to radiation.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0237, RADIATION EFFECTS ON MICROWAVE DEVICES
N. BERG, U.S. Army, Harry Diamond Labs., *Washington, District of Columbia*

Technical Objective: To develop a physical model for the behavior of a Gunn diode in a radiation environment.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0238, RADIATION EFFECTS IN DIELECTRICS
H.E. BOESCH, U.S. Army, Harry Diamond Labs., *Washington, District of Columbia*

Technical Objective: To provide a more adequate description of radiation induced conductivity in organic dielectric material. The basic processes of increased conductivity, charge buildup and decay, and the production of chemical species will be investigated.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0239, FUNCTIONAL EFFECTS OF IONIZING RADIATION ON THE CENTRAL NERVOUS SYSTEM IN MAN
J.G. MAIER, U.S. Army, Walter Reed General Hosp., *Washington, District of Columbia* 20012

Objective: To obtain data on the changes of the central nervous system, both the intellectual and autonomic nervous system during and following the application of ionizing radiation for tumor treatments in man.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0240, RADIATION INDUCED DEFECTS IN CDS (NUCLEAR EFFECTS ON INFRA-RED DETECTION MATERIEL)
L. RANDOLPH, U.S. Army, Harry Diamond Labs., *Washington, District of Columbia*

Technical Objective: The low temperature photoluminescence spectra of CDS consists of several regions, one containing many sharp lines. Some of these lines called bound excitons have been theoretically associated with defects in the material. Changes in the concentration of specific defects are monitored by measuring the relative intensity of bound exciton lines.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0241, RESPONSE OF CELLS DERIVED FROM SJTS INJURED BY PHYSICAL TRAUMA, RADIATION OR INFECTIOUS AGT EXPOSURE
H. SPRINZ, U.S. Army, Walter Reed Army Inst. Res., *Washington, District of Columbia*

To determine the reaction of cultured white blood cells (lymphocytes) as it pertains to antigenic, infectious, radiobiological, drug, biochemical and physical injuries encountered in military operations.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0242, AFRRI RADIATION CHEMISTRY PROGRAM
J.E. LEISS, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

The objective is to permit utilization of the NBS electron linear accelerator facility by representatives of the Armed Forces Radiobiology Research Institute to conduct pulse radiolysis investigations. The role of deoxyribonucleic acid (DNA) in the processes of cell replication and metabolism has been emphasized in recent years. A single molecule of DNA carries in its double helical structure the genetic information necessary for the continued life of the cell. It appears that DNA is a primary target of ionizing radiation and that much of the lethal injury sustained by an irradiated cell is a consequence of permanent changes induced in the unique structure of the genetic material. The purpose of this investigation is to study the transient radiation chemistry of aqueous solutions of DNA and related biological polymers with particular emphasis on the mechanism of radiation damage at the molecular level. The role of free radical and electron scavengers as possible protective agents for animal systems will also be examined.

The Bureau will construct and install on the NBS linear accelerator facility those additional beam handling components and apparatus required to allow the AFRRI investigations to be carried to completion. The apparatus constructed will consist partially of equipment presently available at NBS, plus additional components specifically required for this project. The work will be carried out in close collaboration with a member of the Applied Radiation Division, insofar as the equipment will be used in both AFRRI and projected NBS experiments. Reliable apparatus should be ready for installation in the Linac facility by early July 1969.

The expected output is an understanding of the mechanisms of protection and repair in cellular material exposed to ionizing radiation, based on new information about the primary structural changes in DNA.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

5.0243, ATLAS OF RADIATION PATHOLOGY
D.C. WHITE, U.S. Dept. of Defense, Armed Forces Inst. of Path., *Washington, District of Columbia* 20305 (AT(49-7)2666)

Many excellent informative publications relate to injuries produced in mammalian tissues by the actions of ionizing radiation. Few, however, are concerned with the detailed histopathology and its correlations to the characteristics of the imposed irradiation. It is the purpose of this Atlas of Radiation Pathology to present, by means of high-resolution photo-micrographs, appropriately identified and described, such characteristic alterations in mammalian tissues. This will be augmented by concise and comprehensive discussions of the kinetics of radiation pathology and the employment of charts, diagrams, and stylized drawings emphasizing specific aspects of this injury. This Atlas will provide histologic guidelines assisting the pathologist, radiobiologist, and radiation therapist, in the proper interpretation of presumed radiation-induced injuries. The material utilized in the development of this publication is derived from the files of the Registry of Radiation Pathology of the Armed Forces Institute of Pathology and, therefore, is representative of a large volume of carefully reviewed and documented human cases selected for the characteristic responses to known radiation exposure - predominantly therapeutic by intent. Both surgical and autopsy materials are included in the specimens described and photographed and

the effects to be considered range from the prompt and dramatic degenerative changes in the rapid cell-renewal systems as with a single, whole-body, high-dose exposure to the delayed scarring, atrophy and dysplasia following extensive, protracted radiation therapy.

Results: That segment of the Atlas dealing with lethal acute whole-body exposures has been completed. Five human fatalities are described and illustrated in detail with particular emphasis on the rapidly developing degenerative responses in critical body systems.

SUPPORTED BY U.S. Atomic Energy Commission

5.0244, ALTERATION INDUCED BY X-RAY & ULTRAVIOLET LIGHT ON THE SYNTHESIS & MAINTENANCE OF MACROMOLECULAR COMPONENTS WITHIN MICROORGANISMS

D. BILLEN, Univ. of Florida, School of Medicine, *Gainesville, Florida* 32601 (AT-(40-1)-3596)

The relationship between effects of radiation on DNA and DNA replication and cell survival is being studied. Both radio- and heavy isotopes are being used in the study, employing primarily bacterial cells and their chromosomes. The following projects are underway: a) Characterization of the DNA repair synthesis system vis a vis normal DNA replication and effects on methylation pattern. b) The nature and consequence of new initiation sites induced by irradiation, especially ionizing radiation. c) The replicative fate of DNA following its first cycle of post-irradiation replication. d) Factors responsible for physiologically determined radiosensitivity. e) The effect of radiation and modifying agents on phiX174 DNA.

Results: Qualitative differences in DNA and DNA synthesis regulation, following UV or X-irradiation, have been observed. Three such differences involve: a) Premature initiation of rounds of DNA replication, as seen in UV exposed cells; or unusual initiation sites for DNA synthesis as seen following X- or gamma-irradiation. b) Incomplete replication of DNA during the initial post-irradiation cyles. c) Alteration in the number of cytosine and adenine residues of DNA that are transmethylated following UV exposure

SUPPORTED BY U.S. Atomic Energy Commission

5.0245, A CYTOLOGICAL STUDY OF RADIATION INDUCED ALTERATIONS IN CYTOPLASMIC FACTORS CONTROLLING MALE STERILITY IN CORN

J.R. EDWARDSON, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (AT-(40-1)-2583)

Objectives of this investigation are to detect cytoplasmic sterility factors with electron microscopy and to determine whether sterility factors can be inactivated or induced by gamma radiation. Techniques employed in cytology of plant viruses are being applied to electron microscopy of meristems, leaf tissues, and embryo sacs in cytoplasmic male sterile and maintainer corn, sorghum, petunia, and Crotalaria. Cytological studies of the fertilization process in these lines are in progress. An irradiation program is being initiated in an attempt to inactivate the cytoplasmic factor(s) controlling susceptibility to 'Helminthosporium maydis' in T-type corn. Cytological studies of virus induced cytoplasmic inclusions are continuing in order to obtain information on their structure, composition and relationships to host tissue.

Results: Viruses of the PVY-group have been found to induce cylindrical inclusions in the cytoplasms of different host genera. These inclusions are useful in diagnosing infections by members of the PVY group of viruses. Inactivation of sterility factors is indicated by the occurrence of fertile progenies obtained from irradiated T-type sterile corn. Hybrids in T-type cytoplasm exhibit less radiation damage than do their counterparts in normal cytoplasm.

SUPPORTED BY U.S. Atomic Energy Commission

5.0246, EFFECTS OF GAMMA RADIATION AND DIETARY DEFICIENCIES ON THE PLACENTAL TRANSFER OF MINERALS

J.P. FEASTER, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-AL-01044)

OBJECTIVE: Determine the effects of gamma radiation and/or dietary deficiencies on the rate and extent of placental transfer of certain mineral elements.

APPROACH: Under this project, transfer of radioactive forms of minerals (iron, cobalt, copper, manganese, and iodine) across the placenta of pregnant cattle and swine will be measured, a comparison of rate of transfer being made between animals on complete diets and those on diets deficient in mineral elements or protein. Females will be studied at various stages of pregnancy to determine possible periods of increased fetal demands for the mineral elements. In the radiation phase, placental transfer in animals receiving 200 to 400 R whole-body gamma radiation will be compared with transfer in non-irradiated females.

PROGRESS: The effects of diets deficient in copper (Cu) or zinc (Zn) and containing pesticides (DDT, Parathion and Sevin) at low levels on pregnant rats have been studied. In the study with Cu, feeding a diet inadequate in Cu did not affect weight gains of growing rats, but did significantly reduce levels of Cu in livers. Pesticides reduced weight gains in growing rats fed both adequate and low Cu diets, though not significantly. Neither reproduction nor hemoglobin levels were affected by Cu level or pesticides in the diet. In rats ingesting only DDT normally present in dietary constituents, low Cu intake significantly reduced storage of DDT in adipose tissue. In the study with Zn, neither a low Zn diet nor pesticides adversely affected weight gains, reproduction, or hemoglobin levels in maternal rats, or hemoglobin levels in full-term fetuses. A high Zn diet (7000 ppm compared to 50 ppm in controls) reduced weight gains and resulted in reproductive failure in nearly one-half the females. Fetuses which went to term, were small and showed significant reductions in hemoglobin levels. Feeding the low Zn diet significantly increased the uptake of radioactive Zn by red blood cells, indicating increased retention of available Zn by the deprived rats. Recent findings from a previous study show DDT present in fetal livers, proving that it is transferred across the placenta during pregnancy. It can be concluded that chronic low-level intake of pesticides does not adversely affect pregnant rats, even under the stress of Cu or Zn deprivation.

SUPPORTED BY U.S. Dept. of Agriculture

5.0247, THE EFFECTS AND MECHANISMS OF ACTION OF IONIZING RADIATION ON THE HOUSE FLY MUSCA DOMESTICA

M. ROCKSTEIN, Univ. of Miami, School of Medicine, *Miami, Florida* 33124 (AT-(40-1)-3862)

This is a continuation of a study on the effects and mechanisms of action of ionizing radiation on the house fly, Musca domestica L., particularly as regards the locomotor function of flight. Completion of a current study on the effects of high-energy irradiation effects of the pupal stage upon the flight ability of successfully-emerging adult flies is expected during the current year, as well as initiation of further studies on the effects of such irradiation on the age-related distribution of enzymes and substrates concerned with contraction of flight muscle.

SUPPORTED BY U.S. Atomic Energy Commission

5.0248, LASER SAFETY IN MILITARY TRAINING DEVICES

D.R. BREGLIA U.S. Navy, Training Device Center, *Orlando, Florida*

Technical Objective: Utilizing state-of-the-art data on skin and retinal cell damage, energy or power threshold calculations and experiments will be performed to determine the type of laser to be used in specific military training systems which require direct trainee observations of, or exposure to, laser radiation.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0249, EFFECTS OF MICROWAVE RADIATION ON NAVAL PERSONNEL
D.E. BEISCHER, U.S. Navy, Aerospace Medical Res. Lab., *Pensacola, Florida* 32512

Technical Objective: Excessive exposure of Naval personnel to microwave radiation is an acute problem. Even low doses may reduce the efficiency of personnel in vital duty positions. The maximum safe exposure level presently endorsed by all branches of the armed forces (10 mw/sq cm) is based mainly on extrapolation from animal experimentation and does not take into account transmitter frequency or length of exposure. The great uncertainty in setting safe limits is best illustrated by the wide gap between U.S. and Soviet limits, with the U. S. limit higher by a factor of 1000 than the USSR level. Present and future use by the Navy of microwave generators of increasingly higher power at multiple frequencies makes it appear mandatory to experimentally establish safe levels using human subjects.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0250, THE EFFECTS OF EXTREMELY LOW FREQUENCY (ELF) RADIATION ON MAN
D.E. BEISCHER, U.S. Navy, Aerospace Medical Res. Lab., *Pensacola, Florida* 32512

Technical Objective: ELF radiation will perform a major role in the Navy's worldwide communication system. An urgent need exists for information on the physiological and psychological effects of this radiation on man at the exact frequencies of a considered Navy communication system. No published biological information is available at these specific frequencies, but studies at 10, 50, and 60 hz may serve as guidance. The results of a systematic and controlled exposure of human volunteers in the laboratory and in the field will substantially influence the deployment of the final technical communication system and contribute to alleviate the fears of an environmental radiation hazard to the population near the emitter site.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0251, PERFORMANCE IN NONHUMAN PRIMATES AS INFLUENCED BY LOW FREQUENCY ELECTROMAGNETIC FIELDS
J.O. DELORGE, U.S. Navy, Aerospace Medical Res. Lab., *Pensacola, Florida* 32512

Technical Objective: The primary objective is to make an extensive experimental analysis of numerous operant behaviors in a nonhuman primate, Macaca mulatta, under the influence of low intensity, low frequency electromagnetic fields in order to determine if there are effects and if the effects facilitate or deteriorate animal behavior analogous to human behavior. A secondary objective is to discover if the fields will function as a stimuli for a behavioral measure of arousal. The accomplishment of these objectives will help ascertain the ecological feasibility of an extremely low frequency naval communication system.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0252, ISOLATION AND IDENTIFICATION OF THE HEMOPOIETIC STEM CELL
R.C. LEIF, Florida State University, Graduate School, *Tallahassee, Florida* 32306 (AT(40-1)-2690)

There are now very strong indications that not all of the colony forming units of Till, which give rise to colonies in the spleens of irradiated hosts, are truly effective in providing long term radiation survival. It is proposed to fractionate these mouse bone marrow cells with the bovine serum albumin gradient technique of Leif and Vinograd and to utilize both long term survival and the permanent introduction of a new type of hemoglobin into chronically anemic mice as assays. It is now possible by Centrifugal Cytology to prepare artifact free dispersions of the fractions of mouse marrow cells obtained from these separations on conventional microscope slides. An attempt to identify the radiation survival cell by correlation of its density distribution with that of the various morphological classes of cells will be undertaken. Further purification of the stem cell will be possible by other techniques such as sedimentation and liquid curtain electrophoresis. It will be possible to assay these fractions by the simpler colony forming assay of Till, because any cells yielding spurious results will have been previously eliminated by the prior buoyant density separation.

Results: The technique of Centrifugal Cytology has been developed and interfaced with the albumin density gradient technique. Human blood, and rat and guinea pig bone marrow cells have been successfully separated by the gradient technique and benzidine geisa stained slides prepared from the density fractions. Preliminary histological analysis of the slides indicates that: buoyant density is directly related to maturation, blast cells can be separated from mature forms, many cells like mature megakaryocytes are contained in only one of 28 density fractions of differing cellular composition resolvable by the gradient.

Part 11 of 26.

SUPPORTED BY U.S. Atomic Energy Commission

5.0253, RADIATION INDUCED FREE RADICALS AND RADICAL PAIRS
G.C. MOULTON, Florida State University, School of Arts, *Tallahassee, Florida* 32306

The primary products produced by irradiating organic compounds of biological importance with 3 MeV X-rays, 50 kv X-rays, high speed electrons, or ultraviolet radiation at low temperatures will be investigated. The free radicals and radical pairs produced by the radiation will be detected and analyzed using electron spin resonance, and Endor techniques.

By working at low temperatures, 77 degree K or 4.2 degree K, we hope to be able to trap the primary radicals in a greater percentage of cases and thereby gain a better understanding of the fundamental irradiation effects. We will study single crystals mostly, since considerably more information can usually be obtained from single crystals than powders or amorphous materials. We expect to study amino acids primarily and eventually proteins.

Subsequent to the production and identification of the primary products, we will study the resulting products and the kinetics of the reaction when a sample is warmed slowly to room temperature. In addition to this, the same compound and related compounds will be irradiated with different kinds of radiation, at different dose rates, irradiated in vacuum or in the presence of oxygen, etc., in order to try to determine the importance of these variables in the radiation reactions. It is hoped that a thorough understanding of the fundamental mechanisms in free radical reactions in simple systems should ultimately help in the construction of molecular models of free radical reactions in biological systems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0254, THE STUDIES OF IONIZING RADIATION AS STIMULI
J.C. SMITH, Florida State University, Graduate School, *Tallahassee, Florida* 32306 (AT(40-1)-2690)

The studies of ionizing radiation as stimuli to rats, pigeons and monkeys will be continued. Investigations will be conducted studying the immediate response of these animals to X-ray and Gamma ray stimulations using the modified conditioned suppression technique. Special emphasis will be placed on measurement of the minimum pulse duration and dose rate that can be used in training the subjects. Further studies will be conducted studying the role of olfactory sensitivity in X-ray detection.

Additional studies will be run to use both X and Gamma rays as noxious stimuli in taste aversion studies. Emphasis will be placed on the effects of these exposures at different times during the circadian cycle. Attempts will also be made to quantify the strength of these taste aversions using operant conditioning techniques.

Part 15 of 26.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0255, LASER ACTION O? LIVING CELLS
M. BESSIS, Hospital De Bicetre, *Paris, France* (DAJA37)

Technical Objective: To investigate the effects produced by laser irradiation on isolated human blood cells and on cells and organelles of various other types in culture. The information to be obtained should make an important contribution to the Army's concern with the use of lasers in surgery and in the development of small endoscopic devices for diagnostic use.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0256, MECHANISM OF DIVALENT ION ABSORPTION
H.M. EDWARDS, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO-03-0345)

OBJECTIVE: Determine the influence of calcium level of the diet, zinc level of the diet, and phytic acid of the diet on zinc-65 absorption and excretion. Determine the effect of age, sex and germ free vs contaminated environment on zinc-65 absorption and excretion. Determine the influence of several chelating agents on the absorption, excretion and transport of zinc-65. Determine how orally absorbed zinc- 65 proceeds from the intestine to the tissues.

APPROACH: All absorption and excretion studies will be conducted by utilizing a gamma emitting radioisotope and a whole body counter. Very satisfactory isotopes of zinc, cobalt, iron and manganese are available. All procedures and initial investigations of problems will be investigated utilizing zinc-65.

PROGRESS: The effects of feeding high levels of different elements on the absorption of Co, Fe, Mn and Zn were investigated. Feeding high levels of cobalt, iron, manganese and zinc resulted, in general, in lower absorption and reduced biological half-life of their isotopes, possibly due to a faster metabolism of the elements in the body or to specific homeostatic control for the amounts of each element present in the body. An interaction between zinc and cadmium or mercury was clearly shown, as evidenced by the decrease of Zn absorption and the increase of zero-day retention values. Iron, also, depressed the absorption and increased the retention at zero-days of Zn, and zinc increased Fe absorption, indicating some type of relationship between these elements. The increase in the absorption of Fe and Co when high levels of nickel were added to the diet, were not statistically significant. Studies on Se absorption indicate that chickens between the ages of 2 and 23 days were very efficient in absorbing Se (83 to 100% absorption). Addition of sulfur, tellurium and arsenic to the ration did not greatly influence the absorption or retention of Se. Increasing the levels of supplemental selenium in the diet (0.12ppm to 15.78ppm) caused a decrease in Se absorption and a decrease in the biological half-life of Se in the chicken.

SUPPORTED BY Georgia State Government

5.0257, AN EVALUATION OF THE FACTORS INVOLVED IN BIOACCUMULATION OF GAMMA EMITTING RADIONUCLIDES IN WILD DEER
J.H. JENKINS, Univ. of Georgia, School of Forestry, *Athens, Georgia* 30601 (AT-(40-1)-3905)

Objectives: To determine 1) the amounts and kinds of gamma emitting radionuclides in an important wildlife species the white-tailed deer (Odocoileus virginianus) in the Southeast: 2) elucidate some of their food chains the year around, and 3) see if a relationship exists between bioaccumulation in deer, the soils, the deer foods available, and the rumen contents.

Scientific background: Three whole body counters have been constructed to measure the gamma rays emitted by animals varying in size from warblers (10 grams) and cotton rats (100 grams) up through seventy- five pounds (Coyotes taken in the wild in Georgia have been counted). It has been well known since 1963 that certain arctic animals contain relatively high amounts of radioactivity. There are some comparable situations in some habitats in the Southeast.

Proposed procedure: We shall analyze deer on systematic basis by physiographic province and season in the Southeast to determine the amounts and kinds of isotopes present. Emphasis will be placed on correlation of food intake through analysis of rumen contents and the known food habits of the deer in the areas involved. These facts will be compared with the soil characteristics.

Results: Over 500 deer have been analyzed. Deer from the southeast often have body burdens of Cesium-137 that exceeded those reported from Alaskan caribou at their peak. High Cesium-137 levels are restricted to the Lower Coastal Plain region of the Southeast and the extent within this province has now been delineated. Only Cs137 and K40 were detected in muscle tissue. On most study areas deer reach their peak concentration in winter but on a few areas they have peaked in late summer. Rumens have been analyzed from 135 deer. The factors involved in bioaccumulation are being elucidated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0258, AN EVALUATION OF RADIOACTIVE CONTAMINANTS IN WILD ANIMALS OF FOREST LANDS
J.H. JENKINS, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO-0020-MS)

OBJECTIVE: Determine radioisotopes in selected mammals, birds and other wildlife species. Determine food chain interrelationships between the predators, herbivores, and omnivores. Determine the whole body burden of radiation that the more common species in the above classifications are receiving and the probable effects as now known. Relate the above conditions to domestic animals and man.

APPROACH: Surveys of wildlife species would be made as to their gamma emitting radionuclides (the whole body burden) and their methods of acquiring these would be elucidated and their health significance both to the animals involved and to man would be evaluated. Preliminary data have already been obtained from over 200 specimens taken in this area. These data show several interesting and puzzling interrelationships.

PROGRESS: We are now pinpointing the radiation accumulation areas. We analyzed 383 deer from the Southeast by requesting the Game and Fish Commissions to save a sample from all road kills. This was suggested to us by the U. S. Public Health Service. We know now about where and when radioactivity occurs in deer from fallout biomagnification. We also check deer from 6 locations every 3 months. We have found that Cesium 137 accumulation can sometimes be high in bobcats, raccoons, squirrels, and a few fish species. In general, birds accumulate very little radioactivity. Some wildlife species have a body burden over 300 times that of beef in the Southeast. It is doubtful that wildlife poses much hazard to people since we do not depend on it ordinarily as a steady food source. We should definitely know the mechanics involved in bioaccumulation. Stomach contents of 135 deer were analyzed for radiation. We checked over 200 plant specimens and have taken over 60 soil samples. Work is continuing to ascertain the bioaccumulation factors.

SUPPORTED BY U.S. Dept. of Agriculture

5.0259, RADIOLYSIS OF HETEROGENEOUS SYSTEMS
F.J. JOHNSTON, Univ. of Georgia, Graduate School, *Athens, Georgia* 30601

Studies of the effects of ionizing radiation on colloidal sulfur suspensions having narrow particle size distributions are being continued. Aqueous suspensions and organosols will be studed by light scattering, spectrophotometric and conductometric methods. Our results to this time suggest that the sulfur particles act as 'sinks' for reactive intermediates produced by the radiation in the aqueous phase.

Radiation effects in other systems of known particle size and concentration will be measured.

Efficiencies of energy transfer from irradiated solid adsorbents to adsorbed inorganic gases are being determined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0260, ECOLOGICAL AND RADIO-ECOLOGICAL INVESTIGATIONS AT THE AEC SAVANNAH RIVER PLANT
E.P. ODUM, Univ. of Georgia, Inst. of Ecology, *Athens, Georgia* 30602 (AT(38-1)310,)

Research carried out by University of Georgia and visiting ecologists at the Savannah River Ecology Laboratory is grouped under the following general programs: (1) structure and function of ecological systems, (2) use of radionuclides to measure ecological processes, (3) effects of radiation on ecological systems, (4) effects of thermal enrichment on aquatic ecosystems. During the past years considerable progress was made on 56 subprojects. Thirty-one publications under the contract appeared in the literature, 16 more are in press, 6 are submitted for publication, and 45 were read at scientific, professional and social meetings by members of the staff. Continued use was made of the 10,000 curie 137-Cesium source to irradiate poultry, small mammals, reptiles, and a litter-soil ecosystem. With the declassification of the water temperatures in the Par Pond, seven studies dealing with aquatic organisms living in thermally enriched water were initiated. The extensive thermal gradient within the lake makes these studies of particular interest. New programs in mineral cycling and avian bioenergetics got under way and emphasis in the mammal program shifted to methods of determining absolute density. The drift-fence/pit-fall trap method proved particularly successful in determining migration patterns in reptiles and amphibians.

SUPPORTED BY U.S. Atomic Energy Commission

5.0261, EFFECTS OF RADIATION ON PLANT AND ANIMAL COMMUNITIES
R.B. PLATT, Emory University, School of Arts, *Atlanta, Georgia* 30322 (AT-(40-1)-2412)

This program is now in its fourteenth year and is concerned with population and ecosystem dynamics. It includes stress effects studies, emphasizing multiple factor analyses, and utilizes a variety of plant and animal life. Other aspects deal with metabolic pathways in organisms as well as in ecosystems, population genetics, competition between species, and model building and systems analysis. In order to coordinate the various research activities of the entire group, the research is centered on a large segment of man's environment, the Altamaha River System. The terrestrial ecosystem studies are concentrated on the granite outcrops and adjacent communities at the headwaters of the river. Ionizing radiation is used, either as an ecological stress in effects studies, or as radioisotopes in tracing metabolic pathways. This is a large program, involving many more faculty and staff than listed above. Reprints of past work are available. The program is projected indefinitely, having started in 1956.

SUPPORTED BY U.S. Atomic Energy Commission

5.0262, NAVY ENVIRONMENT - EFFECTS OF MICROWAVE RADIATION ON NAVAL PERSONNEL
R.C. JOHNSON, Georgia Inst. of Technology, Engineering Experiment Station, *Atlanta, Georgia* 30332 (N00014-67-A-0159-0008)

Technical Objective: The objective is to develop, install, and calibrate a microwave illuminator for the Naval Aerospace Medical Center (NAMI). The contractor will assist NAMI in experimental design of a program to test the physiological hazards of microwave exposure in naval personnel.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0263, MECHANISM OF RADIATION EFFECTS ON THE TRANSPORT AND BIOELECTRIC PROPERTIES OF RAT INTESTINE
J.R. MCKENNEY, Medical Coll. of Georgia, School of Medicine, *Augusta, Georgia* 30902 (AT-(40-1)-3882)

The objective of this research is to determine the effects of ionizing radiation responsible for the breakdown of salt, fluid and nutrient absorption. Effects of both acute radiation exposure and bile diversion are being studied. Current results indicate that after 1200 R X-radiation salt and glucose transport are transiently elevated with subsequent depression of salt transport by the third day and glucose transport by the fourth day. Initial electron microscopy indicates related effects on intracellular structure. The unidirectional flux of glucose following X-irradiation appears to be a predictable function of the difference between the unidirectional fluxes for N and Cl ions. Unidirectional electrolyte and water fluxes were coupled. Bile diversion caused a five-fold increase in the unidirectional flux of glucose. This research is being performed with isolated rat intestine and includes (1) flux measurements with radioisotopes and glucose (2) intracellular voltage measurements and (3) electron microscopy. Current objectives are to continue studies on electrolyte, water and glucose transport, bioelectric properties and architecture of the mucosa between one and four days following exposure to 1200 R X-radiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0264, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS
H.J. HAMANN, Gesellschaft Fuer Strahlenfor., *Hannover, Germany*

The effect of intermediate neutrons and the energy dependence of the biological action of fast neutrons on seeds. Irradiation of seeds of various water and oxygen content of Hordeum vulgare, Vicia faba minor and major, Vicia vilosa and Vicia sativa with intermediate neutrons and monoenergetic fast neutrons of 14.7 and 3.4 MeV and with 60-Co-gamma rays. Determination of germination rate, growth inhibition and chromosome aberrations in the first mitotic cycle of the root tip cells. Interpretations of the results on the basis of microdosimetry and with regard to elastic collisions. Testing of new methods of neutron spectra determination and in the intermediate range: 1) a helium-3-counter, which can be shielded by capsules of boron and lithium flouride of different thickness; and 2) a set of resonance detectors consisting of special metal oxides suspended in polyethylene foils.

Investigation of the effect of fast neutrons, thermal neutrons, and gamma rays on algae (Chlorella vulgaris and Scenedesmus obl.) grown in heavy water. The absence of hydrogen in the cells should influence the neutron action more than the gamma action in comparison to the normal algae, because hydrogen is the essential element for the energy transfer in the case of neutron irradiations.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0265, THE EFFECT OF GAMMA IRRADIATION ON THE LIPID METABOLISM OF RADIOSENSITIVE TISSUES
C.J. MIRAS, Athinisin Eth. Kai Kap. Panep., *Athens, Greece*

Experiments performed up to this date have shown that bone marrow cells from irradiated New Zealand rabbits show pronounced differences in their lipid metabolism as compared to sham irradiated animals. However, the lipid metabolisms of 'in vitro' irradiated bone marrow cells do not respond to ionizing radiation.

This project will be continued by investigating the changes produced by whole body irradiation of the animals on the lipid composition of the plasma membranes as well as of the cytoplasmic membranes of thymocytes and possibly of bone marrow cells. These results will be eventually compared with changes found in liver cells.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0266, FIELD AND PHYTOTRON EXPERIMENTS ON RADIOSTIMULATION OF SOME GRAIN AND VEGETABLE VARIETIES
J. SIMON, Central Food Research Inst., *Budapest, Hungary*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0267, IRRADIATION INDUCED CHANGES IN RED BLOOD CELL METABOLISM AND MEMBRANE STRUCTURE

S.R. HOLLAN, Natl. Blood Service, *Budapest, Hungary*

A detailed study of radiosensitization induced by iron and the effect of irradiation on the iron uptake and iron metabolism of erythrocytes. In addition to mature human erythrocytes, foetal type of immature erythrocytes and reticulocytes shall be studied. In the latter, the changes shall be observed that take place in iron uptake and incorporation on irradiation, parallel with the study of the changes in the haemoglobin synthesis. It shall be established to what extent the changes of the specific radioactivity of the non-haemoglobin type intracellular iron binding protein are characteristic of (1) the changes in the iron uptake, and (2) the disturbances of the haemoglobin synthesis induced by irradiation. The project will be studied by a chromatographic separation of the intracellular proteins following the uptake of 59-Fe. Based on the increase of the 42-K-outflow on irradiation, the effects of a great number of radioprotective compounds in a comparative 'in vitro' system shall be controlled. While studying the same characteristics of the antibodies of anti-D specificity, the experiences obtained in radiosterilization of erythrocyte antibodies of anti-A and anti-B specificities shall be used.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0268, EFFECT OF IONIZING RADIATION ON THE STRUCTURE AND FUNCTION OF ERYTHROCYTES

S.R. HOLLAN, Natl. Blood Service, *Budapest, Hungary*

Effect of ionizing radiation on the structure and function of erythrocytes (part of a coordinated programme of research in radiation haematology).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0269, MECHANISMS OF LOCAL CARCINOGENESIS - RADIATION, PLASTIC FILMS, AND OTHER AGENTS

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A most difficult problem in radiation protection is that of evaluating the carcinogenic risks of localized tissue irradiation. Dose-response relationships, relations of area irradiated to response, relative susceptibilities of tissue and cell types, and influence of other factors such as foreign-body reactions, are among the factors not well understood. Carcinogenesis by external beta-irradiation and the influence of cancer-promoting agents, by localized insoluble plutonium deposits, and by implants with and without incorporated radioactive materials, are all under investigation.

Millipore implants in subcutaneous tissues of rodents are carcinogenic when the pore size is 0.1 mu or less and ineffective with pore sizes of 0.4 mu and above. Radioactive implants of plastics are highly carcinogenic in rodents, but are ineffective in dogs for at least 5 years. When plutonium is given so as to be retained about half locally and half in the skeleton, the preponderance of tumors appears in bone.

SUPPORTED BY U.S. Atomic Energy Commission

5.0270, SOFT TISSUE RETENTION OF STRONTIUM-90

A.M. BRUES, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-eng-38)

The soft-tissue distribution of Strontium-90 is of particular interest in relation to gonadal radiation exposure. The dosage resulting from injection varies widely with age and species, depending on two factors: rapid exchange with the labile compartment of bone, and rate of excretion. Translocation of yttrium-90 resulting from Strontium-90 disintegration may result in relatively higher radiation doses to certain tissues which concentrate it. This is to be further investigated using injections of Strontium-90 from which yttrium has been separated.

Results: Integrated soft-tissue concentration curves expressed the basis of body concentration at the time of injection, vary from 2-5 hours in the young rodent to several days in adult large mammals. There is a slight redistribution of yttrium to a few tissues, notably liver.

SUPPORTED BY U.S. Atomic Energy Commission

5.0271, ANALYSIS OF PARAMETERS INFLUENCING CARCINOGENESIS

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In considering factors involved in radiation carcinogenesis, parameters other than total dose such as energy and mode of deposition of radioactive materials, dose rate of either internal or external irradiation, and the volume and type of tissue exposed must be appraised. Other variables such as age, tissue turnover rate, latent period and their differences among species are also relevant. Available data are being analyzed from these points of view in the hopes of effecting valid interspecies extrapolations and elucidating basic mechanisms. In addition, skeletal radiographs of mice exposed to single doses of neutrons, X-rays and fractionated doses of gamma radiation are being examined to estimate bone tumor incidences.

Results: So far the percentage of bone tumors found by the above mentioned technique has been about 4% over-all with the highest percentage in the neutron-exposed group and the lowest in the mice exposed to single doses of X-ray. Some of the dose response data have been fitted by curves with equations having parameters subject to reasonable interpretation biologically.

SUPPORTED BY U.S. Atomic Energy Commission

5.0272, RADIATION RESPONSE AND RECOVERY IN SEA URCHIN GAMETES

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Recovery from gamma ray-induced division delay in fertilized sea urchin eggs has been demonstrated by using various treatments to prolong the duration of the first division cycle - presumably affording more time for repair to take place. By using inhibitors of specific cellular processes it is possible to characterize better the nature of the radiation effect and the recovery mechanism.

Since many biological systems exhibit recovery after exposure to sparsely ionizing radiation but not after exposure to densely ionizing radiation, it was felt important to compare the recovery after sea urchin sperm has been irradiated with alpha particles from Curium144 with that observed after irradiation with gamma rays from Cesium137.

Results: Interference with aerobic metabolism or spindle formation does not block the recovery process while inhibition of protein synthesis in some cases does. It has not been possible to demonstrate any recovery at reduced temperatures. Also, the recovery evident under anoxic conditions after exposure of sperm to gamma radiation is either non-existent or of a much lower order of magnitude after exposure of sperm to alpha radiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0273, RADIATION AND ENZYMES

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Although the effect of ionizing radiation on many tissue enzymes has been described, there is a paucity of information regarding effects on the class of flavoprotein enzymes. This seems particularly regrettable because this is, in general, a class of enzymes producing hydrogen peroxide, which may be of importance in the radiation syndrome.

We have investigated the effects of three doses of X-radiation (5, 50, and 500 r) to the whole body on the activity of the following eight enzymes in mouse liver and kidney: D-amino acid oxidase, L-amino acid oxidase, L-alpha-hydroxy acid oxidase (short chain), L-alpha-hydroxy acid oxidase (long chain), monoamine oxidase, diamine oxidase, uricase, and xanthine oxidase. Of these 16 enzymes (eight each in liver and kidney), nine were not detectable at any time, and four were detectable but not affected in activity by irradiation.

Results: The remaining three enzymes, all of which showed increased activity after all doses of radiation, were: liver monoamine oxidase, kidney D-amino acid oxidase, and kidney L-alpha-hydroxy acid oxidase (long chain).

Because the effects were so few, so small in magnitude (although statistically significant), and relatively independent of radiation dose, this class of enzymes is considered not to be of importance or particular interest in radiation biochemistry, and the project has been terminated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0274, TOXICITY OF RADIOSTRONTIUM IN DOGS

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Dogs were treated with Sr89 and Sr90 under a variety of exposure conditions to determine the influence of age, duration of exposure, and level of radionuclide contamination upon the pathologic consequences. Some animals received a single injection when they were very young or full- grown; others received 257 injections during the course of one year, treatment starting at birth, during the juvenile period, or after two years of age. Another group was treated in utero by injecting radiostrontium into pregnant dogs a few days before parturition. The series includes 182 dogs: 152 beagles and 30 mongrels. Twenty-six of the 62 living dogs are control beagles. The animals receive periodic physical examinations, and roentgenograms of the entire skeleton are viewed once or twice a year. Autopsy when moribund includes histopathologic study of most organs, with special attention given to bone.

Results: Osteosarcoma has been the main cause of death. Other tumors probably attributable to radiostrontium have been myeloid leukemia, epidermoid carcinoma of the oral cavity, and tumors in the head apparently originating in the central nervous system. There has been no indication that the neonatal and juvenile dog is more sensitive than adults to either the lethal or the oncogenic effects of radiostrontium. However, the presence of a large body burden during the period of growth seriously disturbed skeletal development.

SUPPORTED BY U.S. Atomic Energy Commission

5.0275, INTERACTION OF SR90 WITH ONCOGENIC AND NON-ONCOGENIC VIRUS IN PRODUCING BONE CANCER IN MICE

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The hypothesis that radiation induces cancer by inactivating an inhibitor of viral replication, that the virus is present in non-viral form as a necessary and normal constituent of the cell, is being tested by treating CF1 mice with both FBJ osteosarcoma virus and Sr90. FBJ virus has been given at birth and Sr90 at 28 days of age or later. Virus also has been given in immunizing doses during the month preceding injection of radiostrontium, and it has been given after Sr90. Since FBJ-induced and Sr90-induced bone cancers can be differentiated in most cases on the basis of roentgenographic and histologic appearance, it is possible to determine how combined treatment influences the response to these two oncogenic agents for mouse bone. However, in order to avoid some of the complications resulting from death due to FBJ bone cancer before the mice are old enough to be treated with Sr90, a non- sarcomatous CF1 virus, recently isolated in the Viral Carcinogenesis Branch of the National Cancer Institute will be used in some experiments. Also, prevention of Sr90 induction of bone cancer will be attempted by repeated injections of rabbit anti-FBJ serum during the latent period for Sr90 oncogenesis.

Results: FBJ virus given at birth caused an earlier than usual appearance of Sr90 bone cancer. However, if the mice were 28 days old at the time of radioisotope injection, there were fewer tumors than there were without virus pretreatment. Tumor incidence was not changed if the mice were older when Sr90 was injected. Immunization with FBJ virus had no effect on the subsequent development of Sr90 bone cancer, but when FBJ virus was given after Sr90, there were fewer FBJ tumors than there were without radiostrontium pretreatment.

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5.0276, LATENT PERIOD TO THE INDUCTION OF BONE CANCER BY SR90 IN MICE

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It has been recently observed that some CF1 mice treated with 1.0 mu Ci Sr90/gm died with bone cancer sooner than usual. The only difference in customary procedure was that serum was collected from these animals on several occasions by bleeding from the orbital sinus. This suggests that the latent period to bone cancer induction after treatment with Sr90 is shortened when the bone marrow is in an unusually active proliferative state. To test this observation, 30 mice were given 1.0 mu Ci Sr90/gm; 15 received no further treatment, and 15 were bled from the orbital sinus 5 times during the next 18 days. Skeletal damage and neoplastic change are being studied by weekly roentgenographic examination. This kind of approach to latent period problems might be fruitful; information in this area has been very difficult to obtain because it requires an understanding of the processes going on during the period between administration of a radionuclide and first appearance of pathologic change. The reason for concern about latent period is the necessity to know the precise time when irreversible neoplastic change occurs if the absorbed dose from a bone-seeking radionuclide responsible for inducing bone cancer is to be estimated.

Results: The first osteosarcoma was detected roentgenographically in a mouse that had been bled 99 days after Sr90 was injected, and at 114 days there were 2 more cases in this group. The first bone cancer in the non-bled mice was detected at 130 days. This kind of difference has persisted, and at the last examination 193 days after radioisotope administration, there were 25 osteosarcomas in the bled mice and 17 in those not bled.

SUPPORTED BY U.S. Atomic Energy Commission

5.0277, CORRELATIVE ACTION OF THE GAMMA-IRRADIATED LEAF ON ROOT INITIATION IN COLEUS

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It has been shown that auxin, carbohydrate, and nitrogenous factors are required for the de novo initiation of roots on cuttings. The leaf governs the formation of roots by supplying the limiting factors. The present study was undertaken to determine whether or not petiolar root formation is affected by exposure of only the blade to ionizing radiation. If so, the above factors will be investigated in search for loci of in vivo radiosensitivity. Coleus leaves are exposed to Co 60 gamma rays, the petiole base being shielded by lead.

Results: Irradiation of the leaf blade, using dosages that suppress the initiation of roots on the petiole by 50%, had no immediate effect on petiolar levels of carbohydrate or nitrogen. However, the concentration of petiolar RNA began to drop several hours after irradiation. The radiation-induced loss of RNA is apparently not a consequence of an impaired biogenesis, since incorporation rates of C14- labeled uracil into RNA were unaffected. The effect of irradiating the blade on the activity of petiolar RNAase was therefore determined. Gamma-irradiation of the blade causes an enhancement of observed and specific petiolar RNAase activity at 14, 25 and 40 hours after exposure. Hence the loss of RNA that occurs in the petiole base after irradiation of the blade can be attributed to a hormonal activation of RNAase activity. That this hormone is auxin can be inferred from the finding that both the impairment of root initiation and the fall in RNA induced by irradiation can be reversed by supplying auxin. If so, the action of auxin is not simple and direct: immersion of the petiole in auxin solution enhances gross RNAase activity in the petiole. Tentatively, we postulate that the auxin-induced rise in RNA in turn promotes an RNase activity that is compartmentalized with respect to the RNA involved in the formation of root initials.

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5.0278, NEUTRON AND GAMMA RAY TOXICITY STUDIES EMPLOYING THE JANUS BIOLOGY REACTOR COMPLEX

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The need for information concerning the potential hazards to man of long-term low-level exposure to fission neutron and gamma radiation continues to be compelling. These studies will be an integrated experimental approach to this general problem and will have a primary objective of defining basic cellular and tissue mechanisms of chronic radiation injury. These data, when integrated with adequate epidemiologic data on death rate from specific neoplastic and degenerative diseases, short-term and long-term recovery rate data for critical proliferating cell systems, and data from selected species and environmental comparisons, should provide the basis for predictions of the consequences of most occupational or accidental exposures to neutron and gamma radiation. Although the main effort will be on the late effects of radiation, some acute toxicity and lethality studies will be required for baseline purposes. In the course of these studies, information on the normal aging processes of rodent populations will accrue as necessary information for the proper evaluation of radiation induced changes and age: radiation interactions. Initial studies will evaluate fractionated, terminated exposures and certain dose-rate variables on the life expectancy, leukemia death rates, hematopoietic and intestinal system cell kinetics. Extensive duration-of-life irradiation series and regimes involving exposures terminated in mid life and beyond will be established on the basis of initial study results.

SUPPORTED BY U.S. Atomic Energy Commission

5.0279, CHANGE IN RADIOSENSITIVITY OF INTESTINAL CRYPTS FROM GROUND SQUIRRELS DURING THE FIRST 48 HOURS AFTER AROUSAL FROM HIBERNATION

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Although initial energy-transfer reactions following irradiation are probably the same over the temperature range of hibernation (ca 5 to 23 degrees C) as they are for mammalian tissue cultures grown over a temperature from 25 to 37 degrees C, the biochemical events resulting from energy transfer after irradiation are temperature-dependent. Thus, the development of pathology (biochemical events) is retarded in hibernating ground squirrels given lethal doses of radiation and they do not die as long as they hibernate. Following arousal pathology rapidly develops and they die showing that the original radiation injury (initial energy-transfer) had occurred. We observed that mortality of irradiated ground squirrels after arousal from hibernation was less than in non-hibernating irradiated controls. The investigation was aimed at determining the dominant factors that contribute to the decreased radiation injury associated with post-irradiation hibernation. In studies of the effects of hibernation on radiosensitivity and on recovery from radiation injury, we observed that mortality was the same for ground squirrels irradiated while awake or in hibernation. If they were permitted to hibernate after irradiation, a net increase in the rate of recovery was observed as demonstrated by a doubling of the number of survivors. To refine the sensitivity of the system ground squirrels were irradiated with CO60 gamma rays at different times after arousal from hibernation and their intestinal crypts were examined to determine survival. The intestinal crypts provide a uniform population of cells that can be readily scored to assess radiation injury. Results: Hibernating ground squirrels were removed from the cold room and were irradiated with CO60 gamma rays at 15 min, 1 hr, 3 hr, 7 hr, 12 hr, 24 hr, and 48 hr after initiation of arousal. Pieces of ileum were sectioned and the number of intestinal crypts with dividing cells from animals irradiated during the first hour after arousal from hibernation, as compared to non-hibernating irradiated controls, was approximately 3:1 after 1500 R, 6:1 after 1600 R, 12:1 after 1700 R, and 35:1 after 1800 R. As the interval between arousal and time of irradiation increased the response reached control values.

SUPPORTED BY U.S. Atomic Energy Commission

5.0280, TOXICITY OF TRITIUM-LABELED COMPOUNDS

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Continued and increasing use of tritiated nucleic acid precursors requires investigation of the radiological effect of tritium incorporated preferentially into the nuclei of cells including possible radiation effects that introduce experimental error in studies of cell kinetics, and the possibility that tritiated nucleic acid precursors may constitute a serious hazard to the health of man. The latter concern is relevant to the production of tritium and its release into the environment of nuclear power plants and fuel reprocessing facilities.

To properly evaluate the possible radiological hazard of tritium- labeled compounds (e.g., thymidine, uridine, and leucine), factors that control uptake, distribution, excretion, and reutilization must be fully understood. This investigation attempts to obtain quantitative data in order to elucidate these various factors. Liquid scintillation counting in combination with combustion techniques are used to detect and measure low-energy beta emission of tritium. Cerenkov radiation counting of the more energetic beta-emitter are evaluated and studied to give a new and greater dimension in liquid scintillation measurement.

Results: Our experiments indicate that the toxicity of tritium bound to nucleic acid precursors varies with the site of incorporation, the rate of renewal of the labeled macromolecule, and the extent of interconversion and reutilization of catabolites. In comparing DNA, RNA, and protein synthesis in different tissues, the uptake of tritiated precursors and the intensity of the autoradiographic label are differently affected in different organs by the route of administration as well as the specific activity (Ci/mM). For tritiated thymidine the degree of early somatic and genetic effect from intranuclear tritium is that anticipated on the basis of calculated absorbed dose to the cell nucleus.

SUPPORTED BY U.S. Atomic Energy Commission

5.0281, THERAPY OF POISONING BY RADIOACTIVE AND NONRADIOACTIVE METALS

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The overall purpose of this project is the development and evaluation of new concepts and techniques for the therapy of poisoning by radioactive and nonradioactive metals that deposit primarily in the bone and liver. In anticipation of problems of human decontamination arising from the increasing usage of highly radiotoxic actinide elements, current work is being centered on plutonium and americium. Increasing emphasis is being placed on the relationship between the physical-chemical properties of compounds of these nuclides and their physiological behavior, both for applications to therapy and for an improved understanding of the general behavior of macromolecules and colloids in tissues. The mouse is the principal species used, but comparative studies with other species (e.g., rat, rabbit, and dog) are included. Present efforts toward therapeutic removal involve use of the chelating agent DTPA (diethylenetriaminepentaacetic acid), either alone or in combination with other types of therapeutic agents (e.g., the yeast polysaccharide glucan, which increases removal of intracellular plutonium from liver). Another approach aims at alteration of normal physiological processes in bone and liver to liberate the radioelement. Among techniques used are radiochemical assays, electron microscopy, autoradiography, and ultrafiltration. Toxic and therapeutic effects in animals are measured by changes in median lethal dose, tumor induction, histopathology, and longevity. Results: In mice, studies of the lifetime influence of physical-chemical properties of plutonium have thus far shown that after injection of highly polymeric plutonium: 1) about 65% of the skeletal burden is in the marrow (compared to under 5% after monomeric plutonium); 2) deaths from aemia may follow (e.g., all mice receiving 7.8 mu Ci/kg die within 4-9 months); 3) much of the plutonium leaving the liver is translocated to bone surfaces shown earlier to be at high car-

cinogenic risk. In liver cells, both monomeric and polymeric plutonium were found associated with lysosomes; but most of the polymeric plutonium was non-lysosomal, possibly bound to cell membranes.

SUPPORTED BY U.S. Atomic Energy Commission

5.0282, METABOLISM AND DISTRIBUTION OF BONE-SEEKING NUCLIDES BY MAN

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The radiation dose to man from internal deposits of alpha-emitting nuclides is highly dependent on the distribution within the body and the rate of change of body burden with time after exposure. The metabolism of radium 30-40 years after exposure is being evaluated. For living humans the body burden is determined by radon breath and gamma-ray spectroscopy. The rate of change of body burden is determined by the radiochemical assay of blood, urine and feces. The macroscopic distribution of Ra226, Po210 and Pb210 is being determined in 100 specimens from a recently deceased radium dial painter skeleton. In addition, the microscopic distribution is being evaluated by the autoradiographic-microradiographic technique. The metabolic and distribution parameters will be used to test theoretical predictions of the long-term behavior of these and other bone-seeking nuclides by man. Results: The rate of clearance of Pb210 and Po210 from the blood of radium patients was found to average 0.09 and 1.6 liters per day, respectively. From biopsy specimens, the Pb210 to Ra226 ratio in bone was 0.30 which is in good agreement with that expected from radon retention studies.

SUPPORTED BY U.S. Atomic Energy Commission

5.0283, MECHANISMS AND MODELS OF SKELETAL METABOLISM--THEORETICAL

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Purpose: To provide quantitative descriptions of the processes of uptake and release of bone-seeking radioisotopes. These descriptions are directed towards 1) elucidation of the mechanisms of skeletal metabolism, and 2) predictions of the ratios of toxicity of bone-seeking radioisotopes in man and in dog.

Summary of Proposed Work: A new model of bone turnover is being developed which will extend the power function model to describe the microscopic processes of alkaline earth uptake and retention. Local retention functions have been constructed for bone surface, bone volume, cortical bone, trabecular bone, regions of new bone formation, regions of existing bone (the diffuse component), and soft tissue. The effects of resorption and of diminution are explicitly described for each bone component. Available microscopic data, while not plentiful, are sufficient to place realistic constraints upon the model for both dog and man.

The model will be used to calculate dose to endosteal bone surface for ICRP.

Results: A comprehensive analysis has just been published. 'Measurements and Models of Skeletal Metabolism' in Mineral Metabolism, Volume III, edited by C. L. Comar and F. Bronner, Academic Press (1969). This chapter summarizes the work of the bone group 1955-1969, and places the concepts of bone turnover and alkaline earth transfer on a firm operational basis.

The prediction of a final exponential in the retention of radium in man has been confirmed using the data for George Harrison (Radiation Research 39, 445, 1969).

SUPPORTED BY U.S. Atomic Energy Commission

5.0284, METABOLISM AND TOXICITY OF FISSION PRODUCTS IN DOGS

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The ultimate aim of this work is to establish the effects of raw fission-product mixtures in biological systems relatable to man. The complexity of fission product mixtures is such that the problem is approached by selecting representative fission products that have highly different distribution patterns in the body. These are Ce144, Cs137, and I131. In addition, a Co60 gamma-ray source is used to deliver wholebody radiation continuously in order to simulate certain aspects of radiation from internally deposited radionuclides.

Pure-bred beagle dogs are treated with these agents and attempts are made to define the mechanisms and causes of both acute and chronic deaths.

Results: At dose rates to bone marrow of 8 rad/day and above the causes of death are directly relatable to marrow damage. At 28 rad/day death is caused by septicemia secondary to leukopenia. At 14 rad/day the primary cause changes to anemia, while at 8 rad/day leukemia is frequently seen. Low platelet counts do not appear to be a prime factor at any of these dose rates.

The reduction in the hyperplastic response of the thyroid gland to low dietary iodine levels provided an excellent method for evaluating injury to the thyroid at radiation doses below 2000 rad.

SUPPORTED BY U.S. Atomic Energy Commission

5.0285, MEASUREMENTS OF RADIOACTIVITY IN VIVO AND APPLICATIONS IN HUMAN RADIOBIOLOGY

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Three shielded rooms are being constructed in an underground laboratory supplied with radon-free air, in order to make measurements of radioactivity in man at the lowest possible level. Subjects studied will be persons who worked with radium many years ago, as well as those who may become contaminated internally as a result of accidents. Short- and long-term retention parameters will be determined by making repeated measurements over such periods of time as may be necessary. Particular attention will be paid to the determination of distribution within the body as well as of total body content. A special problem is posed by those radionuclides such as Pu-239 which only emit low energy radiation, the attenuation of which by overlying body tissues is severe and variable. Large area low background pr.swich detectors and proportional counters will be used for the measurements, and calibration will be studied with the help of volunteers who inhale short-lived 'mock plutonium.'

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5.0286, THEORY OF AGING, MORTALITY AND RADIATION INJURY

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Purpose is to develop a mathematical theory of radiation injury, and a theory of aging and death, that will make possible the quantitative estimation of morbid and lethal effects of ionizing radiations in various mammalian species, especially for the conditions of long-term exposure. This is essential for the development of a valid predictive model for estimating late radiation effects in man (see SIE 'Acute and Chronic Radiation Effects'). The overall problem is extremely complex, and the attack is therefore by stages, as follows: 1) identify all the significant factors; 2) develop adequate theoretical models for the factors separately; and 3) synthesize progressively more complete models of the whole system. Work is now mostly in stage (2). The kinetics of injury and repair in the blood-forming systems is moving to a third cycle of computer simulation. The theory of the stochastic relation of disease incidence and death to tissue injury has been developed and an advanced computer simulation is under development. Theory of the kinetics of radiation damage to chromosomes and cell division is under development.

Results: The statistical theory of mortality explains how the sigmoid life tables of mammalian populations can arise from steadily accumulating molecular aging injury, and correctly predicts the kind of perturbation of the life table produced by radiation exposure. The mathematical model of dose rate dependence and physiological recovery, now under development, can already account for much of the available data on species differences in chronic sensitivity.

5. RADIATION

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5.0287, ACUTE AND CHRONIC RADIATION EFFECTS IN MAMMALS

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Purpose is to develop a quantitative model of morbidity, mortality and life shortening in mammals that will be valid between species, and capable of estimating radiation effects in human population. As radiation levels in the environment increase, the need for correct estimates of effects in man becomes greater. Since the available human data is limited, any considerable increase of knowledge must come from animal research. Procedure is to measure the effects of a standard set of radiation exposure conditions on blood formation, disease incidence and length of life of a diverse group of mammalian species, and to use the data as the basis for the development of a quantitative mechanistic model of life shortening in mammals. In the current stage the test species are small myomorph rodents of the genera 'Mus', Praomys', 'Peromyscus', 'Sigmodon oryzomys', and 'Tamias'. Subsequent stages will broaden the group to include small marsupials, insectivores and primates. The radiation sources used are gamma rays presently and fast neutrons in the near future.

Results: The group of rodents listed above has been shown to have a 5-fold range of sensitivity to low-level chronic exposure, whereas the conventional 50LD estimate of sensitivity shows them varying by only a factor of 2. Experimental evidence has been produced showing that the life-shortening effect varies as the first or the second power of the dose rate, in different dose rate ranges (see SIE 'Theory of Aging, Mortality and Radiation Injury').

SUPPORTED BY U.S. Atomic Energy Commission

5.0288, THE EFFECT OF RADIUM IN HUMAN BONE

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Human skeletal material burdened with radium (Ra226, Ra228) will be studied at the microscopic-microradiographic level to quantitate the tissue pathology. Autoradiography will be used to measure the microscopic alpha dose to bone. Additional human skeletal materials showing a variety of non-irradiation pathologies will comprise a control series.

Results: We have developed an autoradiographic method which involves coating tissue sections with solutions of cellulose nitrate. These detector films which are selectively sensitive to alpha particles (4.5-5 MeV) (and insensitive to beta rays) can provide for greater resolution than nuclear emulsions. Alphagraphs of this type can be quantitated by track-counting techniques.

SUPPORTED BY U.S. Atomic Energy Commission

5.0289, RADIOSENSITIVITY OF MAMMALIAN CELLS IN TISSUE CULTURES

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A major goal of this study is to investigate the variation in lethal radiation response during the mammalian cell generation cycle and its relation to biochemical events, particularly controlling events, occurring in that cycle. Radiation resistance is in part controlled by DNA synthesis and also as recent results have shown (see below) sulfhydryl groups are implicated. The exact involvement of the latter needs clarification. Using a synchronized system of Chinese hamster lung cells in culture we intend to determine the relative concentrations of free and bound sulfhydryl at different stages of the cell cycle and to further expand recent experiments on sulfhydryl binding agents. The latter show that N-ethylmaleimide (NEM) sensitizes cells most when they are most resistant, i.e. at the latter part of the S period. Future experiments will examine the extent to which NEM and MEA can neutralize each other and the effects of other sensitizers on cells at different stages of the cell cycle. These and other pertinent questions should help to establish the role of sulfhydryls in controlling the cyclic radiation response on mammalian cells.

Results: Mammalian cells in culture show a fluctuation in lethal response to X-rays during the cell generation cycle, being resistant in late S, sensitive in Gsub2 and mitosis, and intermediate and sometimes varying in sensitivity during Gsub1. This is related in part to DNA synthesis during the S period. Results with sulfhydryl protectors such as cysteamine indicate that sulfhydryls are also involved in controlling the radiation response. Further work, directly on sulfhydryl content as a function of time in the cell cycle and on the effects of sulfhydryl binding agents, tends to confirm this.

SUPPORTED BY U.S. Atomic Energy Commission

5.0290, CORRELATED STATISTICAL AND CYTOPHYSIOLOGICAL STUDIES OF THE RADIATION RESPONSE IN HIGHER VERTEBRATES

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Kinetic models of radiation injury and repair, formulated from mortality data from birds and mammals, emphasize dependence of the injury on physical factors of the irradiation (e.g. dose, time, exposure pattern). Models are considered in relation to selected injury reactions of acute and chronic responses that are studied in detail at functional and structural levels. Objectives of statistical descriptions are to identify and separate mechanisms involved in acute radiation death (within 30 days) in higher vertebrates and to describe time-dose relations of processes of injury accumulation and repair after protracted, split, or fractionated exposures. Total exposure periods or intervals between exposure fractions do not exceed 24 hrs. In studies of mechanisms of radiation injury, current emphasis is on early vascular damage. Circulatory collapse is characteristic of the initial syndrome (death within 1-2 days) in the chicken. This effect is subject to rapid repair or reversal and is exposure-time dependent. A similar early vascular damage is observed in mammals but does not terminate in general circulatory stasis. Investigation of early vascular damage includes (1) effects on dynamics of the microcirculation (in vivo cinemicrographic study) and (2) ultrastructural study of blood vessels, with special attention to behavior of tracer particles and to hydrolytic enzyme localizations. A small group of chickens is being maintained for duration of life, for investigation of dose-protraction effects on later mortality.

Results: In the chicken and mouse, acute lethality from a single dose of Co-60 gamma rays is reduced as dose protraction is increased. For early mortality (less than 2 days after exposure) in the chicken, split exposures revealed that a resistance (increased tolerance) can be induced by an initial (conditioning) exposure and a relatively refractory state is produced. Stasis and degeneration of the microcirulation, after either protracted or split exposures, can be correlated with mortality. Ultrastructural studies suggest endothelial degeneration results from direct injury. Long-term observations indicate doses protracted over 24 hrs are less effective than shorter exposures (60 min) in reducing survival time.

SUPPORTED BY U.S. Atomic Energy Commission

5.0291, RADIATION DAMAGE TO RADIUM-BURDENED HUMANS

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The purpose of this work is to find quantitative relationships between radiation dosage and damage to human tissue by the study of radium dial painters and other humans with appreciable body burdens of radium. New data on the incidence of bone sarcoma are being obtained by measurements of radium and examination for sarcomas in bones obtained by exhumations. More complete incidence data and new manifestations of radiation damage are being sought by continued study of living cases into late life. Complete records of past work on radium cases are being accumulated and the search for new cases is proceeding.

SUPPORTED BY U.S. Atomic Energy Commission

5.0292, ULTRASTRUCTURE CHANGES ASSOCIATED WITH CELL DIFFERENTIATION IN NORMAL AND IRRADIATED ORGANISMS

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Cells most vulnerable to radiation damage have become differentiated from undifferentiated stem cells. These include sarcoblasts which differentiate into muscle, germ stem cells that differentiate into spermatozoa, or undifferentiated bone marrow cells that become granulocytes and red blood cells. This differentiation typically follows changes in subcellular structures and the production of other membrane fibers and organelles. Irradiation inhibits some of these essential changes and enhances others, i.e., supernumerary tails in sperm and the over production of plasma cells by bone marrow. The study of ultrastructure in both normal and irradiated material provides evidence of the cause for deviations from normal development. To gain this information cytochemical, cytological, and physiological methods are used in combination with biochemistry, light, and phase microscopy and high resolution electron microscopy. Insect testis, embryos and muscle, and canine bone marrow are used in this study of irradiation injury. Chemicals and antibiotics that are specific intracellular inhibitors are used to compare chemically induced deviations with those produced by ionizing radiation, to establish specific radiation effects.

Results: Paracrystallinity is typically produced during differentiation, i.e., chromatic sperm acrosome and mitochondria. Irradiation produces the same condition in nuclei, mitochondria and myelination of the cytoplasm. This paracrystalline condition has been compared with crystalline proteins and enzymes by high resolution electron miscroscopy.

SUPPORTED BY U.S. Atomic Energy Commission

5.0293, EXPERIMENTAL MODIFICATIONS OF ANTIBODY PRODUCTION

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Our experiments, to supply basic information on the nature of immune mechanism, have dealt intensively with antibody formation. A major part of the work has involved the hemolysin response in rabbits immunized with the Forssman antigen contained in such materials as sheep red blood cells or heated horse kidney. The response has been modified by X- irradiation with doses varying from 25 to 700 R. Another line of attack has dealt with the antibody, ablastin, developed in the rat when infected with 'Trypanosoma lewisi.'

SUPPORTED BY U.S. Atomic Energy Commission

5.0294, PREPARATION AND PROPERTIES OF SUBCELLULAR FRACTIONS

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Isolation of subcellular fractions is an important analytical tool for the study of cell physiology and biochemistry, including the study of the fine structure of cell organelles. Our study is directed toward the development and application of methods of density-gradient centrifugation that relate the concentration of the cellular components to the size of the particulates with which they are associated, rather than to morphologic labels of doubtful meaning.

The procedures already developed in this laboratory have been valuable in the comparison of tissues from normal animals and those treated in various ways, including exposure to X-rays. They have also been sucessfully adapted as preparative techniques. Sucrose gradients are prepared by use of various gradient-forming devices. After a tissue homogenate is layered over this gradient and the tube containing it is centrifuged, successive layers are collected and are analyzed for a number of constituents. Since the average particle size in each layer can be predicted from an equation derived from Stokes' Law, the relationship between concentration and particle size can be estimated. Currently, we are carrying out tissue fractionations in a zonal centrifuge, which provides much finer resolution of subcellular particles than is possible by other procedures that involve centrifugation.

Results to date: Mitochondria isolated from mice previously injected with various radioprotective thiols show an altered sedimentability. Treatment with cysteine, mercaptoethylamine, or aminoethylthiophosphate results in significantly decreased sedimentability, whereas AET S-(2-aminoethyl) isothiouronium bromide hydrobromidel) has the opposite effect. An N-substituted compound, N- (aminopropyl)-aminoethylthiophosphate affects sedimentability very little. These in vivo effects do not correlate well with results of in vivo experiments on mitochondrial swelling.

SUPPORTED BY U.S. Atomic Energy Commission

5.0295, KINETIC MODELS OF PHOTOREACTIVATION IN BACTERIA

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UV irradiated bacteria of many strains are reactivated by visible light and the degree of reactivation is dependent on its intensity and duration. It was first postulated that visible light simply reduced the effectiveness of the irradiation. Inherent in this postulation is the assumption that the effects of UV are not primary and can be nullified before the initial injury (lesion), leading to inactivation of the cell, is established. This 'dose-reduction hypothesis' is too restrictive to account for the observed survival patterns of many organisms after photo reactivation. In this study, we attempt to construct a phenomenological model of greater generality. The underlying assumptions upon which our approach is based are: (1) among the lesions produced by UV irradiation there are specific events that inactivate the cell, (2) registration of a single event in the cell is sufficient to inactivate the cell; (3) events are reversed sequentially or randomly by exposure to visible light; (4) the cell is reactivated when, and only when, all events sustained are reversed. Four models were constructed that differ either in the postulated distribution (Poisson or Binomial) of UV events in the cell, or in the postulated method by which reversal takes place (Sequential or Random). Appropriate survival data using cells of 'E. coli', strains WP2-hcr, AB2480 and AB1886 in stationary phase, were supplied by Dr. D.J.G. Davies of Bath University of Technology, Bath, England.

Results: Analysis of data under the postulated Binomial-Sequential model indicates that a maximum of five lethal and photo repairable events are sustained by the cells from UV irradiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0296, PHOTOINACTIVATION AND CELLULAR REPAIR

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Harmful effects of far ultraviolet (200-300nm), near ultraviolet (300-390 nm), and visible light (390-750 nm) on cells are investigated with the purpose of identifying the molecular mechanisms involved. Athough there are many beneifical effects of sunlight, many of the photochemical reactions that occur in biological systems are deleterious. Sensitization to near ultraviolet and visible light by exogenous chromophores, such as acridine dyes, and by endogenous chromophores, to be identified, is being studied in various microorganisms. The identity of the lesions produced, the identity of the chromophores involved, the role of oxygen, and the roles of various kinds of cellular repair are being investigated. Enzymatic photoreactivation is studied to aid in the identification of the lesions produced. The contrasting effects of acridine dyes in protecting cells against lethal and mutagenic effect of far ultraviolet radiation is also being studied.

Dose-response curves are routinely obtained with the ability of the cell to produce a visible colony as the biological end-point. Numerous radiation sources with monochromators and interference filters are employed.

Results: Extensive data on the inactivation of 'Escherichia coli' K 12 AB 2480, 'E. coli' WP2, and 'E. coli' WP2hcr by radiation from 254 nm to 750 nm implicates both excision repair and post-replication repair at wavelengths up to 500 nm. For the first time enzymatic photoreactivation (ratio, 4:1) has been demonstrated in 'E. coli' K 12 AB 2480 after inactivation by 365 nm radiation. Inactivation by 365 nm radiation is oxygen dependent in contrast to the oxygen independence of 254 nm inactivation. The photoreversal of 365 nm damage implicates pyrimidine dimers in DNA as the major lethal lesion produced by this radiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0297, PHOTODYNAMIC MUTAGENESIS

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Mutagenic effects of a broad spectrum of radiations are studied in continuous cultures of bacteria with the purpose of detecting initial events that lead to mutational lesions. Continuous culture techniques permit the study of mutation induction at very low (chronic) levels of the mutagen in the absence of detectable lethality. There is an ongoing program for the improvement of apparatus for maintaining continuous cultures. A photocell- controlled continuous culture device (Nephelostat) has been built.

Acridine sensitized mutagenesis is studied to relate molecular structure, physical properties, molecular affinities, and binding characteristics (intercalation?) to the mutation process. The mutagenicity of near ultraviolet (320-390 nm) and visible light (390-750 nm) is being studied in the absence of added sensitizers. The naturally occurring chromophores for this oxygen-dependent mutagenicity are of special interest because of their likely association with DNA in normal cell processes. Far ultraviolet (200-300 nm) and chemical mutagenesis are studied for the purpose of comparison.

These studies employ continuous cultures of both the chemostat and the Nepholostat type. A variety of 'Escherichia coli' strains are used. Mutations to resistance to the bacteriophages T5 and T6, resistance to streptomycin, and reversion to tryptophane independence are studied.

Results. An action spectrum for the induction of phage T5 resistance in chemostat cultures of 'E. coli' revealed an effective band between 330 nm and 500 nm. A high level of visible-light mutagenesis in 'E. coli' B/r in the absence of added tryptophane ruled out this amino acid in these oxygen- dependent processes. Results with chemostat cultures of 'E. coli' B/r/1,trp suggest that mutagenic processes affecting phage T5 resistance and streptomycin resistance are different at 254 nm, 330 nm, and at 400-750 nm.

SUPPORTED BY U.S. Atomic Energy Commission

5.0298, PULSE RADIOLYSIS IN RADIATION BIOLOGY

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The initial steps in radiation inactivation of aqueous enzymes such as lysozyme and trypsin are being investigated with pulse radiolysis, with current emphasis on the basic mechanisms of chemical protection. The work involves the spectral identification of intermediates produced by radical attack, measurements of rate constants and kinetics, and parallel enzymatic activity determinations. The extension to zymogen enzyme systems is planned, to clarify the effect of the primary chemical lesions on the enzymatic functions of the protein. In addition, the current study of chemiluminescent reactions between solvated electrons and triplet dye states is being continued. Evidence is accumulating that the primary step leading to additional electronic excitation of the dye involves the triplet excimer (triplet-dye complex molecule) which has broader implications for dye-sensitized reactions than the aqueous eosin system in which the effect has been first observed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0299, HUMAN-PRIMATE COMPARATIVE EYE STUDY FOR LASER SAFETY CRITERIA

P.S. COOGAN, Presbyterian Saint Lukes Hosp., *Chicago, Illinois* 60612 (F41609-71-C-0006)

Technical Objective: The objective of this study is to acquire sufficient comparative human/primate retinal data to establish human laser permissible exposure criteria for Air Force operational laser systems. Presently all threshold injury data are acquired from rhesus monkeys and although their eyes are similar to man there are differences in size, retinal ultrastructure, pigment density and distribution. This study will quantify comparative human/primate thicknesses of retinal layers and retinal-choroidal pigment distributions and make possible valid extrapolations from animal data to man.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0300, EFFECTS OF RADIATION AND DRUGS ON HAIR AND HAIR GROWTH

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Continuing investigations of the effects of high dose radiation on telogen mouse hairs revealed that 15 months after radiation cell cycle division times were equal in irradiated and control sites. The reduced mitotic index in treatment sites (0.68%) compared to control areas (1.51%), however, indicated that persistent post-irradiation reductions in hair lengths reflected irreversible reductions in matrix stem cell populations.

Studies of alopecia after irradiation of anagen hairs revealed that despite immediate total loss within 5 days after doses of 1250-2000 rads, 73-88% of follicles showed hair regrowth 7-8 months later. Hair irradiated in telogen showed delayed loss 6 to 9 weeks post- radiation. Four to five-fold greater doses of radiation were required to produce threshold alopecia in non-proliferative hair cell populations (telogen) than in proliferative (anagen) matrix cells. Studies of immediate post- radiation alopecia after electron beam irradiation (5 MEV) yielded a 'hair survival curve' essentially identical to that obtained with X-ray irradiation (45 Kv).

Cell kinetics studies of anagen matrices in mice given tritiated thymidine revealed that the repeated trauma of 'double plucking' produced marked reductions in labeled cells and total mitoses as compared to singly plucked animals. Reductions in the proliferative cell pool after double plucking were also reflected in lowered levels of radioactivity following combustion and assay of groups of follicles at multiple intervals during the anagen phase of the cycle.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0301, CELLULAR EFFECTS OF RADIATION AND CHEMOTHERAPY

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Walker-256 carcinoma was transplanted subcutaneously in the dorsum of male Sprague-Dawley rats weighing 100 to 120 gm. The tumors were allowed to grow to 1 cm in diameter. The animals were divided into experimental and control groups. The tumors in the experimental animals were irradiated, the dose ranging from 50 to 2000 rads. Specimens were dissected from the irradiated tumors at intervals of 1, 2, 4, 12, 24 and 48 hours, and one week and two weeks after irradiation, and from the control animals at the same intervals. Light microscopy showed no cytoplasmic changes in the irradiated group when the dose was less than 500 rads. With 1000 and 2000-rad doses the nuclear profile changed and cytoplasmic basophilia was diminished. Enzyme histochemical stuies showed diminution of succinic dehydrogenase and coenzyme I and II as the dose was increased to 2000 rads, starting 24 hours after irradiation, with marked diminution on the seventh day. The hydrolytic enzyme activities were not altered with a dose up to 1000 rads. With a 2000 rad dose, diminution of acid phosphatase activity was seen one week after irradiation. Reaction for lipases was weaker in tumors ir-

radiated with 1000 rads or more. The cytoplasm of the tumor cells in the irradiated group showed diminution in the mitochondrial and microsomal population, most marked when the dosage was increased to 2000 rads, and one week after irradiation. On the basis of our results it can be confirmed that radiosensitivity of a malignant cell in an experimental system is largely dependent on the cytoplasmic organelles.

SUPPORTED BY U.S. Veterans Administration

5.0302, ANALYSIS OF THE MORBIDITY AND MORTALITY OF CHILDREN IRRADIATED IN FETAL LIFE
M.L. GRIEM, Univ. of Chicago, School of Medicine, *Chicago, Illinois* 60637 (AT(11-1)-69)

This project is an aalysis by computer techniques of the 1st and 2nd follow-up data of 1,008 primiparas who were irradiated in utero in 1948. Control data are from unirradiated populations in 1947 and 1949. Since these subjects are now approaching child-bearing age, it has been suggested that a follow-up of the progeny of the irradiated population may also be of value in estimating radiation injury. The feasibility of such a follow-up is to be examined.

Results: The first follow-up of studies of this population (1966) indicates an increase in the number of hemangiomas (a benign tumor). Congenital malformations, eye diseases and malignant neoplasms were sought for, but there was no increased incidence in either the first (1966) or second (1969) follow-up.

SUPPORTED BY U.S. Atomic Energy Commission

5.0303, THE LATE EFFECTS AND METABOLISM OF THE BONE SEEKING RADIOELEMENTS
R.J. HASTERLIK, Univ. of Chicago, School of Medicine, *Chicago, Illinois* 60637 (AT(11-1)69)

Radiography of the radium-bearing patients who have formed the basis of these studies will be continued at selected intervals. We shall continue with our evaluation of the relationship of the present body burden, peak burden and cumulative radiation dose to the induction of osteosarcomata, tumors of the sinuses and mastoids and central nervous system. Experimental studies on mice will attempt to elucidate whether there is selective concentration of radon in the lipid rich supporting cells of the central nervous system.

A study of the alteration of micro-bone structure as revealed by scanning electron microscopic techniques will be carried out.

An apparent significant increase in tumors of the central nervous system in radium-bearing patients was demonstrated during the past fiscal years. All data on our patients has been reduced to a standard format and stored on computer tape, and a 600-page 'data book' has been jointly published by Argonne Cancer Research Hospital and Argonne National Laboratory. We expect to complete a monograph on the radium studies in 1970.

SUPPORTED BY U.S. Atomic Energy Commission

5.0304, THE MECHANISM OF THE CELL MEDIATED IMMUNE RESPONSE
R.D. PETERSON, Univ. of Chicago, School of Medicine, *Chicago, Illinois* 60637

The object of the propose research is to extend a preexisting line of investigation directed at understanding the mechanism of the cell mediated immune response. The line is the experimental model, previously developed by this investigator and his colleagues, that makes it possible to obtain a chicken capable of manifesting cellular immunity but incapable of producing serum antibodies. Bursectomized, irradiated chickens, after recovery from irradiation, lack the population of lymphocytes that synthesize serum antibodies but they regenerate those lymphocytes responsible for cellular immunity. The aim of the proposed study will be to explore this model at the cellular level because lymphocytes from such chickens may afford the unique opportunity of studying cellular immunity in a population of cells unable to synthesize serum antibodies. Sensitized lymphocytes from such chickens will be studied in vitro for clues to the mechanism responsible for their capacity to recognize and interact with antigens. An attempt will be made to determine which, if any, of four feasible possibilities is the basis of cellular immunity. These are 1) secretion of small amounts of antibody, 2) production of cell-bound antibody, 3) presence of a non-immunoglobulin material on the cell surface capable of relating specifically to an antigen, and 4) an unknown intrinsic antigen-induced alteration of the cell urelated to cell surface change.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0305, IDL PHYSICS, GENERAL
R.L. PLATZMAN, Univ. of Chicago, Graduate School, *Chicago Illinois* 60637

Technical Objective: This theoretical research is directed principally toward improved understanding of the early events taking place in the interaction of ionizing radiations and matter. These events are equally crucial for the physical, chemical, and biological action of the radiations. Subjects under study include: (a) Degradation of high-energy radiation; the charged-particle spectra effective in radiation action are being investigated, together with the role of such 'degradation spectra' in establishing the qualitative and quantitative character of radiation effects. (b) Detailed characterization of initial (primary) products in gases; the first state here is attainment of the complete oscillator-strength distribution of a molecule. From this distribution, inelastic scattering cross-sections can be obtained, and from these, together with the degradation spectra, absolute yields of primary products can be calculated. (c) Characterization of initial products in condensed media. (d) Immediate behavior of primary products; emphasis here is accorded the decomposition of superexcited states.

SUPPORTED BY U.S. Dept. of Defense - A.R.P.A.

5.0306, HISTOPATHOLOGICAL CHANGES IN LABORATORY ANIMALS EXPOSED TO PROTRACTED LOW-LEVEL TOTAL-BODY NEUTRONS AND GAMMA RAYS
J.H. RUST, Univ. of Chicago, School of Medicine, *Chicago, Illinois* 60637 (AT(11-1)1487)

A study of the histological changes in small laboratory animals subjected to low levels of protracted total-body irradiation with fast neutrons. The work to be conducted at the Argonne National Laboratory as a cooperative effort, except for the histological examination of tissues which will be conducted at the University of Chicago.

SUPPORTED BY U.S. Atomic Energy Commission

5.0307, PLANS FOR A COMPARATIVE ONCOLOGY RESEARCH PROGRAM
J.H. RUST, Univ. of Chicago, School of Medicine, *Chicago, Illinois* 60637

For planning a cooperative interdepartmental research program in comparative oncology to be conducted largely within the new A.J. Carlson Animal Research Facility and its related subfacilities.

The primary elements to be under consideration will be the plans for the feasibility of comparative oncological studies in, (a) chemical and biological carcinogenesis, (b) physical (radiation) carcinogeresis, (c) localization of carcinogens (autoradiography) and the biochemical and morphological changes in cells and organs induced by these carcinogens (ultra-microscopy and light microscopy).

Secondarily, under consideration will be the plans for and/or the feasibility of comparative oncological studies, (a) feline leukemia as a model for cancer research, (b) carcinogenic capacities of radio- synergizing or related radiomimetic drugs in several animal species, (c) possible potentiation or detoxification of carcinogens by artificially induced liver microenzymes in several animal species.

5. RADIATION

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0308, RADIOBIOLOGIC STUDIES ON TUMOR TRANSPLANTATION AND IMMUNE PROCESSES
E.L. SIMMONS, Univ. of Chicago, School of Medicine, *Chicago, Illinois* 60637 (AT(11-1)-69)

This program is concerned with changes in the mammal caused by ionizing radiations administered at various ages, and modification of these changes by shielding of hematopoietic tissues during irradiation, injection of them postirradiation, or preirradiation treatment with drugs.

We intend to extend the work reported below to determine the reason for the variation in radiation sensitiveness noted including such factors as nutrition, bacteremia, stage of cell cycle of stem cells, hormonal levels. Effects of shielding, injection of tissues and drugs upon this sensitivity will also be noted. Other experiments will investigate the effects of bone marrow injections upon recovery in mice irradiated under hyperbaric conditions, correlation of date of appearance and type of tumors in mice with time of postnatal irradiation.

Results: Mice 1, 7, 14, 21, 28 and 35 days of age were X- irradiated with either single doses of 320R or with 2 doses of 160R 4 days apart. All experimental groups contained approximately 100 mice. LD50(30) figures showed that split dose treatment at 7, 14 and 28 days were significantly more lethal than single irradiations. The recovery rate was also decreased at these ages. Proliferative capacities of bone marrow cells increased progressively after birth while those of the spleen cells declined.

SUPPORTED BY U.S. Atomic Energy Commission

5.0309, PARTIAL-CELL IRRADIATION OF MITOTIC CELLS
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The goals of this research are to gain, through investigations featuring partial-cell irradiation, better understanding of (a) the actions of ultraviolet and ionizing radiations on eukaryotic cells, especially on the structures and processes involved in their division, and (b) the mechanisms of normal mitosis and subsequent nuclear reconstitution.

The specific tissue-culture cells are of urodeles 'Triturus, Ambystoma'. Partial-cell irradiations are achieved through microbeams of monochromatic or heterochromatic ultraviolet light and of 1.7-MeV protons.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0310, PROTECTION AGAINST RADIATION DAMAGE TO CHROMOSOMES
S. MITTLER, Northern Illinois University, School of Liberal Arts, *Dekalb, Illinois* 60115

The problem under study is that concerning the mechanism of the repair of injured chromosomes and indirectly with the mechanism of radiation injury. The approach in the proposed study is via the hypothesis that ATP is needed in the repair process, for posttreatment with anoxia and certain substances which interfere with ATP formation or the repair process results in increased radiation damage. Exogenous ATP has been shown (Mittler, S. U. S. Public Health Grant RH00140) to protect chromosomes from loss in those cells in spermatogenesis in Drosophila that are about to go into or are in meiosis at the time of radiation. The proposed project will continue to study the effect of injected ATP upon radiation induced genetic changes and the sex-linked recessive lethals, translocations, and loss of X and Y chromosomes. Information on dominant lethals and deletion of the X chromosome will also be obtained from the various cells in spermatogenesis at the time of radiation by the brood method. If ATP formation is responsible for repair, then interference with ATP formation should enhance radiation damage. Some of the factors which decrease ATP synthesis, namely, polycations, 2-4-dinitrophenol, phospholipids and calcium, will be investigated and, of course, those that aid ATP synthesis, polyanions, hypotonicity and high pH, will be tested as to the effect on radiation induced chromosome damage. Other triphosphates, namely, adenosine 5'- triphosphate, guanosine-5'-triphosphate, cytidine-5'triphosphate, uridine-5'-triphosphate, and thymidine-5'-triphosphate will be tested for ability to repair radiation induced aberrations in chromosomes.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0311, RADIATION INDUCED CHROMOSOME DAMAGE AND CELL RESPONSE
F.J. SOBKOWSKI, Southern Illinois University, School of Dentistry, *Edwardsville, Illinois* 62025

The primary objective of this project is to obtain information on the pathophysiologic processes involved in the production of late somatic effects of ionizing radiation in vivo.

Experiments are designed to simulate the temporal and physiologic conditions under which the late effects of radiation develop. The parameters to be studied include the incidence and types of radiation- induced chromosomal lesions, the kinetics of cellular and tissue regenerative phenomena and the histopathologic response of the irradiated tissue.

It is hoped that the data from this project, when correlated, will provide information that not only is presently unavailable, but that will provide a base on which additional information may be developed so that an appreciation may be gained of the mechanisms underlying the pathologic processes involved in the production of the late somatic effects of radiation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0312, STUDIES ON BONE MARROW IMMUNOLOGIC CELL(S) IN VITRO AND IN VIVO
S.S. STEFANI, U.S. Veterans Administration, Hospital, *Hines, Illinois* 60141

Purpose: This program seeks to reduce death resulting from secondary disease after treatment of lethally irradiated mice with allogeneic bone marrow preparations.

Plan: To achieve such ends, allogeneic bone marrow cell suspensions have been treated with mild immunosuppressives to selectively eliminate the immunologically active cells without destroying the other hemopoietic components.

Results and Conclusions: Of the immunosuppressives tested in this laboratory, we have selected prednisolone, phytohemagglutinin (PHA), and anti-lymphocyte serum (ALS) for further investigation. In vitro studies of these agents showed a lymphocyte-killing effect of 20% for prednisolone, 40% for PHA, and highly variable effects with ALS. Of the three, PHA and ALS also reduced the number of red and white cell precursors. In vitro, a combination of cell irradiation (400 R X-ray) and prednisolone gave the best results in terms of selective suppression. Spleen colony assays obtained with identically treated cell suspensions correlated well with in vitro cell survivals. In vivo preliminary results suggest that PHA will render higher survival (50%) than prednisolone (30%) after lethal irradiation, but that both agents significantly reduce 'runt disease' manifestations. Our ALS preparation did not achieve higher than control survival. We feel that scrutinizing the preparative steps and final evaluation for ALS preparations may resolve these difficulties.

Future Plans: With a view toward improving the 90 day survival (overcoming the secondary syndrome) both PHA and prednisolone will be studied for individual and synergistic effects on the secondary syndrome. As soon as the difficulties with ALS have been resolved this agent will also be re-evaluated in vivo.

SUPPORTED BY U.S. Veterans Administration

5.0313, IN VITRO EFFECT OF IMMUNOSUPPRESSIVE AGENTS ON MARROW CELLS
S.S. STEFANI, U.S. Veterans Administration, Hospital, *Hines, Illinois* 60141

Purpose: The purpose of this experiment is to determine: (a) whether the lymphocytes from the blood differ from those of the bone marrow in their function and sensitivity to x-ray and to immunosuppressive agents in vitro; (b) whether the bone marrow lymphocytes are more sensitive to immunosuppressive agents than other cell lines.

Plan. After sternal bone marrow aspiration the bone marrow particles are washed, separated, and resuspended in the appropriate media. Survival of the various bone marrow cell lines after any given experiment is determined by phase contrast microscopy and by the dye exclusion technique, associated to standard hemocytometer methods and suspension smears. The response of bone marrow lymphocytes is to be compared to that of blood lymphocytes from the same patient.

Results and Conclusions. Meticortelone (10 microliter/ml) showed a decrease of about 20% in the number of lymphocytes as compared with the control untreated suspensions. Tested were also antihuman lymphocyte serum and phytohemagglutinin. The first gave varying and disappointing results, namely a cytotoxic effect not only to lymphocytes but also to all other bone marrow components. Phytohemagglutinin, although also somewhat toxic to bone marrow was particularly toxic to the lymphocyte component (40% killing effect at 2 days), as compared with the control suspensions. However, the best results were obtained when 400 and 10 microliter/ml of meticortelone were combined.

Future Plans. Due to shortage of manpower and technical difficulties, few experiments have been carried out during the last year. However, further experimentation along the above-mentioned lines will be undertaken in the near future in order to make these observations statistically valid.

SUPPORTED BY U.S. Veterans Administration

5.0314. PREVENTION OF RADIATION-INDUCED LEUKEMIA

S.S. STEFANI, U.S. Veterans Administration, Hospital, *Hines, Illinois* 60141

Purpose. The purpose of the proposed experiment is to determine whether phytohemagglutinin (PHA) causes a decrease in the incidence of radiation induced leukemia.

Plan. Male RF mice will be injected with PHA or saline and subjected to a leukemogenic dose of irradiation. They will be observed until natural death, and gross and microscopic histologic studies will be made.

Results and Conclusions. This study may lead to a possible method for preventing leukemia in humans exposed to therapeutic or accidental irradiation.

SUPPORTED BY U.S. Veterans Administration

5.0315. ELECTRON MICROSCOPE STUDIES OF IRRADIATED BLOOD LYMPHOCYTES IN VITRO

S.S. STEFANI, U.S. Veterans Administration, Hospital, *Hines, Illinois* 60141

Normal human lymphocytes were exposed in vitro to graded single doses of irradiation (from 100-20,000 R), then fixed at 15 minutes to 18 hours after irradiation and studied under the electron microscope. The early subcellular effects of irradiation and the mode of death of the lymphocytes were compared using low or high single radiation doses.

Two different types of radiation-induced damage could be observed. Up to doses of 4,000 R damage consisted of localized bleb formation of the plasma membrane, with swelling of the endoplasmic reticulum and mitochondria, and dilatation of the perinuclear space. At doses of 10,000 R and 20,000 R damage consisted of diffuse edema of the peripheral cytoplasm, with apparent maintenance of the normal aspect of the inner structures of the cytoplasm and the nucleus. Dilatation of the perinuclear space was seen in many cellular sections, sometimes with invagination of the inner nuclear membrane into the nucleus. Sections through these invaginated areas would give the false impression of intranuclear vacuoles. This electron microscope study has failed to reveal any sign of associated damage to the nucleus; specifically, there was no intranuclear vacuoles as described in previous work using light phase microscopes. Our findings contradict also previous reports indicating the 'intranuclear vacuole' to be the initial or one of the first signs of radiation-induced degeneration. The present investigation tends to implicate the plasma membrane as the site of the initial and most important events leading to lytic or interphase cellular death.

SUPPORTED BY U.S. Veterans Administration

5.0316. METABOLISM AND REMOVAL OF SR 90 AND RA 226 IN MAN

H. SPENCER, Loyola Univ., School of Medicine, *Maywood, Illinois* 60153 (AT(11-1))

Sr90 excretion and balance studies in man will be continued under strictly controlled dietary conditions. These investigations will be performed under different study conditions, the aim being to develop methods of decreasing the intestinal absorption of chronically ingested Sr90. Several antacids similar in composition to aluminum phosphate gel, which has been shown to decrease the intestinal absorption of acutely administered radiostrontium, will be used in the Sr90 studies. Another substance which will be used in the Sr90 studies in man is fluoride given in relatively large amounts. Studies of the removal of previously deposited Sr90 will be continued using compounds which have been shown to be effective in the removal of Sr85 in man such as hormones (corticosteroids, parathyroid hormone, sodium sulfate, sodium citrate, and certain chelating agents).

Results. In studies of the inhibition of the intestinal absorption of radioactive strontium in man, aluminum phosphate gel has been shown to be highly effective. These results have been recently confirmed by total body counting in this laboratory.

SUPPORTED BY U.S. Atomic Energy Commission

5.0317. ANIMAL METABOLIC STUDIES OF STRONTIUM AND CALCIUM WITH SPECIAL REFERENCE TO FALLOUT RADIONUCLIDES

J.J. ANDERSON, Univ. of Illinois, School of Veterinary Medicine, *Urbana, Illinois* 61801 ((11-1)-1339)

The purpose of the proposed work are two-fold: (1) to investigate with the aid of 47Ca the role of estrogen in calcium metabolism during late gestation and early lactation of normal and thyroidectomized cows and goats on different Ca:P ratio intakes; and (2) to complete studies initiated during the previous period designed to determine the age of swine at which 85Sr is maximally retained, as measured 200-days post- administration of the dose. The first objective has resulted from previous investigation using the goat as a model of the cow in the study of parturient hypocalcemia, a metabolic disease of the cow also known as parturient paresis and milk fever. A question arises as to why parathyroid hormone, shown by radioimmunoassay to be present at greater than normal concentration in parturient cows, is unable to stimulate the resorption of sufficient amounts of calcium from the so-called deep bone and, hence, restore blood calcium concentration to a more nearly normal level. The breakdown in the calcium homeostatic mechanism has been suggested to result from a depressed end-organ (bone cells) responsiveness to parathyroid hormone and, furthermore, that increasing titers of estrogen in later pregnancy may be involved in antagonizing the action of parathyroid hormone at the level of bone cells. The only evidence in the literature that gives indirect support to a relationship between estrogen and calcium metabolism is a report by Bach and Messervy (Vet. Rec. 84:210, 1969), who demonstrated that not only did ionic calcium fall abruptly 24 hours after estrus but also after parturition and after the administration of stilbesterol to ovariectomized cows. To test this relationship blood concentrations of estrogens will be measured by new radio-immunoassay procedures, and of calcium, total and ionic by standard methods, and additionally the 47Ca kinetic parameters of the readily exchangeable Ca pool will be measured in pregnant and lactating cows and goats, both normal and parathyroidectomized by our usual procedures. These animals will also be placed on rations containing different levels of Ca and P and some will be administered exogenous sources of estrogen.

Abnormal dietary intakes of Ca and P (4 to 1 and 1 to 3 ration) have been shown to influence the size and transfer rate of the readily exchangeble calcium pool of non-pregnant non-lactating goats.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0318, GENETIC EFFECTS OF RADIATION ON BIOMETRICAL TRAITS
R.W. TOUCHBERRY, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-35-0367)

OBJECTIVE: The broad objectives of this research were to determine the genetic effects of X-irradiation on quantitative traits in the generation immediately following irradiation and the cumulative genetic effects of irradiation in successive generations.

APPROACH: Both mice and Drosophila were used in measuring such effects. The mouse experiments consisted of matings in all combinations of females exposed to 0, 10, 20, 30, and 40 r and males exposed to 0, 50, 100, 150, and 200 r of whole body X-irradiation. This mating scheme was followed for fifteen successive generations in which data were collected on number of young per litter at birth and 38 days of age, sex ratios, and weights at 2, 8, 14, 20, 26, 32, and 38 days in both a hybrid and an inbred strain of mice.

PROGRESS: Three basic experiments have been conducted. The first to determine with mice the effects of acute doses of X rays administered each generation on hybrid and inbred populations indicates that the hybrid population was more able to withstand the accumulated effects of irradiation than were the inbreds. As the level of irradiation given each parent increased the average weight of the offspring increased but litter size decreased. In diallele experiments with seven inbred mice strains irradiation had no effect on litter size but the male progeny of irradiated males were larger than from control sires and the female progeny were smaller. In Drosophila experiments after 22 generations of selection the irradiated population showed greater response to selection for thorax length and a depression of three day egg production. Reciprocal recurrent selection was more efficient than mass selection for the two traits, of relatively low and intermediate heritabilities, studied.

SUPPORTED BY Illinois State Government - Springfield

5.0319, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS
A. GOPALAYENGAR, Bhabha Atomic Research Centre, *Bombay, Mahrashtra, India*

Studies on the effect of neutron irradiation on seeds (part of a coordinated program of research on the use of neutrons in seed irradiation).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0320, LOW-LEVEL X-IRRADIATION OF THE BRAIN DURING DEVELOPMENT - MORPHOLOGICAL, PHYSIOLOGICAL AND BEHAVIORAL CONSEQUENCES
J. ALTMAN, Purdue University, School of Science, *Lafayette, Indiana* 47907 (AT(11-1))

The histochemical and morphological maturation of the cerebellar cortex in normal rats will be studied from birth to adulthood with various enzyme-histochemical techniques and with electron microscopy. 2. This normative material will be used to determine changes produced in cerebellar maturation by its irradiation with single or multiple (1- 10K) doses of 100, 150 and 200 r soft X-ray, delivered daily from birth onward. 3. The histochemical and morphological changes that are produced by X-irradiation will be assessed qualitatively and quantitatively immediately after irradiation (1-2 days after irradiation); during the reconstitution period (4-10 days after irradiation); and, to determine terminal damage, during adulthood. 4. With the information available about the chronology of the origin of basket and stellate cells, attempts will be made to selectively destroy one of these interneurons by 'timed' irradiations (0-3, 4-7, 8-11, 12-15 days of age.) 5. Radiation induced cell pyknosis will be used as a marker technique for determining the regional rates of cell proliferation between 0-21 days throughout the entire brain. 6. We will continue our studies of the effects of low-level cerebellar irradiation on the development of motor coordination during infancy and of lasting deficits that persist through adulthood. Delayed deficits produced in the aging animals will also be studied. 7. Finally, we will begin to study the maturation of the electrical activity of the cerebellar cortex in normal and irradiated animals and the terminal functional alterations produced in the adult cerebellar cortex as a result of reduction or elimination of its interneurons by X-irradiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0321, RESEARCH PROGRAM IN DEVELOPMENTAL NEUROPSYCHOLOGY
J. ALTMAN, Purdue University, School of Science, *Lafayette, Indiana* 47907

(1) The postnatal development of the central nervous system is studied with histological, histochemical and electron microscopic techniques in rats and cats. (2) Alteration in the development of the brain as a consequence of various environmental influences are studied. Special attention is paid to the effects of low-level X-irradiation of specific brain regions on their development. (3) The factors that may affect neural recovery after early retardation of brain development are studied. (4) In all these studies attempts are made to correlate brain development with concurrent behavioral maturation. (5) Our efforts are concentrated at present on the development of the cerebellar cortex and the maturation of motor coordination under normal and abnormal conditions.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0322, EFFECTS OF GAMMA-IRRADIATION ON DNA TRANSCRIPTION AND RNA TRANSLATION IN PLANTS
J.H. CHERRY, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907 (AT(11-1))

X- and gamma-irradiation inhibits RNA and protein synthesis in many plant tissues, so far studied. We propose that ionizing radiation directly or indirectly inhibits protein synthesis by greatly affecting the transcriptional process. Inactivation of RNA polymerase and destruction of DNA template by ionizing radiation would result in the damaging effects noted with living systems. To test the effects of gamma-irradiation on RNA synthesis, it is planned to determine the activities of chromatin-bound and soluble RNA polymerase, DNA template of chromatin and protein synthesis of sugar beet tissue. Error frequencies of RNA polymerase and template activity of the chromatin RNA product will be studied.

RESULTS: Present results indicate that gamma-irradiation of sugar beet tissue inactivates chromatin-bound RNA polymerase and reduces DNA template of chromatin. Gamma-irradiation stimulates the production of invertase and the methylation of RNA.

SUPPORTED BY U.S. Atomic Energy Commission

5.0323, EXPERIMENTAL POPULATION GENETICS IN THE LABORATORY MOUSE
D.P. DOOLITTLE, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01605)

OBJECTIVE: To test the applicability of theoretical developments in population genetics to living populations, and to estimate the potential value of such developments if applied to economically important mammalian species.

APPROACH: The theory of correlated response and indirect selection procedures will be tested by attempting to increase first litter size through selection for third litter size, which is more highly heritable. Independent culling levels will be tested by selection for rapid early growth rate combined with intermediate adult weight. This study will also demonstrate the practicability of combining these two desirable traits. These specific studies exemplify the general type of experimentation intended.

PROGRESS: Since the pig and the mouse are both polytocous mammals, population genetics studies in the mouse may be particularly applicable to swine breeding. Direct selection of mice for first litter is being compared to indirect selection

through third litter size as means of increasing first litter size. Selection to combine rapid growth with medium adult body weight is proceeding as planned. Selection to compare index, tandem, and independent culling levels methods of simultaneous selection for growth rate and litter size is being initiated. Results of these studies should prove applicable to increase productivity in swine. Attempts to protect J strain mice from lethal X-rays by alloxan treatment have failed, apparently because these animals are unusually sensitive to alloxan. Mice from a four-way cross of inbred lines, which approximately replicates the cross in which alloxan radioprotection was originally shown, are being gathered for alloxan-radiation tests. Each of the four inbreds is also being tested. Mortality data on diabetic and normal mice from line MDB/Dt, which carries Hummel's diabetic gene (db), are being gathered preparatory to alloxan-radiation tests in this line. The aim of these studies is to genetically define the basis of alloxan radioprotection, as a step toward clearer understanding of the biological effects and treatment of radiation, in man and his domestic animals, in an increasingly radioactive world.

SUPPORTED BY U.S. Dept. of Agriculture

5.0324, BIOCHEMICAL ASPECTS OF ERYTHROPOIESIS IN CHRONIC IRRADIATION

C.E. BRAMBEL, Univ. of Notre Dame, School of Science, *Notre Dame, Indiana* 46556 (AT(11-1)-2005)

The objective of the research is to critically examine a modified molecular species of hemoglobin appearing during continued radiation exposure in an hypoxic environment; and, to explore the possibility that it may have its origin in the normoblasts of the erythropoietic spleen. It is proposed to ascertain whether the stem cells of the spleen are capable of biosynthesis of hemoglobin under the conditions mentioned. If this be established, the biosynthetic pathway for the modified hemoglobin would be investigated to ascertain the deviations from sequences involved in the normal entity.

Rats in a radiation environment of 70 rads/day present the following events: erythropoietic elements of the bone marrow disappear; when a critical level of anemia develops, there is emergence and proliferation of erythroid elements in the spleen with associated reticulocytosis and increased nemoglobin concentration in the peripheral blood circulation.

Evidence has accrued that new hemoglobin production has proceeded from an emerging erythroid precursor in the spleen. This process was enhanced when an hypoxic state was maintained during the course of radiation exposure. A priori, it may be predicated on this basis that the hemoglobin molecule arising under conditions of stress of anemia may be modified.

Results: Rat globin reveals 5 globin chains in non-irradiated and continuously irradiated rats in the eluates from cation exchange column chromatography with a urea gradient at low pH. Precision urea acrylamide gel electrophoresis reveals characteristic heterogeneity of all the chains. Amino acid analysis of the chains of the two groups manifests significant differences in the number of residues obtained.

SUPPORTED BY U.S. Atomic Energy Commission

5.0325, RADIATION PROTECTION AND RECOVERY IN GERMFREE ANIMALS

R. WILSON, Univ. of Notre Dame, School of Science, *Notre Dame, Indiana* 46556

Germfree animals afford a model system for assessing the effect of microorganisms on the response of mammals to wholebody ionizing irradiation. The projects that have been singled out for special emphasis this year are the treatment of secondary disease in radiation chimeras and the protection of animals irradiated in 'gut death' range by alteration of the migration rate of cells along the villus.

Attempts are being made to conventionalize germfree allogeneic radiation chimeras by controlling their environment and gradually exposing them to a normal bacterial flora. Germfree radiation chimeras are being treated with antilymphocyte serum (ALS) to obviate the tissue degeneration that occurs in these animals; a combination of treatment of ALS and an immunosuppressive agent such as cyclophosphamide may become feasible. A comparison will be made in the response to an allogeneic bone marrow transplant by an X-irradiated host and one that has been rendered immunologically incompetent by chemical immunosuppressive agents.

We are investigating the relationship between the movement of epithelial cells along the villus and radiation protection in the 'gut death' range by trying to identify the factor (s) responsible for that movement and attempting to alter that movement (e.g., control of stimuli to the muscularis mucosa in the lamina propria which is responsible for villus contraction).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0326, RADIONUCLIDES IN THE STUDY OF BODY COMPOSITION AND THYROID DISEASE

R.E. PETERSON, U.S. Veterans Administration, Hospital, *Iowa City, Iowa* 52240

Body composition by the isotope dilution principle is worthy of development because of the need of techniques for nondestructive analysis of the total living organism in health and as influenced by treatment of disease. For 40 k measurements to be applicable to a wide variety of clinical situations requires improved reproducibility and accuracy. Exogenous gamma-labeled metabolites present opportunities for unique turnover data, but require further clarifacation of equilibration phenomena.

I131, I125 and I123 are all utilized for clinical studies of thyroid disease yet vary widely in physical half-life and manner of decay. We wish to use them to examine the specific problem of whether the biologic effects of weak beta interactions may be greater than anticipated in the thyroid, as well as the more general problem of possible differences in biologic effects related to rad dose rate. Observing the effects of this irradiation on tritiated thymidine uptake of thyroid monolayer cultures was chosen as the system which would facilitate the clearest answer.

Thyroglobin and antibodies to thyroglobin have been invoked as involved in thyroid diseases as diverse as hyperthyroidism, chronic thyroiditis, hyperthyroidism, chronic thyroiditis, hypothyroidism and thyroid carcinoma. The hemagglutin techniques for assay have shown the diverse interrelations with thyroid disease, but have not permitted quantitation of both reactants so as to more clearly delineate the varying autoimmune factors in these diseases. The investigators have developed pilot radioimmunoassays for these factors, which now warrant application in sufficient volume to clarify their role in hypothyroidism.

SUPPORTED BY U.S. Veterans Administration

5.0327, THE ACTIONS OF RADIATIONS ON SOME BIOLOGICAL MODEL SYSTEMS

G. STEIN, Hebrew University, *Jerusalem, Israel* (AT(30-1)-3242)

To investigate the action of ionizing radiations on aqueous solutions of proteins, in particular to elucidate the role of excited states and of free radical intermediates respectively. Use will be made of enzyme proteins, containing aromatic and divalent sulfur containing amino acids, to search for functional correlations between these. Use will be made of UV irradiation, and of chemically produced H atoms and hydrated electrons in the study of mechanism. Use will be made of nanosecond pulse radiolysis techniques.

Results: Elucidation of the mechanism of excited state formation and its quenching by radicals in aqueous solutions irradiated with ionizing radiations; comparison in this respect with organic solutions. Discovery of linked process involving aromatic and divalent sulfur containing amino acids in enzyme proteins, leading to inactivation by ionizing radiations and radicals.

SUPPORTED BY U.S. Atomic Energy Commission

5.0328, STUDIES ON NEUTRON IRRADIATION OF SEEDS

G. SCARASCIAMUGNO, Comitato Nazl. Lenergia Nucl., *Rome, Italy*

Studies on neutron irradiation of seeds (part of a coordinated program of research on the use of neutrons in seed irradiation).

5. RADIATION

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0329, RADIATION DAMAGE - METABOLISM IN REPRODUCTIVE SYSTEM
V. MONESI, Univ. Degli Studi, *Rome, Italy*

The general objective of the research plan is to investigate the effects of ionizing radiation at different stages of oogenesis and spermatogenesis in the mouse and the rabbit, and to study those molecular events which might control the sensitivity to radiation damage and the repair mechanisms at definite stages of germ cell differentiation and early embryogenesis. The following problems will be investigated; a) fertilizing capacity in vitro of male and female germ cells irradiated at different stages of gametogenesis; b) analysis of chromosome abnormalities, changes in metabolic activity and rate of development in cleaving embryos in culture following irradiation of germ cells at different stages of gametogenesis. The effects observed will be correlated with specific metabolic events occurring during the irradiated stages. The existence of stable RNA molecules which could influence the developmental process and the response to radiation at subsequent stages and the presence of a 'nuclear' RNA fraction will be taken into consideration. The research project will therefore include also a) characterization by sucrose gradient analysis of the RNA classes synthesized during male meiosis, spermiogenesis, oogenesis and early embryogenesis, and kinetics studies of the RNA turnover; b) analysis of the stable RNA molecules produced during meiosis and utilized in spermiogenesis or synthesized during oogenesis and activated after fertilization, c) analysis of 'nuclear' RNA in male meiosis. Methods will be used to fractionate different cell populations of germ cells from the testis and to isolate and label in vitro with radioactive precursors oocytes free of follicular cells.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0330, CHROMOSOMES OF BONE MARROW CELLS IN RADIATION-INDUCED LEUKEMIA IN JAPAN
H. UCHINO, Hiroshima University, *Hiroshima, Japan*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0331, BEHAVIOUR OF RADIONUCLIDES IN MARINE BIOTA IN CONNECTION WITH THEIR ENVIRONMENT
Y. HIYAMA, Univ. of Tokyo, *Tokyo, Japan*

As same as previous report, recently added project is the radiation effect by radio nuclides on embryological development of marine organisms.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0332, STEM CELL PROLIFERATION AND DIFFERENTIATION
C.W. GURNEY, Univ. of Kansas, School of Medicine, *Kansas City, Kansas* 66101

The regulatory mechanisms leading to extramedullary hematopoiesis are under investigation. Mice are rendered aplastic by Sr89, a beta- emitting, bone seeking isotope which destroys the marrow but delivers less than 10r to extramedullary sites. In such animals, minimal extramedullary hematopoiesis is observed in lymph nodes, but the spleen increases in size for 16 days, after which time hyperplasia of its red pulp is adequate to sustain normal erythropoiesis.

At the present time, the factors responsible for erythroblastic hyperplasia and colony-forming hyperplasia are under investigation. If marrowprival animals sustaining erythropoiesis primarily from the spleen, are transfused and used to assay 1 unit of erythropoiesis, they are found to be less responsive to erythropoietin than normal animals. Bioassay of plasma from strontium treated mice demonstrates a very slight elevation of erythropoietin. These observations suggest continuous excessive stimulation of the splenic red pulp may be one factor in accounting for splenic hyperplasia following bone marrow destruction.

Current studies are directed at an investigation into changes in the concentration of colony-forming units in the spleen during splenic hyperplasia induced by radiostrontium administration.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0333, STUDIES ON MECHANISMS OF IMMUNOSUPPRESSION AND CELLULAR MECHANISMS OF SECONDARY DISEASE
E.M. UYEKI, Univ. of Kansas, School of Medicine, *Kansas City, Kansas* 66101 (AT(11-1)-1632)

1) Investigate the mechanism of immunosuppression by radiation and chemicals. We want to delineate the temporal sequence of immunosuppression of hemolytic plaque-forming cells (PFC), in vitro. 2) To study the early cellular interactions of graft and host tissue. By using the MLI-PFC assay (mixed lymphocyte interaction coupled to in vitro PFC culture), we will investigate the nature of allogenic interaction.

SUPPORTED BY U.S. Atomic Energy Commission

5.0334, KINETIC AND BIOCHEMICAL ANALYSIS OF INTERACTING RADIATION RECOVERY SYSTEMS IN ESCHERICHIA COLI
B.S. FRIESEN, Univ. of Kansas, School of Engineering, *Lawrence, Kansas* 66044 (AT(11-1)-1686)

It is proposed that this project will be a continuation of the investigation of the physiologically-induced variations in recovery from genetic damage in strains of 'Escherichia coli' which are genetically characterized for their repair capabilities. Special emphasis will be on glucose-induced resistance (GIR) to gamma-rays and to certain drugs. The changes in the distribution in size of the DNA as a function of time after irradiation will be followed by the use of alkaline or neutral sucrose gradient centrifugation. It is proposed that DNA synthesized prior to irradiation and after irradiation be studied. From these experiments, the hypothesis will be tested that GIR reflects an enhanced amount and/or rate of repair of potentially lethal lesions.

Results: GIR to gamma-rays and methyl methane sulfonate is exhibited by rec-plus lon-plus cells and is not exhibited in rec-minus cells. As revealed by alkaline sucrose gradient centrifugation, more single- strand breaks in the DNA of GNB-grown rec-plus uvrAB or rec-plus uvr-plus cells are repaired and at an earlier time after irradiation than in NB- grown cells. No repair under either condition of growth is seen in a recA13 recB strain.

SUPPORTED BY U.S. Atomic Energy Commission

5.0335, GENETICS OF CANDIDA ALBICANS - NUTRITIONAL MUTAGENESIS AND COMPARATIVE SUSCEPTIBILITY TO ULTRAVIOLET IRRADIATION
A. SARACHEK, Wichita State University, Graduate School, *Wichita, Kansas* 67208 (AT(11-1)-1772)

The phylogenetic distribution in yeasts of light-dependent and light-independent mechanisms for recovery from ultraviolet (uv) induced damage is being examined. Specifically efforts are directed toward determining whether (a) a correlation exists between the sorts of recovery mechanisms occurring in 'Hansenula' species and the well defined phylogeny of that genus, (b) radiation repair mechanisms can serve as indicators of systematic relationships between species of the diffuse genus 'Pichia', as well as between various pathogenic species of 'Candida', (c) photoreactivation action spectra offer indications of possible evolutionary divergence of the gene for photoreactivating enzyme associated with the genus dependent nature of photoreactivation in yeasts.

These studies are designed to provide insights into (a) the potential of radiobiological phenomena as tools in taxonomic analysis of yeasts and (b) the possible ecological and systematic factors which underly evolutionary fixation of particular recovery mechanisms in various organisms.

Results: A temperature-sensitive mechanism for dark recovery from non-genetic uv damage occurs in all yeasts. Photoreactivation, however, is genus dependent. Separate mechanisms for amino acid, lipid or postirradiation respiration influenced dark recoveries have been shown to be species dependent.

SUPPORTED BY U.S. Atomic Energy Commission

5.0336, LASER EFFECTS UPON VISUAL PERFORMANCE

D.I. RANDOLPH, U.S. Army, Med. Research Laboratory, *Fort Knox, Kentucky*

Technical Objective: To measure the effects of exposure to laser radiations and other high intensity light sources upon the behavioral and electrophysiological functions of the rhesus monkey eye.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0337, STUDY OF OCULAR EFFECTS OF CHRONIC EXPOSURE TO LASER RADIATION

T. LAWWILL, Univ. of Louisville, School of Medicine, *Louisville, Kentucky* 40202 (DADA17)

Technical Objective: To study the ocular effects of exposure to continuous wave helium-neon and argon lasers, will provide information on the hazard of exposure to current and proposed CW laser systems, operating at energy levels below threshold of immediate energy.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0338, EFFECTS OF GAMMA RADIATION ON TREE SEED AND SEEDLINGS

M.B. HEASLIP, Morehead State University, School of Science, *Morehead, Kentucky* 40351 (AT(40-1))

'Pinus' a relatively radiosensitive plant genus, is a desirable indicator of lowlevel radiation stress. 'Pinus echinata', 'P. strobus', and 'P. virginiana' were planted over nuclear waste disposal trenches in 1967-68. Exposure to above and below soil level plant parts are monitored with CaF2 dosimeters. Seedlings are periodically ashed and their activity is determined to learn whether specific isotopes are accumulating. Biological effects of radiation on length and number of needles, elongation, sprouting and survival of seedlings are recorded. Of seven deciduous tree species grown from gamma irradiated seed in 1958, three species are bearing seed. Germination and survival of seed from controls and X1 generation trees are being tested for relative viability to determine long term radiation effects on populations, and gamma irradiated to test for changes in species radiosensitivity and the possibility of using recurrent irradiation as a breeding tool. First year seedlings of 'Quercus alba', 'Juglans nigra' and 'Fraxius americana' were gamma irradiated while dormant in 1966-67 or after the buds opened in 1967. Seedlings were planted in a secondary forest to ascertain the effects of irradiation on seedlings exposed to the physical and biotic stresses of their native ecosystem. The growth rates, growth patterns, and survival of seedlings are being studied to gain insight into and understanding of population dynamics.

Results: 'Pinus strobus' internode elongation was reduced to tufts of needles on scattered seedlings over burial trenches. Germination and survival of tree seed from control and X1 generation ash and red bud didn't differ significantly during a good seed year but did when stresses were great during seed development. Relative gamma sensitivity of the tree seedlings increased in the following order: ash, walnut, white oak, and physiologically active seedlings have greater gamma sensitivity than the dormant.

SUPPORTED BY U.S. Atomic Energy Commission

5.0339, A QUANTITATIVE STUDY OF THE MUTAGENIC EFFECT OF TRANSMUTATION IN DROSOPHILA & THE HONEY BEE

W.R. LEE, Louisiana State University, Graduate School, *Baton Rouge, Louisiana* 70803 (AT-(40-1)-3728)

The objective of this proposal is to determine in organisms with a true karyotype the genetic consequences of transmutation following incorporation of radionuclides into specific positions within nucleotides of DNA. The results should contribute to the genetic interpretation of molecular structure of eukaryote chromosomes and our evaluation of the genetic consequence of having radionuclides in our environment. 14C will be incorporated into DNA of Drosophila melanogaster spermatozoa and for comparison into their nuclear proteins. Spermotazoa labeled with this radionuclide will be stored in unlabeled females and any increase in the mutation rate due to radioactive decay during storage will be determined. Tests will be conducted for loss of a genetically marked Y-chromosome and sex-linked recessive lethals observed in the F2, F3, and F4.

Results to Date: Previous work by the principal investigator has shown that the transmutation effect of 32P incorporated into Drosophila melanogaster spermatozoa can be separated from the mutagenic effect of accompanying beta radiation. Transmutation of 32P in DNA of Drosphila spermatozoa did induce sex-linked recessive lethals observed in the F3 but did not produce any detectable increase in sex-linked recessive lethals observed in the F2 or in loss of genetically marked Y- chromosome.

SUPPORTED BY U.S. Atomic Energy Commission

5.0340, MUTAGENIC EFFECT OF TRANSMUTATION FROM RADIONUCLIDES INCORPORATED INTO DNA OF DROSOPHILA MELANOGASTER

W.R. LEE, Louisiana State University, School of Arts, *Baton Rouge, Louisiana* 70803 (AT(40-1))

The dilution principle is used to determine the mutagenic effect of transmutation in the eukaryote chromosome and to separate the mutagenic effect of beta radiation from transmutation. Mature labeled spermatozoa are stored in unlabeled females under conditions in which the flux from beta radiation is too dilute to be significant. The number of disintegrations per cell during storage is determined, and the mutation rate is measured before and after storage. The following genetic tests were conducted: loss of a dominant marker on the Y chromosome; sex-linked recessive lethals observed in the F 2, F 3, and F 4. Transmutation of C 14 is less effective than P 32 in inducing lethal mutations. To determine if the lower effectiveness of C 14 is due to lower energy of disintegration P 33 will be compared to P 32.

Results: Transmutation of C 14 within DNA like transmutation of P 32 does not break the eukaryote chromosome or induce lethal mutations that are present in all the cell lineage. If transmutation of C 14 is mutagenic at all, it is less effective tha P 32 by at least two orders of magnitude.

SUPPORTED BY U.S. Atomic Energy Commission

5.0341, RADICAL AND RADIATION CHEMISTRY OF SULFUR COMPOUNDS

W.A. PRYOR, Louisiana State University, School of Chemistry, *Baton Rouge, Louisiana* 70803

The importance of radical reactions in biochemistry are being studied in a number of related projects. The areas include: (a) Radiation destruction and protection mechanisms. (b) The reactions of the hydrogen atom in solution. (c) Free radical pathology. (d) Aging mechanisms and free radical reactions.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0342, LONG TERM EFFECTS OF PRENATAL GAMMA-IRRADIATION ON RAT BRAIN

K.R. BRIZZEE, Tulane University of Louisiana, Delta Reg. Primate Res. Ctr., *Covington, Louisiana* 70433 (AT(40-1))

Studies on the effects of prenatal, whole body, gamma-irradiation and postnatal prolonged intermittent gamma irradiation will be continued on cerebral cortex and other subdivisions of the brain in adult rats at progressively older age levels. Two different dose patterns will be employed. In one series the animals will receive a single dose of 100 R gamma-irradiation (Co-60) at 50 R/minute on gestation day 13.5. In a second series young adult animals will receive 10 R for each 17 hour day throughout the life span. Seven hours each day will be devoted to cage cleaning, feeding and watering animals in the radiation field.

Quantitative studies will include a determination, at 20 successive cortical depth levels and in individual cytoarchitoectonic cortical laminae, of cell packing density and glia/neuron index, cell and nuclear volume, and proportion of cortical tissues occupied by capillaries and by larger vessels (vascular volume). Quantitative studies on dendritic branching patterns and synaptic den-

sity of neurons in laminae III and V of cerebral cortex will be carried out and morphologic characteristics of glial cells and glial packing density will be determined in corpus callosum and medullary pyramids as compared with cerebral cortex. The accumulation and changing patterns of distribution of lipofuscin pigment in neurons and glia in cerebral cortex, cerebellar cortex and deep nuclei, and in many brain stem nuclei will be studied by fluorescence microscopy and by electron microscopy. Similar studies on glia alone will be carried out in corpus callosum and medullary pyramids.

Radioautographic studies on the cell generation cycle and cortical histogenesis in the fetal brain will be carried out with a view to obtaining information basic to an understanding of long-term effects of fetal gamma-irradiation.

A preliminary investigation will also be carried out on effects of low-dose, continuous gamma irradiation (10 R/day) on cerebral cortex of young adult subhuman primates (M. mulatta).

SUPPORTED BY U.S. Atomic Energy Commission

5.0343, ROLE OF THE RETICULOENDOTHELIAL SYSTEM IN RADIATION INJURY AND RECOVERY

N.R. DILUZIO, Tulane University of Louisiana, School of Medicine, *New Orleans, Louisiana* 70118 (AT(40-1)-3853)

Our previous studies have demonstrated the essential role of humoral recognition factors or opsonins in promoting phagocytosis. Indeed, the mechanism of recognition of 'self' and 'non-self' by macrophage cells is mediated exclusively through the interaction of the particulate and humoral recognition factor. The proposed studies will continue to clarify the sequence of events and kinetics of the phagocytic process, as well as the relative importance of humoral recognition factors on macrophage cell activity in phagocytosis and immune phenomena. The proposed study will continue to delineate the importance of opsonins in the profound phagocytic alterations observed under such conditions as X-irradiation exposure and neoplasia. Studies on recognition factor activity in neoplasia and the effect of radiation therapy on recognition factor activity will be continued. Correlations will be made relative to the possible diagnostic and prognostic use of our recognition factor assay procedure. Experimental counterparts will also be developed to assay the new concept of tumor growth and development as related to recognition factor loss. Studies will continue evaluating RE function as well as intracellular digestive and lysosomal activity of Kupffer cells derived from X-irradiated rats. In addition, the influence of radio-protective agents on irradiation- induced alterations in phagocytosis will be observed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0344, EFFECT OF SPERMATOGONIAL X-IRRADIATION ON REPRODUCTIVE FITNESS OF MICE

E.L. GREEN, Roscoe B. Jackson Mem. Lab., *Bar Harbor, Maine* 04609 (AT30-1)-1979)

Genetic variations in enzymes of mice hold great promise for (1) analyses of biochemical differentiation, (2) improving the technical usefulness of the genetic linkage map, and (3) supplying insight into the evolutionary forces that tend to preserve genetic variability in natural populations. We are searching for these variations in the available inbred strains of mice.

SUPPORTED BY U.S. Atomic Energy Commission

5.0345, EFFECT OF X-IRRADIATION ON THE GERMINAL EPITHELIUM OF THE MALE MOUSE

E.L. GREEN, Roscoe B. Jackson Mem. Lab., *Bar Harbor, Maine* 04609 (AT(30-1)-1979)

The hereditary fitness of a population is expected to decrease as the accumulated genetic exposure to spermatogonial irradiation increases generation after generation. This expected result has not been observed, at least not as markedly as anticipated. The question, therefore, is how the germinal epithelium of irradiated male mice becomes repopulated with essentially normal cells. The surviving cells have means either of repair of or of escape from the radiation damage. The dynamics of the repopulation cycle will be tested by successively irradiating and mating male mice, called allophenics, produced by fusing the cleaving eggs of two genetically distinct strains of mice.

Results: We have produced 50 allophenic mice and have observed and bred them. We recently changed to a new combination of genotypes that provides a more nearly equal proportion of both parental cell types in various tissues. Irradiation of the allophenic males has begun.

SUPPORTED BY U.S. Atomic Energy Commission

5.0346, RADIATION-INDUCED CHROMOSOMAL INVERSIONS IN MOUSE POPULATIONS

T.H. RODERICK, Roscoe B. Jackson Mem. Lab., *Bar Harbor, Maine* 04609 (AT(30-1)-3671)

Our objective is to produce in mice chromosomal inversions which can then be used to uncover and study radiation-induced recessive lethals and detrimentals. Chromosomal inversions have not heretofore been defined genetically in mammals. Their production and genetic analysis would be a significant refinement in mammalian genetic technology.

We have produced paracentric inversions in male mice by exposing their testes to 900 R of X-irradiation and by searching for high frequencies of first anaphase bridges in one testis of each of their sons. The length of the inversions should be proportional to the frequency of anaphase bridges. Since there is a small but consistent frequency of anaphase bridges in all males regardless of ancestral irradiation, it is practical to keep only those inversions which are large enough to be easily distinguished from the normal bridge percentage. We have settled on 15 per cent anaphase bridges as the minimal acceptable percentage for identification and development of new inversion stocks. The particular stocks we use make it possible in a single backcross to search for linkage relations of newly induced inversions with eleven loci covering more thaf one-third of the genome.

Results: In more than 1,000 sons screened we have found several inversions, 5 of which we are studying intensively. The first inversion is in Linkage Group XIII between 'Id-1' (Isocitrate dehydrogenase-one) and 'Dip-1' (Dipeptidase-one), a distance of approximately 20 map units. The second inversion is near 'bf' (buff) in Linkage Group XVII.

SUPPORTED BY U.S. Atomic Energy Commission

5.0347, CONTROL OF CELL GROWTH, DIFFERENTIATION AND FUNCTION

C. WAYMOUTH, Roscoe B. Jackson Mem. Lab., *Bar Harbor, Maine* 04609

Using methods developed over the past 17 years in this laboratory, it is planned to move beyond the present common practice of using chemically defined tissue culture media indiscriminately for cultivation of cells and tissues other than those for which the media were designed, and to define for several normal and malignant cell types specific optimal requirements for growth, differentiation, and function. These requirements include not only medium composition, which will be examined mainly in terms of the roles of hormones and specific stimuli, and of ionic balance, but also other environmental variables, e.g. pH, gas phase, redox potential, and osmolarity. Immediate attention will be directed to the requirements of normal hepatocytes from fetal and perinatal mouse livers, and to the growth and differentiation of other cells from liver (Von Kupffer cells, granulocytes, and erythrocytes). Erythropoiesis in normal and genetically anemic mice will be compared. Other tissues selected for study in vitro are lung, kidney cortex, and medulla, as well as established heteroploid cell lines.

The indirect effects of ionizing irradiation upon heteroploid and euploid cells will be studied by examining the effects upon them of exposure to irradiated chemically defined culture media. Essential nutrients are significantly altered by such irradiation. The nature of the changes in individual components of the medium that result in cytotoxic and cytostatic effects and means of protection against these effects will be examined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0348, INVESTIGATION OF POSSIBLE SYNERGISTIC EFFECTS OF NEUTRONS AND PHOTONS ON SELECTED MATERIALS

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Technical Objective: To investigate possible synergistic effects on neutron and photon radiation by observing the response of several solid state dosimetric materials. These materials were selected because neutrons and photons produce responses which are readily observable.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0349, PARENTAL RADIATION EXPOSURE AND DOWN'S SYNDROME, WITH PARTICULAR ATTENTION TO IONIZING RADIATION AND RADAR (21)

B. COHEN, Johns Hopkins University, Graduate School, *Baltimore, Maryland* 21218 (DADA17)

Technical Objective: To study the genetic and chromosomal effects of microwave radiation specifically in relation to Down's syndrome (mongolism).

SUPPORTED BY U.S. Dept. of Defense - Army

5.0350, MORPHOLOGICAL AND HISTOCHEMICAL CHANGES IN BONE CELLS AFTER IRRADIATION - A LIGHT AND ELECTRON MICROSCOPIC STUDY

S.B. DOTY, Johns Hopkins University, School of Public Health, *Baltimore, Maryland* 21205 (AT(30-1)-3917)

Using a combination of histochemical and radioautographic techniques it is proposed that correlations can be made between enzyme response, time of irradiation insult, and alterations in cell structure. Superimposed onto this problem is the fluctuating size of the cell population due to irradiation effects on the mitotic index; however, this question can be answered by studying cell times under irradiated conditions.

Enzyme changes can be found after relatively low doses of radiation and histochemical changes have been found in bone after X-ray irradiation. Previous radioautography experiments have shown an altered cell cycle time in marrow after radiocalcium administration. We have shown with Pu-239 that the mitotic rate of the osteo progenitor cell is also affected, resulting in decreased numbers of observable osteoclasts.

Radioautography at the electron microscope level has been standardized according to the method of Caro. However, because we will be interested in determining the resolution of calcium-45 radioautography, we must determine this, and will use a system similar to Salpeter.

Doses of calcium-45 will be introduced to femoral bone via intravenous perfusion or in vitro incubation. This tissue will be fixed with glutaraldehyde or quick-frozen and prepared for electron and light microscopy radioautography.

Histochemical techniques are to be applied to these tissues containing radio calcium, to determine the activity of alkaline and acid phosphatase, adenosine triphosphatase, sulfatase and glucose-- phosphatase. The time periods under study will vary from 15 minutes to 6 months following initial injection of radio calcium. The uptake of tritrated proline, thymidine and glucose-6-phosphate will be studied during these experiments. Electron microscopy of cell structure will be studied to ascertain morphological damage.

Results: The radioautography technique for bone and calcium-45 has been successful, however the resolution may be as high as 5,000 angstroms. The various histochemical techniques are now applicable to bone tissue at the electron microscope level. It appears that the only possible method for getting large doses of calcium-45 into and around bone cells is by an in vitro method.

SUPPORTED BY U.S. Atomic Energy Commission

5.0351, CURRENT TRENDS IN SURVIVORSHIP OF RADIOLOGISTS

G.M. MATANOSKI, Johns Hopkins University, School of Public Health, *Baltimore, Maryland* 21205

The life-shortening effect of ionizing radiation as an occupational hazard of exposed physicians has been indicated through studies of mortality rates of radiologists. Physicians from other specialities with a lower risk of exposure represent an optimum comparison population since both groups enjoy similar socio-economic and medical advantages which can prolong life. A previous study by Drs. Seltser and Sartwell utilizing such a population confirmed that radiologists had a lower life expectancy than other specialists. The objective of the present proposal is to reestablish and expand the population from the previous study to include new members of the five societies. A decline in the difference between age-specific mortality rates for radiologists and for other specialists would indicate that modern safety measures were reducing the hazard of ionizing radiation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0352, STUDIES ON EFFECT OF MICROWAVE IRRADIATION ON TURNOVER RATE OF SEROTONIN AND NOREPINEPHRINE IN RODENT BRAIN

S.H. SNYDER, Johns Hopkins University, School of Medicine, *Baltimore, Maryland* 21205 (DADA17)

To determine the nature and extent of microwave effects on central nervous system neurotransmitters involved in thermoregulation and other autonomic functions.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0353, ULTRAVIOLET IRRADIATION OF NUCLEIC ACIDS AND RELATED COMPOUNDS

S.Y. WANG, Johns Hopkins University, School of Public Health, *Baltimore, Maryland* 21205 (AT(30-1)-2798)

Nucleic acids play an important role in cellular functions, any alteration of nucleic acids caused by irradiation could result in the production of mutagenic, lethal, and other biological effects. Any changes produced by irradiation must be physicochemical in nature, therefore, the study of the photochemistry of nucleic acids is of great importance. Our prime concern is the stepwise isolation and identification of the products from the irradiated compounds and the study of the actual mechanisms of their formation. Derivatives of uracil, thymine, cytosine, 5-bromouracil, nucleosides, nucleotides, RNA and DNA have been investigated. For identification of products, we examined not only UV, IR, NMR and mass spectra, but also the syntheses of these new compounds. In order to establish a reasonable reaction mechanism, reaction kinetics, variation of reaction conditions, intercepting reactive intermediates, tracer techniques, etc. are being used.

Results: Last year, we unequivocally established the structures of a new product derived from thymine in the acid hydrolysate of UV irradiated DNA, a photoproduct from thymine irradiated in frozen aqueous solution and a dehydration compound of the above photoproduct from thymine. Apparently, these compounds are analogous and are derived from either azetidine or oxetane derivatives. These results indicate that formation of cycloaddition products, i.e. oxetane and azetidine, is a common reaction for pyrimidine bases.

SUPPORTED BY U.S. Atomic Energy Commission

5.0354, RADIATION AND RADIOBIOLOGY RESEARCH CENTER

M.J. WIZENBERG, Univ. of Maryland, School of Medicine, *Baltimore, Maryland* 21201

The project aims to improve radiation therapy and radiobiological research through the interaction of the laboratory and the clinical area. In addition to their mutual supportive functions, individual projects are carried on in each section. The Clinical Center is continuing its study of the treatment of advanced head and neck cancer, the use of electron beam and the treatment of gynecological and urinary tract malignancies. The physics and Radiobiology Sections support the Clinical Center through computer applications to radiotherapy, in dosimetry, data storage and retrieval, and the development of techniques for improved tumor localization.

5. RADIATION

The main thrust of the radiobiological laboratory will be a continuation of its studies of heat, microwave radiation and ionization radiations on cell growth, intracellular biochemical changes, and tumor response.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0355, EQUIPMENT AND METHODS FOR DECONTAMINATION OF AGRICULTURAL LANDS CONTAMINATED BY RADIOACTIVE FALLOUT
P.E. JAMES, U.S. Dept. of Agriculture, Agricultural Engin. Res. Div., *Beltsville, Maryland* 20705 (AT(49-7)-1527)

This research was conducted to determine how best to treat farmland exposed to radioactive contamination. Such information is becoming of increasing importance with more widespread use of radioisotopes. During the past 8 years, experiments have tested the effectiveness of crop- removal machinery including sickle bar and rotary mower, rake, flail harvester, direct-cut forage harvester, corn picker and combine harvester thresher. Also, comparison tests of earth moving machinery have been made to obtain data on effectiveness of various machines in removing the top layer of soil. The machinery tested included road graders, bulldozers, pan scrapers, and elevating and rotary scrapers. Methods of disposal of contaminated soil so removed were investigated. These include burial of contaminated soil in the field at the end of the scraper rows and between the scraper rows as well as stockpiling the soil above the ground, and plowing the contaminated soil 3 feet below the surface with a large plow. Seeds were planted through and beneath the surface layer of radioactivity, at different depths, with no subsequent cultivation. Crops were assayed after maturity to determine the degree of radiouptake. A U.S. Department of Agriculture Handbook, 'Treatments for Farmland that has been Contaminated with Radioactive Material,' was prepared.

RESULTS: The most effective method of decontaminating farmland is to scrape the top surface and haul away the soil. A street sweeper is also effective under some conditions. Harvesting and disposing of crops is not an adequate method because much radioactive dust falls off the foliage onto the ground. Burial of contaminated top soil by deep plowing permits radiouptake by plants. Planting seeds through the undisturbed surface layer of soil also permits radiouptake, regardless of depth of planting. Neither deep plowing nor punch planting is considered to be a satisfactory decontamination method.

SUPPORTED BY U.S. Atomic Energy Commission

5.0356, ACCUMULATION AND MOVEMENT OF FISSION PRODUCTS IN SOILS AND PLANTS - I. MECHANISMS OF RADIATION DAMAGE IN PLANT CELLS
T. TANADA, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Beltsville, Maryland* 20705 (AT)

The objective of this research is to determine the mechanisms by which ionizing radiations inhibit cell growth and cause cell death. Since the effects appear some time after exposure to radiation, the biochemical location of the initial damage cannot be directly identified. However, there is a possibility that radiation damage could be due to radiation-induced deleterious effects on phytochrome (a protein controlling plant growth), or in processes immediately controlled by it. Since phytochrome controls the generation of a bioelectric potential in root tips, measurement of changes in potential is an indicator of phytochrome activity and could be an indirect method of assessing damage to the system by ionizing radiation. Initial studies will use barley shoots and mung bean tops as test materials to determine measurement methods.

Results: Using barley shoots or mung bean tops, measurements have been made of changes in bioelectric charge with exposures to red and far-red light with intervening dark periods. A system for measuring the potential indirectly by means of the centrifugal force needed to detach root tips from a glass surface is also being considered. As procedures are developed the effects of X-ray irradiations and plant hormones on the phytochrome-controlled system will be studied under standardized conditions. Part 1 of 3.

SUPPORTED BY U.S. Atomic Energy Commission

5.0357, AIRCREW VISUAL IMPAIRMENT/INJURY THRESHOLDS FROM NUCLEAR WEAPONS
R. CAVONIUS, Eye Res. Found. of Bethesda, *Bethesda, Maryland* 20014 (F41609-69-C-0027)

Technical Objective: Predictions of eye safe separation distances are required for operational analysis and mission planning and by research personnel for evaluating eye protection requirements and devices. At present such predictions are based on animal data extrapolated to humans and on limited human data extrapolated to high exposure levels. The objective of this effort is to determine threshold levels of radiant energy for permanent eye damage in humans and to assess visual impairment associated with exposure levels approaching or exceeding the permanent damage threshold values. Data will be applied in assessing man's response in a nuclear environment for S/V analysis of weapons systems. This is one of three contract efforts for essential human data.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0358, FUNCTIONAL AND STRUCTURAL ALTERATIONS FOLLOWING X-IRRADIATION OF THE CEREBRAL CORTEX OF THE MONKEY
W.F. CAVENESS, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

Functional changes following X-irradiation, with 3,500 rads, of the right visual cortex and the left homologous non-irradiated cortex are monitored by the evoked electroencephalographic response from programmed photic stimulation of the retina. Structural changes are determined at sequential intervals by examination with routine histological, Golgi-Cox and electron microscopic preparations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0359, HISTOPATHOLOGIC, SERUM ENZYME AND OTHER CHANGES PRODUCED IN ANIMALS BY VARIOUS ENVIRONMENTAL AND OTHER STRESSES
B. HIGHMAN, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

Animals are subjected to exercise or whole-body or regional X- irradiation and/or exposed for varying periods to cold or in a low pressure chamber to simulated high altitudes. Blood samples are taken at intervals for serum enzyme determinations. Histologic studies are also made on tissues of these animals and of animals given certain drugs and compounds under study or infected with certain bacteria.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0360, RADIATION EFFECTS ON MAMMALIAN TUMOR CELLS
R.E. JOHNSON, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

The effects of ionizing radiations including fast neutrons on the leukemia LI210 murine tumor are being studied in an effort to increase understanding of radiation effects include repair of sublethal damage with high and low LET radiations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0361, EFFECTS OF IONIZING RADIATION ON THE ELASMOBRANCH BRAIN
I. KLATZO, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

Studies have shown the shark brain to exhibit a profound and unusual resistance to changes in vascular permeability and blood-brain barrier following severe local injury. The present investigation is to determine if such a resistance to radiation effects might be also present, and if so, what are the factors causing such a resistance. This project is almost completed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0362, STUDY OF THE CANCER EXPERIENCE OF NON-URANIUM HARD ROCK MINERS IN THE ROCKY MOUNTAIN AREA

F.E. LUNDIN, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

The purpose of this study is to delineate factors responsible for the excess respiratory mortality previously reported among men with 15 or more years experience as metal miners. Also to be determined is the relationship between lung cancer and the degree of exposure measured by length of underground employment and changing ventilation and the importance of age at first exposure, and latent period.

Company records of 120,000 metal miners have been reviewed and the occupational medical and vital statistics data have been abstracted for the 16,000 men who worked in the industry in 1937 or later, with initial employment before 1954, and with one or more years of underground service. Deaths are ascertained by reviewing the records of the companies and claims from the bureau of Old Age and Survivors Insurance. Death certificates are obtained from state health departments and classified by cause of death. The miners respiratory cancer mortality experience specific for each of the variables mentioned above will be compared with expectation generated by use of population rates for the same area.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0363, NEMATODE MUTANTS WITH DEFECTIVE BEHAVIORAL AND NEURONAL FUNCTION

R. PERTEL, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

Mutagens such as ethyl methane sulfonate and X-rays have been used to induce the formation of mutants of Caenorhabditis elegans var. Bristol, with defective behavioral (chemotactic, locomotive, galvanotactic, etc.), neuronal and developmental functions. The purpose in mind is to study the biochemical and genetic basis of these mutants in reference to the function and developmental original of individual neurons and composite ganglia in a relatively simple nerve net and their relationship to behavior.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0364, THE EFFECTS OF IONIZING RADIATION ON MACROMOLECULES OF BIOLOGICAL IMPORTANCE

P. RIESZ, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

To investigate the molecular damage produced in biologically active macromolecules by ionizing radiation and to determine what part of the molecular damage is responsible for the loss of biological activity.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0365, TISSUE CULTURE STUDIES OF HUMAN LYMPHOCYTES

J.H. ROBBINS, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

Objectives: 1) To investigate the mechanisms concerned with the control of mitosis, differentiation, function, and potentialities of normal and pathologic cells, with particular reference to the lymphocyte and cells of the lymphoreticular system. 2) To determine which cells in human peripheral blood contain 'immunologic memory' and to elucidate the nature and mechanism of action of this memory. 3) To study the effect of ultraviolet light on human blood cells with particular reference to the induction of thymidine uptake in irradiated cells and to the possible relationship of such uptake to cellular repair mechanisms.

Methods Employed: Human peripheral blood lymphocytes are cultured in vitro and stimulated to transform into large blastoid cells by factors such as phytohemagglutinin, antigens, and foreign tissue. This phenomenon of blastogenesis is evaluated by the morphologic and biochemial changes which the lymphocytes undergo. The mechanisms by which these blastogenic factors act and the culture conditions required for blastogenesis are determined. Human peripheral blood leukocytes are separated into a glass-adherent cell population, composed largely of macrophages, and into a population consisting of small lymphocytes. By recombining such populations obtained from the same and from different individuals, the function of each population is determined. Interactions and contacts between cells are examined by light and electron microscopic techniques.

Methods Employed: Human leukocytes are irradiated with ultraviolet light and then incubated with radioactive thymidine. The degree of incorporation of radioactive label into the DNA of the cells is determined by autoradiography and by scintillation counting.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0366, THE MECHANISM OF RADIATION SENSITIZATION BY 5-BROMODEOXYURIDINE IN CULTURED CHINESE HAMSTER CELLS

W.U. SHIPLEY, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

5-Bromodeoxyuridine (BUdR), when incorporated into mammalian cells, yields marked potentiation of X-ray damage in vitro, in vivo, and clinically when given directly to tumors by selective intra-arterial infusion. To get a better insight into the molecular basis of radiation damage and its repair, experimental observations, yielding insight re mechanisms, were pursued on the method of BUdR-induced intracellular potentiation of X-ray killing using, and interrelating, the following techniques: a) X-ray survival parameters as measured by colony formation; b) X-ray induced physiochemical changes in the DNA and its repair as measured by alkaline sucrose gradient analysis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0367, COMPARATIVE STUDIES OF PROTEIN RADIOLYSIS BY VARIOUS MEANS OF IRRADIATION

F.W. WHITE, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

The effects of various means of irradiation on lyophilized proteins have been studied with regard to radiation damage (as expressed by effects on biological activities and losses of specific amino acids) and to distributions of carbon free-radicals among the amino acids. Thus far, gamma radiation, electrical discharge, and ultraviolet radiation have been studied. The project will be extended to include similar studies on other biological macromolecules, including nucleoproteins and nucleic acids.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0368, WEAPONRY RADIATION PENETRATION IN MATTER FOR EVALUATING ATOMIC WEAPONS' EFFECTS

M.J. BERGER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Gaithersburg, Maryland*

Technical Objective: The objective is to evaluate Naval communications systems in an atomic weapons' environment. High frequency radio communication systems used in operational circuits depend on electron and ion densities in the normal and disturbed ionosphere. Such densities are affected by the penetration of gamma rays and neutrons in air following an atomic weapon explosion. The present work will obtain the penetration of such radiation needed for estimating the effect on communications systems. The work also has application to the detection and diagnostics of atomic weapons.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0369, GUIDELINES FOR MINIMIZING DAMAGE TO FOOD PROCESSING INDUSTRY IN CASE OF NUCLEAR ATTACK

W.C. CROW, U.S. Dept. of Agriculture, Transp. & Facilities Res. Div., *Hyattsville, Maryland* 20782 (TF1-122A)

OBJECTIVE: Edit and make supplemental additions to handbook prepared by contractor regarding practical guidelines to minimize nuclear attack damage to food processing facilities.

5. RADIATION

APPROACH: Determine for each type of processing plant the principal types of damage that can be expected, the structural or equipment modifications and operating procedures that would minimize damage to these facilities, the pre-attack preparations that should be made to insure effective and expeditious emergency repair, the repair and maintenance procedures that should be used after attack, and the methods of handling problems of contamination. Include in the study flour mills, bakeries, meat packing plants, oilseed mills, shortening manufacturing plants, dairy manufacturing plants, food canning plants and sugar refineries. Cooperate with contractor in developing his data, supplement the study with additional information as needed, edit the report and prepare it in the form needed by Agricultural officials.

PROGRESS: Refer to TF 1-122 for progress report.

SUPPORTED BY U.S. Dept. of Agriculture

5.0370, EXPERIMENTAL ELECTROMAGNETIC RADIATION STUDIES

D.E. JANES, U.S. Environ. Protection Agcy., Twinbrook Research Laboratory, *Rockville, Maryland* 20852

The principal objectives of this program are to define the biological effects of exposure to electromagnetic radiation and provide the scientific bases for furmulating, evaluating, and supporting population exposure standards. The detailed objectives are: (1) to determine if there are genetic effects from exposure to non-ionizing radiation, (2) to determine and describe the effects of radiation on the central nervous system and glands controlling physiological integration, (3) to determine the interactions between electromagnetic fields and molecular systems that could lead to genetic and central nervous system effects, (4) to define the physical and biological parameters that determine energy absorption and hence biological hazard in the near and far field of electromagnetic radiators, (5) to examine whether data from high dose radiation studies, ionizing and non-ionizing, can be used to predict moderate or low dose effects, (6) to determine if there are cumulative effects and if there is an irreversible component to non- ionizing radiation effects, and (7) to determine whether certain subpopulations (e.g., developing fetus, aged, genetic variants) are more radiation sensitive than the normal adult.

The laboratory effort in FY 72 and 73 will be to identify the interactions between electromagnetic fields and molecular systems that lead to genetic and neurophysiological effects and to investigate directly the existence of genetic and behavioral effects. Molecular levels effects will be explored, initially at 2.45 GHz in solutions of proteins, bovine serum albumin and ribonuclease, and nucleic acids both during and after irradiation. Genetic effects, e.g., mutations, chromosome aberrations, and changes in the biological activity of DNA, will be examined in bacterial and mammalian systems, initially E. coli and Chinese hamsters. Behavioral and neurophysiological effects will be examined in small primates, dogs, and rodents at 0.4 and 2.45 GHz; dependent variables will include EEG changes and changes in performance, learning, memory, and other behavioral and physiological indices.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0371, MULTIPLE ENVIRONMENTAL STRESS STUDIES

C.D. LYTLE, U.S. Environ. Protection Agcy., Twinbrook Research Laboratory, *Rockville, Maryland* 20852

The object of multiple environmental stress studies is to investigate possible synergistic or addictive effects of environmental agents coupled with the effects of radiation. These environmental agents including viruses, metals such as methyl mercury and cadmium, such chemicals as DDT and NTA, and various physical agents were chosen according to their occurrences in man and his environment and the likelihood of their interacting with radiation.

Within the multiple environmental stress studies program, projects have been developed to investigate: 1) The role of viruses in radiation caused tumors using tissue culture techniques with mammalian (when appropriate, human) cells and simian or human viruses. Screening for tumor viruses in cats is done electron microscopically. 2) Synergistic effects of alpha radiation and tobacco smoke to be determined by comparing the incidence of cancer in cigarette smoking rats, non-smoking rats, and rats smoking cigarettes containing polonium-210. 3) Effects of environmental agents, such as methyl mercury, cadmium, lead, DDT, NTA, and elevated temperature on radiation responses of hamsters and rats, including tumorigenesis, teratogenesis, genetic changes, life shortening, and other physiological changes. An aquatic animal (salamander or fish) will be used in similar preliminary studies. 4) Effect of above environmental agents on the metabolism of selected radionuclides, for example, tritium.

The experimental results will constitute a bank of information on the synergistic or additive nature of the action of environmental agents on radiation effects. Biological, chemical, and physical agents of importance to radiation response will have priority, with emphasis on biological endpoints of value in estabilishing radiation protection guides and standards.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0372, HUMAN RADIATION STUDIES

E. TOMPKINS, U.S. Environ. Protection Agcy., Twinbrook Research Laboratory, *Rockville, Maryland* 20852

The objective of these epidemiologic studies is to quantify the risk to man of developing various disease states following exposure to radiation.

A knowledge of the risks to man associated with exposure to radiation is essential to develop a program to protect him against the hazards of radiation. All of these studies will involve the collection and statistical evaluation of data on persons exposed to radiation to determine and evaluate the risk of effects resulting from the radiation. Established epidemiological methods of collecting such as use of questionnaires, record searching, and abstracting of pertinent data will be used to obtain original and follow-up data.

The specific risks to be evaluated in the stated populations are: 1) The development of neoplasms of all organ sites in the Japanese atomic bomb survivors, patients treated with I131 for hyperthyroidism, and patients treated for malignant neoplasms with external radiation. 2) The development of thyroid neoplasms in young adults who received diagnostic doses of I131 as children, and in the young adults of Utah who were exposed to fallout from the Nevada test site. 3) The development of lung malignancies in patients who have body burdens of thorium dioxide and are continuously exhaling thoron.

The results of the three study areas will be: 1) The establishment of the relative organ sensitivity to radiation induced tumor formation. This is input data for the establishment of standards based on total cancer risk associated with radiation exposure. 2) The establishment of the dose-response curve for thyroid tumor formation following exposure of children to radioiodine. This data will be used to establish criteria for exposure of a presumed critical population group to specific radionuclides. 3) The establishment of the risk associated with continued exhalation of thoron. This data is needed to evaluate the hazards associated with long-term exposure to radon from uranium tailings.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0373, EFFECTS OF THERMAL RADIATION ON PERSONNEL IN NUCLEAR WARFARE

W.L. DERKSEN, U.S. Navy, Ordnance Laboratory, *Silver Spring, Maryland* 20910

Technical Objective: The overall objective is to develop the technology and information required by the military services for predicting the effects of thermal radiation on personnel in nuclear warfare. The particular objectives are to develop a mathematical model of the radiating source of casualties due to thermal radiation. To conduct experimental and theoretical studies on basic mechanisms of skin burns and other casualties due to thermal injury and to determine the hazard to military personnel in protected or semi-protected areas from toxic products given off by materials exposed to the thermal radiation pulse of nuclear weapons.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0374, OCULO-VISUAL EFFECTS - PHYSICAL STIMULUS IN NUCLEAR WARFARE
W.L. DERKSEN, U.S. Navy, Ordnance Laboratory, *Silver Spring, Maryland* 20910

Technical Objective: The objective of this work unit is to develop the technology and information required by the military services for predicting the effects on vision of viewing the blinding flash of nuclear weapon bursts and protecting personnel from vision hazards of flashblindness and retinal burns.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0375, BIOLOGY OF THE EASTERN CHIPMUNK, TAMIAS STRIATUS
D.P. SNYDER, Univ. of Massachusetts, Graduate School, *Amherst, Massachusetts* 01002 (AT(30-1)-3626)

The objectives are (1) to develop an extensive ecological knowledge of natural populations of the eastern chipmunk on permanent study plots and (2) to utilize these sample populations in controlled experiments to evaluate the effect of sublethal exposure to gamma radiation and to test hypotheses concerning population regulation mechanisms.

The principal study area is in the Green Mountain National Forest, Vermont. Three sample plots have been established at each of three elevations. This design provides control and experimental populations at each elevation and will permit the comparison of experimental treatment effects in closely related populations existing under different environments.

Treatment in the irradiation experiment is accomplished by placing each individual of the experimental population in the shielded chamber of a portable Cesium 137 source and is limited to a single exposure at levels below that which cause visible damage to treated individuals. Juvenile recruits to the population are not treated until they reach adult size and no animals are treated when in breeding condition. Ecological experiments involve manipulation of food supply and population density. Treatment effects are evaluated by comparison of ecological characteristics of experimental with control populations.

Results: Work to date has shown that it is feasible to study free- ranging chipmunks, Tamias striatus in the context of an experimental design using replicated samples of natural populations. Density, reproductive rates, juvenile recruitment, age distribution, and range of movement are parameters which have been quantified on the nine study plots and which will aid in assessing ecological effects of irradiation and the other experimental treatments.

SUPPORTED BY U.S. Atomic Energy Commission

5.0376, EFFECTS OF RADIATION ON SEMICONDUCTORS AND DEVICES
C.D. TURNER, U.S. Air Force, Cambridge Research Labs., *Bedford, Massachusetts*

Technical Objective: AF function - radiation hardening of communication statellites. Deficiency - satellites for reconnaissance, communications, early warning, navigation, and meteorology are not sufficiently hardened to radiations found in space or created by nuclear detonation. Development - evaluate the interactions of radiation induced defects in semiconductors. How development contributes - provides information necessary for the improvement of semiconductor materials and devices for hardened electronic systems. This work is concerned with mechanisms of radiation damage processes resulting from the interaction of energetic radiation with semiconductor materials and the effects of radiation-induced defect structures on the electrical and optical properties of materials. The prime importance of this work lies in its connection to the operation of spacecraft and missles in space and nuclear environment. Degradation of electronic systems can be attributed to damaging effects of energetic radiation to individual electronic devices and, ultimately, to the semiconductor material itself. However, interactions of radiation induced defects with each other and with crystal imperfections are not fully understood. Such interactions dramatically affect electrical properties and need further investigation. The study of radiation effects on semiconductor materials is one approach to improving our position of being able to predict and control the damaging effects of radiation environments to military electronic systems.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0377, THE BIOLOGY OF THE RETINAL PIGMENT EPITHELIAL CELL
E. FRIEDMAN, Boston University, School of Medicine, *Boston, Massachusetts* 02215

The long-term goal of this project is to increase our understanding of the role of the retinal pigment epithelium in the pathogenesis of retinal pigmentary degenerations. The morphology of the retinal pigment epithelial cell is studied by means of flat preparations of the retinal pigment epithelium as well as conventional histologic methods. Of particular interest are the effects of toxic agents on retinal pigment epithelial cells in animals. Also investigated are the effects of radiant energy on the retinal pigment epithelial cell. Thresholds to intense radiation for short periods of time have been studied. Current interest is focused on the effects of long-term illumination of the retinal pigment epithelium of the Rhesus monkey.

SUPPORTED BY Fight for Sight Incorporated

5.0378, RADIATION CARCINOGENESIS
S. WARREN, Cancer Research Institute, *Boston, Massachusetts* 02215 (AT(30-1))

Our current program on radiation carcinogenesis is currently focused on tumor induction by external radiation in perinatal mice and their descendants, the dose and dose-rate effect relationships in carcinogenesis due to internal sources in rodents, and the relationship of degenerative and reparative phenomena to the induction of cancer by external irradiation in parabiont rats. Special attention is being given to leukemia, cancer of the skin, osteogenic sarcoma and cancer of the uterus. Analyses of data will be carried out from experiments now nearly completed on effects of continuous radiation during intrauterine life, the neonatal period and adult life.

SUPPORTED BY U.S. Atomic Energy Commission

5.0379, CYTOCHEMICAL AND MACROMOLECULAR RADIATION EFFECTS
S.J. ADELSTEIN, Harvard University, School of Medicine, *Boston, Massachusetts* 02115

It is proposed to study the activity of thymidine kinase in the liver of growing mice. An attempt will be made to define the nutritional factor(s) responsible for the changing levels of soluble enzyme found on fasting and refeeding. The relation of enzyme activity to the stability of polyribosomes will be examined.

The effect of the primary aqueous radical species (OH, H, Eaq and HO2) in ribonuclease will be examined. An attempt will be made to identify the particular sulfur-containing and aromatic amino acids which are primarily degraded. The mechanisms of the radical reactions and the effects on enzyme structure will be elaborated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0380, RADIATION RESPONSE OF MAMMALIAN CELLS
J.A. BELLI, Harvard University, School of Medicine, *Boston, Massachusetts* 02115

It has been demonstrated that mammalian cells in culture are able to repair radiation damage which would have suppressed colony formation. The interaction between this kind of damage and various drugs will be studied using colony formation as an endpoint and with regard to the sedimentation characteristics of DNA and alkaline sucrose density gradients.

5. RADIATION

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0381, DERMATOLOGIC REACTIONS INDUCED BY SOLAR RADIATION
T.B. FITZPATRICK, Harvard University, School of Medicine, *Boston, Massachusetts* 02115

New and better approaches, applicable to large populations that will enhance the protection of normal human skin and of those diseases (nearly 30) aggravated by UV light are proposed. Exposure to sunlight is an important cause of basal and squamous cell carcinomas. Approximately 150,000 basal cell carcinomas and over 40,000 squamous cell carcinomas occur in the U.S.A. alone each year. Thousands of work days are lost by industrial employees, by agricultural workers and other people engaged in outdoor activities because of the acute sunburn or adverse cutaneous photosensitization reactions caused by certain agents (e.g. phenothiazines, tetracyclines, sulfonamides, furocoumarins etc.). There are nearly 30 diseases entities (e.g. porphyria, solar urticaria, etc.) in which exposure of skin to sun plays a major role in the pathogenesis of the disease. The net sensitivity of human skin to UV and visible energy of solar radiation often represents a balance between the damage, the extent of which depends on the dose and the sensitivity of the target; and the repair process, the extent of which varies with the genetic, the physiological state of the cell, and with the environment in which the man lives. The interaction of radiant energy with mammalian system and particularly with human skin is proposed to be investigated in an attempt to define: a) the biological target of the photon, and b) the mechanism of the damage and c) the nature of the repair process; d) the identification of the photoexcited states of the photosensitizers; e) identification of their photoproducts; f) the nature of the cutaneous damage by photosensitizers (e.g. DNA, RNA or cytoplasmic). The ultimate aim of the proposed program is the prevention of both the acute and chronic injury of human skin and of the disease caused by solar radiation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0382, PROLIFERATION AND DIFFERENTIATION OF STEM CELLS
S. HELLMAN, Harvard University, School of Medicine, *Boston Massachusetts* 02115

The studies are concerned with the hematopoietic stem cell compartment, the kinetics of proliferation and differentiation, and how these can modify and be modified by radiation and cytotoxic agents. Three major areas of investigation are to be pursued: 1) Study of changing differentiation patterns of stem cells surviving radiation or other cytotoxic agents; 2) Identification and suppression of specific differentiated progenitor cells of murine bone marrow; 3) Radiation and drug response of murine bone marrow as a function of position in the cell cycle.

The techniques all study murine bone marrow assayed in irradiated syngeneic recipients. Such studies will increase our understanding of the ways by which this primal cell maintains a sufficient quantity of mature progeny both in the resting and perturbed state. From such information perhaps therapeutic regimens can be instituted to maximize tumor cell kill while preserving bone marrow function.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0383, THE INTERACTIONS BETWEEN ALPHA RADIATION AND CHEMICAL CARCINOGENS IN EXPERIMENTAL LUNG CANCER
J.B. LITTLE, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Amer. Cancer Society Inc. - New York, N.Y.

5.0384, EFFECTS OF RADIATION ON STATIONARY CELLS
J.B. LITTLE, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

The basic objective of this research program is to gain specific information as to the response of stationary or very slowly proliferating human cell populations to ionizing radiation, particularly their response to fractionated or prolonged X-ray exposure. Most previous studies of radiation effects on mitosis and progress through the replicative cycle have been carried out with exponentially growing cells; little specific data is available related to the effects of irradiation on these processes in very slowly proliferating mammalian cells or in cells which, although capable of proliferation, are not actively progressing through the replicative cycle. Yet, such stationary cell populations are known to comprise an important component of many normal tissue complexes, as well as malignant tumors.

The cell system we will use is stationary or plateau phase cultures of an established line of human cells. We plan initially to study the proliferation kinetics of these cultures, and subsequently the effects on proliferation kinetics and net survival of single and fractionated radiation doses given alone and in combination with chemotherapeutic agents. We will also investigate in detail the capacity of these stationary cells to recover from both sub-lethal and potentially lethal radiation damage before entering cell division. In all experiments, the effects in plateau phase cultures will be compared with those observed when the same cells are irradiated during exponential growth. The results of this investigation might eventually lead to the development of more rational schemes of fractionated X-ray exposure and chemotherapy in the treatment of human cancers.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0385, CAROTENOID PIGMENTS AND PHOTOTOXICITY AND PHOTOPROTECTION IN BACTERIA
M.M. ROTH, Harvard University, School of Medicine, *Boston, Massachusetts* 02115

The toxicity of ultraviolet light has long been recognized. Recently it has become clear that visible light may also be toxic to cells. Visible light is also toxic to bacteria. It has also been shown that the carotenoid pigments present in certain bacteria can protect them against this toxic photosensitization. Since carotenoid pigments are found in animal cells, the question arises, can these pigments protect against the toxic actions of visible light in animal cells as they do in bacteria? Recent experiments with mice indicate that they might be able to do so. The purpose of this investigation is to study the mechanism of the toxic effects of light on bacteria, and the mechanism of the protective action of the carotenoid pigments against the lethal effects of light. The bacteria to be used in this study are: Mycobacterium marinum which produces pigments only when exposed to light; Sarcina lutea which contains carotenoids at all times; and a colorless mutant of S. lutea. This study of the fundamental aspects of photosensitization and photoprotection is a necessary prelude to the investigation of the possible therapeutic effects of carotenoids in light-sensitive diseases.

SUPPORTED BY U.S. National Science Foundation

5.0386, LATE EFFECTS OF THORIUM DIOXIDE RETENTION IN HUMANS
M.L. JANOWER, Mass. General Hospital, *Boston, Massachusetts* 02114

The effects of long term exposure to chronic low dose internal emitter radiation are based largely on findings provided by previous studies of radium dial painters. There is only one other large group of humans with substantial body burdens of chronic radiation, these are patients who received Thorotrast, a radioactive contrast material which is virtually completely retained within the body. The intensive study of a large group of Thorotrast patients should make a significant contribution to knowledge of the delayed effects of radiation, and should aid in the establishment of human safety standards.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0387, LASER RADIATION IN PHOTOCHEMISTRY AND PHOTOBIOLOGY
K. WEISS, Northeastern University, School of Arts, *Boston, Massachusetts* 02115

The biological effects of laser radiation are of much current interest, and there is need for detailed knowledge about the interactions at the molecular level. This research is concerned with the elucidation of the nature of specific photochemical effects in biological damage caused by laser radiation. We have developed the apparatus for laser flash photolysis, which provides photochemistry and photobiology with a unique new investigative technique. The absence of stray light and the shortness of the laser pulse make it possible to detect and characterize shortlived intermediates which cannot be observed by conventional flash methods. The technique has been successfully applied to the study of some simple model chemical systems. In the present project we are using laser flash photolysis as well as conventional flash photolysis to investigate the behavior of selected molecules of biological significance which are likely to be affected by laser radiation under damage-causing conditions. The study includes multiphoton processes, which are of great potential significance with respect to the health hazards associated with non-ionizing electromagnetic radiation. We are seeking evidence for photochemical changes in biologically significant compounds under conditions which preclude direct (one-photon) excitation. The compounds selected for investigation include dyes, flavins, flavones, amino acids, purines, and visual pigments.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0388, THE EFFECT OF IRRADIATION ON THE BIOCHEMICAL CHANGES OF MAMMALIAN CELLS IN THE ABSENCE AND PRESENCE OF PARTICULATE MATERIAL

A.J. SBARRA, Tufts University, Saint Margarets Hospital, *Boston, Massachusetts* 02125 (AT(30-1))

This investigation will be directed toward acquiring information on the effects of low dose x-irradiation on a mammalian cell. The marker to be used to monitor the x-irradiation effect will be the overall phenomenon of phagocytosis. This approach should permit us to gain information regarding the effect of low-dose irradiation on a mammalian cell and in addition should permit us to define more precisely the biochemical reactions involved with phagocytosis.

We will attempt to identify which stages in the development of the myelogenous cell lines are radiosensitive in terms of the biochemically- defined and previously discussed phagocytic effects. Since PMN development is occurring in the marrow, information relative to the bactericidal, phagocytic and biochemical activities of sternum marrow cells would be of interest and will be undertaken.

The effect of x-irradiation on spleen cells will be continued. The possible significance of the stimulated activities noted soon after x- irradiation will be explored in relation to their possible physiological significance. Finally, we will study the relationship of H_2O_2 production and aldehyde generation to host defense post x-irradiation. Since these compounds can effect the antimicrobial activities of the phagocyte and thus susceptibility of the host to a study such as this would be of value.

SUPPORTED BY U.S. Atomic Energy Commission

5.0389, EFFECT OF X-RAY ON RESISTANCE TO LEUKEMIA IN MICE

J.A. HALKETT, U.S. Veterans Administration, Hospital, *Boston, Massachusetts* 02130

Continued studies on the effect of X-irradiation on the radiosensitive and radioresistant phases of allograft rejection have substantiated the results reported last year. Various concentrations of an AKR/J leukemic allograft homogenate were injected into nonsusceptible Swiss mice hosts which were exposed to whole body X-irradiation either at some time before or after injection. For the groups exposed to X- irradiation two days following injection, the percent nonsusceptible hosts dead from leukemia was 0% and 5% for the concentrated and one millionth dilution respctively. However for the various dilutions between these two extremes the percent nonsusceptible hosts dead was higher reaching 40% for the 1/10,000 dilution. Though Brent and Medawar have suggested that an explanation of the effects of radiation is, in the case of radiosensitivity, the loss of cellular proliferation and radioresistance occurs following the development of antibody producing cells; it would appear that additional explanations may be justified. Consideration may be given to the possibility that the concentration of the allograft is important in stimulating the rejection mechanism; that one step in the rejection mechanism may be the limiting of the allograft concentration; and the uncontrolled cellular multiplication, as in the case of the leukemic allograft occurs when X-irradiation exposure occurs before injection (radisensitive phase). A paper entitled 'The Relationship Between Various Dilutions of an AKR Leukemic Allograft and the Time of whole Body X-irradiation to the Survival of Nonsusceptible Swiss Mice Hosts' will shortly be submitted.

SUPPORTED BY U.S. Veterans Administration

5.0390, THE EFFECT OF LASER RADIATION ON BIOLOGICAL SYSTEMS

G.W. PRATT, Mass. Inst. of Technology, Materials Science Center, *Cambridge, Massachusetts* 02139 (DAHC15-67-C-0222)

Technical Objective: To study the effects of laser radiation on biological systems.

SUPPORTED BY U.S. Dept. of Defense - A.R.P.A.

5.0391, EFFECT OF PROCESS CONDITIONS ON REDUCING THE MINIMAL RADIATION DOSE OF RATION ITEMS

A. ANELLIS, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Technical Objective: Establish the influence of environmental factors which might lower the radiation resistance of Cl. botulinum spores in ration items without adversely affecting the quality of these products.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0392, EFFECT OF RADIATION ENERGY ON THE ESSENTIAL AROMATIC AMINO ACIDS

E.M. HAYON, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Technical Objective: The role of photo-ionization processes singlet-triplet excited states and oxidation-reduction reactions resulting from the effect of radiation energy (both UV and ionizing radiations) on basic aromatic amino acids will be investigated.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0393, INVESTIGATION OF LIGHT SENSITIVE MATERIALS FOR FLASH BLINDNESS PROTECTION

E.M. HEALY, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Technical Objective: Objective- To investigate classes of compounds and materials which, when activated by a high intensity light flash, will react in sufficiently short time to prevent transmittance of a significant portion of the flash. The ultimate purpose of this research is to develop compounds and materials which, by themselves, or incorporated into suitable systems will be effective flashblindness protective devices against flashblindness and chorioretinal burns.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0394, COUNTER MEASURE STUDIES AGAINST VULNERABILITY OF PERSONNEL AND MATERIALS TO TACTICAL LASER RADIATION

J.A. SOUSA, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Technical Objective: Elucidate the complex phenomenon of induced luminescence in dyed systems by laser irradiation at multiple wave lengths. Determine dye laser mechanisms for possible extension of wave lengths from the ultraviolet to the near-infra red region of the spectrum.

5. RADIATION

SUPPORTED BY U.S. Dept. of Defense - Army

5.0395, THE WRITING OF A CRITICAL CREATIVE REVIEW ON THE TOPIC, RADIATION SENSITIVITY OF PLANT MERISTEMS
T.S. OSBORNE, Smith College, Graduate School, *Northampton, Massachusetts* 01060 (AT(30-1))

Plant meristems in the last decade or so have been studied from increasingly sophisticated viewpoints (radiobiology, ultrastructure, cytophotochemistry, autoradiography), and it appears timely to seek a synthesis of findings and to suggest areas where crucial knowledge is lacking. This project is a critical review of published works supplemented by research discussions, aimed at illuminating conflicts in terminology and in concepts, and at outlining topics for further research.

SUPPORTED BY U.S. Atomic Energy Commission

5.0396, EFFECTS OF IONIZING RADIATION ON MAMMALIAN SPERM AND EGGS
M.C. CHANG, Worcester Found. for Exp. Bio., *Shrewsbury, Massachusetts* 01545

It is proposed to study the effects of irradiation on (1) the fertilizing life of sperm in the male and female tract, (2) fertilizable life of eggs, (3) the ovarian oocytes of ferrets, (4) the fertilizing capacity of sperm in vitro under various conditions, and (5) the chromosomal behavior and karyotype following irradiation at very early and late meiosis during gametogenesis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0397, STUDIES ON BIOLOGICALLY ACTIVE AMINES
Y. KOBAYASHI, Worcester Found. for Exp. Bio., *Shrewsbury, Massachusetts* 01545 (AT(30-1)2085)

The proposed program has two specific aims. First, to delineate the mechanisms underlying the radiation damage to gastric mucosa and second, to elucidate the role of histamine in gastric physiology. A connection between the radiation effect and histamine metabolism in the rat has already been established by this laboratory. The studies envisaged will be dependent on a close liaison between several scientific disciplines with particular emphasis on structure to function relationships. This program will inevitably lead to a greater understanding of the factors affecting gastric physiology and some of the findings will be highly relevant to treatment of gastric disorders in man. Both technically and conceptually the program will provide the basis on which the role of other intestinal hormones may be studied in the future. An added fall out is that these studies will provide information on the general question of hormone-enzyme interactions and their susceptibility to irradiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0398, SOME ASPECTS OF THE MECHANISM OF BACTERIOPHAGE REPLICATION
D. FREIFELDER, Brandeis University, Graduate School, *Waltham, Massachusetts* 02154 (AT(30-1)-3797)

The objective is to understand the mechanism of injection and replication of phage DNA using the bacterium, Escherischia coli and its phages, T7, and Lambda. With phage Lambda we are determining (1) whether all fragments of a broken molecule are injected and (2) the direction of normal injection. With T7 we are studying the properties of the natural termini of the DNA using preferential, P 32 labeling by polynucleotide kinase. Since we choose to interfere with some of the normal processes by X-irradiation, we are continuing our studies of the molecular alterations in DNA produced by X-rays. We are initiating a study of the mechanism of induction of lysogenic phage.

SUPPORTED BY U.S. Atomic Energy Commission

5.0399, HUMAN EYE LASER THRESHOLDS FOR AIR FORCE OPERATIONAL PERSONNEL
D. SHEENA, Whittaker Corporation, *Waltham, Massachusetts* 02154 (F41609-70-C-0006)

Technical Objective: Air Force use of laser systems requires quantitative description of laser eye effects to establish safe exposure limits. Most work is done in experimental animals. Additional confidence is required in current ability to extrapolate data from animals to aircrews. To address the deficiency, this effort will be to determine energy levels of laser radiation necessary to produce minimum threshold retinal lesions and permanent functional damage in human eyes for the establishment of Air Force safety criteria.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0400, STUDIES OF RADIATION DAMAGE TO BIOLOGICAL MATERIALS
R.S. ANDERSON, Clark University, Graduate School, *Worcester, Massachusetts* 01610

This research will involve detailed studies of the effects of various radiations in producing radiation damage in molecules of biological interest. To secure maximum understanding of the radiation damage process, single crystals will be studied. Radiation-produced, trapped radicals will be detected, identified and examined using the highly sensitive electron spin resonance technique.

It is planned to study the effects of (1) gamma rays, (2) ultraviolet light, (3) laser beams, (4) ultrasonic beams and (5) hydrogen atoms. Compounds to be studied include (1) those of general biological interest, such as amino acids and mono- and dicarboxylic acids, (2) organic compounds having unsaturated chemical bonds, hence susceptible to hydrogen atoms, and (3) possible radiation protective agents such as sulfur and selenium compounds.

From this research it will be possible to locate the point in the molecule at which the damage occurred, and to determine a number of the chemical and physical properties of the damaged molecule. The relative radiation sensitivity of the various molecules will be established.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0401, EFFECT OF IONIZING RADIATION ON BIOLOGIC HALF-LIFE OF 57COBALT IN THE MOUSE
K.L. BECK, U.S. Veterans Administration, Hospital, *Allen Park, Michigan* 48101

Only limited information is available on the biologic half-life of radiopharmaceuticals used in medicine today. Biologic half-life (T1/2b) varies with the rate of metabolism, is affected by diseases of metabolism, and is altered by external factors including irradiation. The specific aim was to show the effects of external ionizing irradiation on the biologic half-life of Tc99m sulfur colloid.

The effective and biologic half-lives were determined for normal healthy female mice given 1 microCi doses of Tc99m sulfur colloid. The short physical half-life interfered with accurate measurement of the biologic half-life.

The study was continued using the relatively long half-life nuclide Co57. Three groups of mice received 0.25, 0.50 or 0.75 of the LD 50/30 dose of external gamma irradiation (100 R/m). These and nonirradiated controls were injected with 2 to 4 microCi 57Co and the effective and biologic half-lives were determined. Another group of mice was irradiated 338 hours after their injection with Co57.

The radioactivity in all the mice decreased to approximately 70 per cent 24 hours after injection. Thereafter radioactivity continued to decrease at a slower rate. The biologic half-life was 17 plus or minus 0.3 days in unirradiated female mice. The T1/2b was decreased slightly with increasing external irradiation except that the T1/2b was increased to 26.4 days for the mice irradiated at 338 hours after injection.

SUPPORTED BY U.S. Veterans Administration

5.0402, EFFECTS OF RADIATION AND OTHER FACTORS ON THE DEVELOPING FORM AND FUNCTION OF THE NERVOUS SYSTEM
S.P. HICKS, Univ. of Michigan, School of Medicine, *Ann Arbor, Michigan* 48104 (AT(11-1))

This research studies effects of brain injury by radiation and other means in early life on subsequent structural and functional development, and compares these with effects of similar injuries in adulthood. It aims to determine limits of residual function set by various injuries to different parts of the nervous system.

SUPPORTED BY U.S. Atomic Energy Commission

5.0403, AREA PROGRAM IN POPULATION GENETICS
J.V. NEEL, Univ. of Michigan, School of Medicine, *Ann Arbor, Michigan* 48104 (AT(11-1)1552)

This is a multidisciplinary project in population genetics which, at the one extreme, involves extensive field work among some of the most primitive Indians still in existence and, at the other extreme, attempts computer simulation of many aspects of the breeding structure of Indian populations, in an effort to explore many questions concerning inbreeding levels, genetic drift, stabilizing selection, etc., not susceptible to deterministic formulations. A particular effort is being made to determine how man's interaction with potential pathogens differs in this environment from that in the more familiar culture of civilized man. This year especial foci of interest will be, 1) a search for the cause of the large amount of chromosomal damage discovered last year, 2) completion of the collection of demographic data in areas previously contacted, and 3) penetration of several new areas.

In addition, efforts will continue to develop and refine new genetic systems of value to population genetics (Cp,Lp,Xm,Ag,Gm) and to understand the basis for species similarities and differences in isozyme patterns.

Finally, the Program includes provisions for the continuing participation of Dr. Blooom in the cytogenetic studies of the Atomic Bomb Casualty Commission.

Results: Report by approximately 50 papers on inbreeding effects, biochemical variants, and population genetics of the American Indian.

SUPPORTED BY U.S. Atomic Energy Commission

5.0404, X-IRRADIATION OF BRAIN OF PATIENTS WITH MULTIPLE SCLEROSIS - CEREBROSPINAL FLUID LIPOPROTEINS - WHITE MATTER GANGLOIDS
W.W. TOURTELLOTTE, Univ. of Michigan, School of Medicine, *Ann Arbor, Michigan* 48104

1. Will X-irradiation of the brain of patients with multiple sclerosis decrease the immunoglobulin-G concentration, leucocyte count, lipids and bromide ion concentration in the cerebrospinal fluid and significantly change the neurological function?

2. Are the lipids in the cerebrospinal fluid protein bound? Are they abnormal in multiple sclerosis cerebrospinal fluid?

3. Are the gangliosides in the white matter compartmentalized to the axoplasm? Are they abnormal in plaques and in surrounding normal appearing white matter?

SUPPORTED BY National Multiple Sclerosis Society - N.Y.

5.0405, CYSTEAMINE AND X-RAYS PRENATALLY - BEHAVIOR OF THE RAT
J.M. ROBERTS, Univ. of Detroit, School of Dentistry, *Detroit, Michigan* 48221

There is comparatively little behavioral data (learning, emotionality, activity level, sensory responsiveness, etc.) available in the literature in the area of protective agents and radiation damage as observed postnatally in the prenatally-irradiated animal.

The purpose of the proposed project is to: (1) elucidate the role of the fetal adrenal cortex in the maternal organism's biological reaction to the stress of radiation; (2) clarify the role of cysteamine in regard to radiation protection of the fetus when given either before or after irradiation of the pregnant mammal; and (3) to extend our investigations of the effects of radiation on measures of central nervous functioning.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0406, PHYSICAL MECHANISMS IN THE INACTIVATION OF PROTEINS BY RADIATION
E. KUNTZ, Michigan State University, School of Natural Sciences, *East Lansing, Michigan* 48823 (AT)

We propose to extend our study of the preferential destruction of cystinyl residues adjacent to tyrosines in ribonuclease by UV to ionizing radiations. Investigations on the nature of the interactions between aromatic groups and peptide or cystinyl groups will continue. Photosensitized crosslinking in proteins will be investigated.

Results: Evidence for preferential destruction of cystines adjacent to tyrosines in ribonuclease irradiated by UV light. Interactions between aromatic residues and peptide bonds or cystinyls to quench fluorescence and phosphorescense. Inactivation of trypsin by slow electrons.

SUPPORTED BY U.S. Atomic Energy Commission

5.0407, BIOCHEMICAL CHANGES CAUSED BY RADIATION INACTIVATION
E. KUNTZ, Michigan State University, School of Natural Sciences, *East Lansing, Michigan* 48823

Long Range Goal: To understand the molecular processes in proteins and nucleic acids which are initiated by radiation products and result in loss of biological activity. Ultimately, we want to be able to predict what type of energy transfer, localization and damage will result from excitation of nearby solvent or of any of the components in a complex structure such as a chromosome.

Immediate objective: The radiation induced processes occurring in condensed systems such as protein films and cellular structure such as mitochondria will be compared to those which occur in dilute solution of enzymes and nucleic acids.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0408, FACTORS RESPONSIBLE FOR CHANGES IN RADIOSENSITIVITY OF EMBRYONIC TISSUES
L.W. MERICLE, Michigan State University, School of Agriculture, *East Lansing, Michigan* 48823 (AT(11-1)-1400)

Changes in radiosensitivity and patterns of response undergo marked changes during the proembryo period in barley and floral bud development in 'Tradescantia', with changes, in the latter, also associated with inflorescence aging and alteration of the environment. The purpose of this research is to delineate those factors (inherent or external) which are responsible for, or capable of modifying, the radiosensitivity in these embryonic tissue systems, and to determine insofar as possible the mechanisms involved. Microspectrophotometry measurements of changes in nuclear components of barley proembryos are being carried out to find explanations for their puzzling radiation response behavior. Confirmation of DNA data is being sought and study extended to include basic and acidic proteins. Somatic mutations for flower color at the delphinidin, D, locus in clone 02 'Tradescantia' probably constitute the most radiosensitive biological indicator known. Evidence is being sought as to the specific cytogenetic mechanisms involved. Receiving current attention are those responsible for (a) spontaneous mutations, (b) ones actuated by temperature extremes or other environmental variables, and (c) dissemination of the product(s) of a single mutational event (in a linear structure, such as a stamen hair) which results in the formation of multiple, discrete, mutant sectors separated by non-mutated cells.

Results: Preliminary data on DNA content, coupled with absence of cytological evidence of endopolyploidy, indicate the probable presence of polyteny in early proembryos of barley. Somatic mutations at the D locus often involve chromosome aberration, but ones of spontaneous origin seem to arise by mechanisms such as mitotic crossing-over or gene mutation which do not yield micronuclei. Diurnal differences of 0-35 F- deg. have no readily detectable effects on spontaneous mutation rate, but increasing the range by 5 F-deg. raises mutation rate 9-fold. Individual stamen hairs containing multiple mutant sectors arise early in hair

development, not when mutation rate is highest, indicating their probable origin as single mutational events.

SUPPORTED BY U.S. Atomic Energy Commission

5.0409, MECHANISMS OF ION UPTAKE AND TRANSPORT BY ABOVE GROUND PLANT PARTS

S.H. WITTWER, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00088)

OBJECTIVE: Resolve mechanisms of foliar absorption of mineral nutrients and fallout materials. Accurately determine foliar absorption rates, not biased by transport, of various mineral nutrients and constituents of fallout for several crop plants. Resolve mechanisms of transport and redistribution in the plant, and underlying factors responsible for degrees of mobility and for immobility of foliar absorbed nutrients.

APPROACH: Studies will be initiated relative to factors affecting absorption and mobility of foliar applied cesium 137. The mobilization of foliar applied nutrients by the developing fruit of the tomato variety Farthest North (highest fruit/foliage ratio of known varieties) as influenced by graft unions and certain growth substances will be followed. Influence of root temperatures on foliar absorption of specific nutrients by several species will be determined.

PROGRESS: Review papers on foliar absorption and phosphorus nutrition were prepared and published. Factors affecting the penetration of iron carriers through cuticular membranes of Euonymus and tomato fruits and isolated tobacco leaf cells were identified. Zinc and calcium uptake and distribution studies were conducted with beans and special reference given to the Sanilac and Saginaw cultivars. The mechanism of uptake of zinc in bean tissues was passive. DMSO enhanced zinc uptake, but concomitantly reduced respiration and RNA and protein synthesis. There were differential subcellular accumulations of zinc and calcium which were variety dependent.

SUPPORTED BY U.S. Dept. of Agriculture

5.0410, EFFECTS OF IRRADIATION ON LICHENS AND LICHEN-FORMING FUNGI AND ALGAE

F.H. ERBISCH, Michigan Technological Univ., School of Science, *Houghton, Michigan* 49931 (AT-(11-1)-2085)

The objective of this study is to determine if the symbionts (fungi and algae) of Cladonia sylvatica, a fruticose lichen, are more gamma radiosensitive when in association, forming the intact lichen, or when separated from each other.

In 1968 several crustose lichens and one fruticose lichen were irradiated at the Lawrence Radiation Laboratory of the University of California. No physical or cellular damage was noted in the irradiated material. Later a more intensive study with Cladonia sylvatica was undertaken. Physical damage was first observed at 2,000 Kr. Oxygen consumption of irradiated material (0.1 to 1,000 Kr) varied, somewhat, for the first week after irradiation, but by the third week it paralleled that of the control. Phycobiont damage within the intact lichen was first noted two weeks after 100 Kr doses, and immediately after doses of 1,000 and 2,000 Kr. No more than 5% of the phycobiont cells appeared damaged. Chronic irradiation studies, at the North Central Forest Experiment Station at Rhinelander, Wisconsin have also indicated that Cladonia sylvatica is highly gamma radioresistant.

Chronic irradiation studies at Rhinelander are continuing with field and cytological observations being made periodically of the lichen clumps that were transplanted into the field during 1969.

Acute radiation studies using both the intact lichen and the individual symbionts will be conducted to determine the effects of irradiation on respiration, photosynthesis, membrane permeability, and cell structure. Uniform patches or clumps of Cladonia 30-40 centimeters in diameter, will be used for each series of experiments. Typical Warburg manometric techniques will be used to study photosynthetic and respiratory rates. Membrane permeability will be measured by rate of uptake and incorporation of 32P into the cells. Thin sections and squashes will be prepared for examination with phase contrast and Nomarski optics. These slides will be examined for choloroplastid and nuclear shape and volume changes along with chromosome and other cellular damage within the symbionts.

SUPPORTED BY U.S. Atomic Energy Commission

5.0411, BIOCHEMICAL STUDIES IN THE OCULAR LENS IN RELATION TO CATARACTOGENESIS

V.E. KINSEY, Oakland University, Inst. of Biological Sciences, *Rochester, Michigan* 48063 (AT(11-1)-2012)

The mechanism by which the level of glutathione falls in lenses exposed to ionizing radiations will be examined by investigating possible alterations in the permeability characteristics in lenses at intervals following X-irradiation.

Further studies are proposed to separate the effects of the electrical and chemical potential on the transport of ions in and out of the lens. A mathematical model which considers the lens as a pump-leak system derived from classic enzyme kinetics and diffusion theory has been devised which describes the parameters of the system governing active transport and passive diffusion across membranes. Multiple cross saturation experiments are planned to determine the effect of concentration of K, Rb and Cs in bathing media and the movement of these ions in and out of cultured lenses to test the validity of the model and evaluate the parameters of the system. This procedure will make it possible to decide whether one or more carrier systems participate in the transport of these ions and whether inhibition is competitive or non-competitive. It will also afford information concerning the effect of concentration on the permeability characteristics of the lens.

Further studies are also planned to explore the implications of the translenticular current, apparently produced by the active transport of sodium across the lens, as well as investigations on the transport and synthesis of amino acids by this organ.

Results: A current of 15 Micro Amperes due probably to movement of Na flows across the lens through a resistance of approximately 1250 ohms. The open circuit voltage is about 20 mV. A mathematical model of the pump-leak system of transport in the lens, of usefulness in evaluating the parameters of the system, has been devised. The active transport of taurine in the lens has been characterized.

SUPPORTED BY U.S. Atomic Energy Commission

5.0412, CELLULAR PROLIFERATION AND REGENERATION FOLLOWING TISSUE DAMAGE

C.V. MARDING, Oakland University, School of Arts, *Rochester, Michigan* 48063 (AT)

The goal of this program is to further elucidate the mechanisms that control mitosis and cellular migration in normal and injured lenses. This should lead to a better understanding of those phenomena which are related to mitosis and migration: Differentiation, regeneration, growth, wound-healing, and response to injurious agents such as radiation. With regard to the lens, it should increase our understanding of the mechanisms of cataract formation. The specific aim of this project is to delineate the pattern of macromolecular synthesis and ultrastructural changes, i.e. changes in cell-to-cell relationships, which precede the initiation of cell division in the epithelium of lenses which have been induced to divide as a result of injury or culture of the lens in media containing rabbit serum or insulin. An additional aim is to characterize the factor(s)in serum which engenders mitosis and migration and to determine its mode of action. Investigations will be focused upon changes in ultrastructure of the injured epithelium at different stages of the cell cycle during wound- healing. A further characterization of the mitogenic serum factor(s), (Harding et. al., 1968, J.C. Physiol., 72, 213-220) and the effect of radiation on serum factor production will be evaluated. The ultrastructural and metabolic changes which occur during triggering of the cell cycle in vitro and which accompany the re-establishment of the G-O state will be investigated. We also propose to study the mechanism by which insulin triggers cell division in the cultured lens (Reddan and Harding, 1969, J.C., 43, 114A).

SUPPORTED BY U.S. Atomic Energy Commission

5.0413, EFFECTS OF IONIZING RADIATION & OTHER ENVIRONMENTAL FACTORS ON BREEDING BEHAVIOR,

ACTIVITY PATTERNS & MOVEMENT OF SELECTED VERTEBRATES

J.R. TESTER, Univ. of Minnesota, Museum of Natural History, *Minneapolis, Minnesota* 55455 (AT(11-1))

The objectives are to determine effects of ionizing radiation and other environmental factors on breeding behavior, activity patterns and movement of selected vertebrates and to interpret these effects in terms of their possible influence on population dynamics. LD50-30's will be determined when possible for the species under investigation. Studies on the pair-formation in Green-winged Teal and on territorial behavior in Shovelers are being concluded. The effects of ionizing radiation on vocalizations in mallards will be initiated. Studies of the biological, behavioral and physical factors affecting home ranges of snowshoe hares, cottontail rabbits, raccoons, red fox, striped skunks and white-tailed deer under natural conditions are being carried out using an automatic radio tracking system. Also, methodology to monitor the heat budget of these mammals will be developed, in an effort to expand the parameters used to measure the effects of sublethal doses of radiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0414, RESPONSES OF PROTEIN SYNTHESIS TO ENVIRONMENTAL STRESSES AND RESULTANT MORPHOLOGICAL CHANGES

G.N. BROWN, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00606)

OBJECTIVE: Investigate changes in characteristics of transfer ribonucleic acids (tRNA) to changes in levels of temperature and ionizing radiation. Responses of synthetic rates of tRNA, messenger RNA (mRNA), and ribosomal RNA (rRNA) to changes in levels of temperature and ionizing radiation. Responses of synthetic rates of some enzymes fundamental to growth and development to changes in levels of temperature and ionizing radiation. Relationships between these objectives and resultant morphological changes. Changes in objectives during senescence following extreme changes in levels of temperature and ionizing radiation.

APPROACH: Mimosa (Albizzia julibrissin Durazzini) and other hardwood seedlings will be exposed to temperature and ionizing radiation stresses. Quantitative and functional responses of total RNA, DNA, tRNA, mRNA, rRNA, and some fundamental enzymes, all pertinent to protein synthesis will be determined. Morphological changes also will be observed and related to early changes in protein synthesis mechanisms following exposure to temperature and ionizing radiation stresses.

PROGRESS: Changes have been documented in transfer RNA profiles during maturation and changes in growth rates of mimosa epicotyl tissues, and are being reported in a paper currently in press in Plant Physiology and a paper currently in review with Plant and Cell Physiology. Quantitative changes in mimosa epicotyl RNA fractions following gamma irradiation have been reported in a completed MS thesis and a paper in preparation for publication in Biochim. Biophys. Acta. Characterization of an unusual soluble RNA fraction in mimosa epicotyl tissues is in preparation for publication in Biochim. Biophys. Acta. A technique for purification and separation of ribosomal units using higher plant tissues has been perfected, and is in preparation for publication in Plant Physiology. Progress has been made on a study of RNAse activity in response to winter hardening. A study on quantitative changes in RNA fractions in red pine embryonic and megagematophytic tissues during germination is almost completed. Finally, after three years of work a technique has been modified to the point of yielding satisfactory results in an assay for amino acid acceptance by specific transfer RNAs.

SUPPORTED BY U.S. Dept. of Agriculture

5.0415, STUDIES ON THE MECHANISM OF ULTRAVIOLET INACTIVATION OF ENZYMES

C.A. GHIRON, Univ. of Missouri, School of Medicine, *Columbia, Missouri* 65201 (AT(11-1)1667)

The purpose of this research proposal is to investigate the mechanism of ultraviolet inactivation of enzymes. This will be done by studying the rate of enzyme inactivation and amino acid residue destruction as a function of illuminating wavelength, of protein conformation, and of radical scavenger concentration. The enzymes to be studied are trypsin and ribonuclease. In addition a search for acid labile photoproducts will be instituted. For this purpose the ultraviolet sensitivity of the peptide hormones angiotensin and vasopressin will be studied.

SUPPORTED BY U.S. Atomic Energy Commission

5.0416, EFFECTS OF X-RAYS ON NORMAL AND MALIGNANT CELLS

L.J. TOLMACH, Washington University, School of Medicine, *Saint Louis, Missouri* 63110

Study will continue of (a) phase-dependent fluctuations in the response of cells to X-rays; (b) potentially lethal damage and the modification thereof by pre- and post-irradiation treatment of cells with various agents; (c) deficient DNA synthesis associated with physiologic cell death following X-irradiation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0417, MATHEMATICAL BIOLOGY OF NEOPLASTIC GROWTH

R. WETTE, Washington University, School of Medicine, *Saint Louis, Missouri* 63110

This project is concerned with the development and analysis of probabilistic mathematical models representing the growth, dissemination, and radiation response of solid tumors.

The growth of solid-tumor cell populations is modeled as a stochastic birth, death, elimination (of dead cells), and emigration (of live cells) process under the assumption that the respective parameters depend (1) on the space state of the population and (2) on the spatial location of cellular regions in the tumor.

The cellular radiation response is modeled as a stochastic process in which hypothetical cellular replicating units can be reversibly deactivated or irreversibly damaged. This model is sought to represent variable radiosensitivity during the phases of the cell cycle, radiation induced mitotic delay, and latent lethal damage.

It is proposed to then compound the growth process with the cellular radiation response model to obtain a model to represent the radiation response of a tumor cell population. The aim is to quantitatively predict the expected behavior of a solid tumor under radiotherapy so as to further clinical cancer management.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0418, BIOCHEMICAL AND IMMUNOLOGICAL STUDIES OF ENZYMES OF METAZOAN PARASITES

D.L. FERGUSON, Univ. of Nebraska, School of Agriculture, *Lincoln, Nebraska* 68503

The proposed research will primarily involve investigations of enzymes of Ascaris suum and Haemonchus contortus. Where possible, a comparative biochemical and immunological approach will be employed in order to better characterize the enzymes of the metazoan parasite in relation to its host animal. Further investigations of proteins having the same enzymatic activity from various stages of the life cycle of the parasites and from the various tissues or cellular fractions of the parasite will be made concerning their biochemical, physical and antigenic properties. The natural host animal for each parasite will be used to test their antigenic properties. This will include a study of the type, sequence of production, and amount of immunoglobulin (IgM, IgA, or secretory IgA) stimulated by these enzyme antigens and whether these immune globulins inhibit the enzymatic activity of the antigen. Resistance of the immunized animals to infection by infective larvae will be tested.

Another phase of the proposed research will involve the investigation of possible changes induced in enzymes of larvaes of parasites (particularly Ascaris suum) on exposure to X-irradiation. Such a study will necessarily involve a comparison of enzymes of normal to X- irradiated larvae.

5. RADIATION

SUPPORTED BY U.S. National Science Foundation

5.0419, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS

W. OOSTERHEERT, Inst. for Atomic Sci. in Agri., *Wageningen, Netherlands*

Studies on the effect of neutron irradiation on seeds (part of a coordinated program of research on the use of neutrons in seed irradiation).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0420, AEC RADIATION EFFECTS PROGRAM

A.A. MOGHISSI, U.S. Environ. Protection Agcy., Western Environ. Research Lab., *Las Vegas, Nevada* 89114

The objective of this program element is to conduct laboratory and field investigations to aid in determining the potential hazard to humans and the environment resulting from nuclear testing activities.

The potential hazard from selected radionuclides such as might be released to the environment from nuclear sources, e.g. testing activities and power reactors, are investigated in the laboratory and in the field. Radionuclide metabolism in beef and dairy animals, in plants, soil-plant relationships, and transport are included in this project.

The laboratory greenhouse facilities, microplots, and farm and dairy facilities are used in this project. The various components of man's food chain are considered during this study as well as the transport, distribution and exchange within and between these components. The principal pathway considered is the air-forage-cow-milk chain for radionuclides of interest.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0421, AEC ANIMAL INVESTIGATION PROGRAM

D.D. SMITH, U.S. Environ. Protection Agcy., Western Environ. Research Lab., *Las Vegas, Nevada* 89114

This project is conducted to evaluate the uptake and distribution of radionuclides in tissue and bone samples from domestic and game animals in the environs of nuclear testing and to investigate claims of radiation damage to animals. Special objectives include: a) The determination of tissue concentration of fresh and/or aged fission and activation products in bovine and mule deer which range on the Nevada Test Site. b) To study deer migration patterns on the Nevada Test Site as related to environmental parameters, e.g., season, precipitation. c) To maintain a beef herd on the Nevada Test Site and maintain individual health records on the animals.

The radionuclide distribution in animals that are potential components of man's food chain will be studied. Alleged damage to domestic animals from AEC activities will be investigated.

Bovine samples are collected from the beef herd ranging on the Nevada Test Site as well as from animals purchased from ranchers in the near off-site areas. Mule deer are sampled from periodic hunts as are other species, e.g., doves, chukar, ducks, and an occasional road kill of such animals as desert bighorn sheep. Investigation of alleged damage to domestic animals is conducted by veterinarians.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0422, ECOLOGY OF HOT CREEK VALLEY - VEGETATION AND SOIL RESPONSE TO UNDERGROUND DETONATIONS

P.T. TUELLER, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00699)

OBJECTIVE: Investigate influences of AEC underground testing on the flora, funa, and soils in the Hot Creek Valley and surrounding areas.

APPROACH: An ecological resource inventory of Hot Creek Valley is in progress. Determine underground testing influence on native vegetation and soils, the following areas will be studied: Change in species composition. Change in water uptake capacity as a result of root damage. Possible accumulation of radioactive materials by native species. Soil moisture patterns before and after detonation. Possible root-soil interface damage. Revegetation and denuded areas will be studied. Suitable adapted species and artificial revegetation methods will be determined.

PROGRESS: Hot Creek Valley has been mapped by plant communities. Eighty-five soil descriptions were made throughout the communities in the valley. Soil-vegetation correlations are being developed. Permanently located plots have been established on transects surrounding two test holes. Predetonation species composition, cover, frequency, production and soil moisture data have been gathered from these plots. Species trial and seeding method plots were seeded in the spring and fall to obtain vegetation data. Phenological and production data has been gathered from two major plant communities in both Hot Creek and Reveille Valleys. Predetonation mult-spectral aerial photography has been obtained and is being analysed for the UC-3 and UC-4 study areas. A plant collection has been started. Two hundred species were collected, named, and mounted. Preparations are being made to follow changes in the growth of woody plants by annual ring width analysis and sapflow movement. Preliminary data has been collected on a variety of other ecolgical parameters.

SUPPORTED BY Nevada State Government

5.0423, EFFECT OF URANIUM ON THE TRACHEOBRONCHIAL TREE

O. AUERBACH, U.S. Veterans Administration, Hospital, *East Orange, New Jersey* 07019

We have received 201 lung specimens from Dr. Saccomanno in Grand Junction, Colorado, the majority of which are from uranium mine workers. These lungs have been processed and interviews from the families of the individuals are being sought.

During the year several pulmonary cytology task force meetings were held in Salt Lake City and in Grand Junction to discuss the objectives and status of the study. Among other things it was observed that normal sputum cells are found in some individuals and not in others regardless of respiratory irritants; that inspired irritants such as radon, cigarette smoke, smog, silica, etc., produce sufficient irritation to the respiratory mucosa causing alteration of tall columnar cells and squamous cell metaplasia; that continued irritation of the bronchial respiratory epithelium may cause progressive changes in the lining cells which are recognizable in sputum cells, and these aberrations progressively approach all characteristics which closely simulate characteristics of malignant cells and the more atypical the respiratory epithelium becomes, the more likely the possibility of malignancy developing becomes; that the above cellular characteristics are reversible, statistically, as well as actually, and can be demonstrated cytologically. Synergism of chronic irritants is obvious in the etiology of cancer of the lung and deserves much more research attention.

A result of the group meetings was the decision to classify the tumors according to the World Health Organization.

SUPPORTED BY U.S. Veterans Administration

5.0424, STUDIES OF THE DYNAMICS OF CARDIAC DEVELOPMENT

S.H. GILANI, New Jersey Coll. Med. & Dent., School of Medicine, *Jersey City, New Jersey* 07304

Studies are concentrated on the development of the heart in chick embryos with special emphasis on the arterial outflow tract (ventricular outflow tract: bulbus arteriosus and its derivatives); the tract is the most common site of congenital heart disease.

The effects of various teratogenic agents like X-rays, hypothermia, thalidomide and nicotine on the heart development are being investigated by treating the embryos at 2-4 days of incubation--a critical period in the cardiac development. Malformations produced by the procedures noted are being investigated by the study of histological preparations of the experimental material and by the study of blood flow through the treated hearts. The effect of these procedures upon partitioning of the heart (septation), valve formation as well as the direct effect of these teratogens on the cardiac tissues is being emphasized. Histochemical analyses (studies of DNA, RNA, polysaccharides and protein synthesis) are also being carried out.

The analyses of the origins of cardiac defects provided by this type of study will aid in our understanding of congenital heart disease in man.

SUPPORTED BY Essex County Heart Assn. - New Jersey

5.0425, METABOLISM AND DOSIMETRY OF 90Y INHALED IN FUSED CLAY PARTICLES BY THE BEAGLE DOG

J.E. BARNES, Lovelace Fdn. for Med. Ed., *Albuquerque, New Mexico* 87108 (AT(29-2)-1013)

This experiment is part of a long-term study of the biological consequences of inhaling radionuclides such as might be released in certain nuclear accidents. Beagle dogs were exposed once by inhalation to an aerosol of 90Y entrapped in fused clay particles, resulting in initial body burdens of 1,000 to 62,000 muCi. Experimental techniques being used include whole-body counting, scanning, daily collection of urine and feces and serial sacrifices to obtain tissue distribution data. Two groups of dogs have been investigated to date. In the first group consisting of six dogs, sacrifices were made at 0, 2, and 4 days post-exposure. The second group consisted of seven dogs sacrificed at 0, 6, 8, and 12 days post-exposure.

RESULTS: Forty to 60 percent of the initial body burden was excreted rapidly, during the first few days, presumably by mucociliary clearance and swallowing. During the first four days post-exposure essentially all excretion of 90Y was via the feces, indicating the relative insolubility of 90Y in the fused clay vector. Tissue distribution data were obtained by radiochemically analyzing tissue samples following serial sacrifice. After initial clearance most of the 90Y remaining in the dogs was found in the lung, with small amounts in the tracheobronchial lymph nodes, liver and skeleton. Because of the short physical half-life of 90Y (64 hr), practically all of the total radiation dose was delivered during the first two weeks post-exposure. The lung had an initial dose rate of 0.22 rad/min/mCi deposited in lung, and a total cumulative dose of approximately 1200 rads/mCi initial deposit. These data play an important role in the comparison of biological effects to the lung as a function of dose rate, for various inhaled beta emitters.

SUPPORTED BY U.S. Atomic Energy Commission

5.0426, TOXICITY OF 144CE INHALED IN FUSED CLAY BY THE BEAGLE DOG

B.B. BOECKER, Lovelace Fdn. for Med. Ed., *Albuquerque, New Mexico* 87108 (AT(29-2)-1013)

This experiment is part of a long-term study of the biological consequences of inhaling radionuclides such as might be released from a nuclear accident. Beagle dogs were exposed once by inhalation to Ce144 entrapped in a fused clay aerosol. Sufficient Ce144 activity was present to produce biological damage and lifespan shortening. Clinical, hematological, biochemical and microbiological changes attributable to the radiation insult are being followed throughout their remaining lifespan and pathologic examinations are performed at death. Observed biological effects are related to radiation dose using data from whole- body counting, excreta collections and tissue-distribution studies.

RESULTS: This longevity study involves two series of dogs. Series I with 15 dogs exposed to aerosols of Ce144 in fused clay to yield initial lung burdens of 88 to 2100 muCi and 3 control dogs exposed to non-radioactive clay and Series II with 48 dogs exposed to date to aerosols of Ce144 in fused clay to yield initial lung burdens of 0.10 to 580 muCi and 6 control dogs exposed to non-radioactive clay. The Ce144 in fused clay is retained tenaciously in the lung with only small quantities being translocated to tracheobronchial lymph nodes, liver and skeleton. However, because of the small size of the tracheo-bronchial lymph nodes, they exceed the lung in Ce144 concentration by 100 days post-inhalation. To date, 9 of the 15 dogs in Series I and 5 of the 48 dogs in Series II have died or have been euthanized at 143 to 410 days after inhalation of Ce144. The prominent pathological finding is a severe pulmonary fibrosis. The cumulative radiation dose to the lung to time of death has ranged from 20,000 to 110,000 rads. Serial observations are continuing on all survivors with special attention directed to evaluating various clinical, pulmonary function, hematologic, serum chemical and microbiologic parameters.

SUPPORTED BY U.S. Atomic Energy Commission

5.0427, METABOLISM AND DOSIMETRY OF 90SR INHALED IN FUSED CLAY PARTICLES BY THE BEAGLE DOG

B.B. BOECKER, Lovelace Fdn. for Med. Ed., *Albuquerque, New Mexico* 87108 (AT(29-2)-1013)

This experiment is part of a long-term study of the biological consequences of inhaling radionuclides such as might be released in certain nuclear accidents. Beagle dogs were exposed once by inhalation to an aerosol of Sr90-90Y, entrapped in fused clay particles, resulting in initial body burdens of 200 to 500 muCi. Experimental techniques being used include whole-body counting, scanning, daily collection of urine and feces and serial sacrifices to obtain tissue distribution data. A preliminary experiment was conducted with nine dogs scheduled for sacrifice in groups of 3 at 8, 256 and 512 days post- exposure. The second experiment, based in part on results from the preliminary experiment, involves 26 dogs scheduled for serial sacrifice in groups of three out to 2048 days post-exposure.

RESULTS: For most of the dogs, from 40 to 60% of the initial body burden was cleared within the first day or two post-exposure; in one dog 84% of the initial body burden was lost. Presumably this initial clearance was the result of mucociliary action, swallowing, and excretion via the gastrointestinal tract. Urine and feces samples collected on selected dogs during the early post-exposure period are currently being analyzed radiochemically. After initial clearance the remaining Sr90 was retained with a long effective half-life of approximately 400 days in the lungs of the dogs in the preliminary experiment. Tissue analyses of dogs sacrificed to date (at 8 and 256 days post-exposure) have shown over 90% of the body burden in the lung and tracheobronchial lymph nodes, the remainder being in skeleton. These data will be an important part of the comparison of biological effects of various beta emitters inhaled in a relatively insoluble form, since they represent a situation in which the total radiation insult is delivered over a period of many years in contrast to shorter-lived radionuclides.

SUPPORTED BY U.S. Atomic Energy Commission

5.0428, TOXICITY OF INHALED 90SR CHLORIDE IN THE BEAGLE DOG

B.B. BOECKER, Lovelace Fdn. for Med. Ed., *Albuquerque, New Mexico* 87108 (AT(29-2)-1013)

This experiment is part of a long-term study of the biological consequences of inhaling radionuclides such as might be released from a nuclear accident. Beagle dogs were exposed once by inhalation to Sr90Cl2, at levels presumed to produce biological damage and lifespan shortening. Clinical, hematological, biochemical and microbiological changes attributable to the radiation insult are being followed throughout their remaining lifespan, and pathologic examinations are performed at death. Observed biological effects are related to radiation dose using data from whole-body counting, excreta collections and tissue distribution studies.

Forty-eight dogs have been exposed to CsCl aerosols containing Sr90, resulting in initial body burdens ranging from 2.6 to 280 muCi Sr90/kg. These are being maintained for lifetime observation and have been placed in four groups based on their retained Sr90 burden at 14 days post inhalation. Group means were 1.4, 6.2, 30 and 75 muCi/kg.

RESULTS: To date, 24 dogs have died or were euthanized, 6 with severe hematologic dyscrasia, during the first 31 days, and 18 between 585 and 1540 days. The latter group includes 7 with angiosarcomas, 3 with fibrosarcomas, 4 with osteosarcomas, 1 with osteochondrosarcoma, 1 with osteochondrofibrosarcoma, 1 with leukemia, 1 with an epileptic seizure and 1 with cerebellar hemorrhage. (One dog had both an angiosarcoma and an osteosarcoma.) The skeleton of these dogs received initial radiation dose rates of 16 to 60 rad/day and cumulative doses to death of 7500-19000 rads. Serial observations are continuing on the survivors.

SUPPORTED BY U.S. Atomic Energy Commission

5.0429, DISTRIBUTION AND EXCRETION OF 137 CS INHALED IN FUSED CLAY PARTICLES BY THE DOG
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This experiment is part of a long-term study of the biological consequences of inhaling fission product radionuclides such as might be released in certain nuclear accidents. Beagle dogs were exposed once by inhalation to an aerosol of Cs137 encapsulated in fused clay particles resulting in initial body burdens of 5 to 130 muCi. Experimental techniques being used include whole-body counting, daily collections of urine and feces and serial sacrifices to obtain tissue distribution data. In a preliminary experiment, three dogs were exposed and sacrificed at 180 days post-exposure. A second experiment, now in progress, involves 30 dogs that are being sacrificed in groups of two at times ranging from immediately to four years post-exposure.

RESULTS: From 30 to 82% of the initial body burden was excreted with the first few days post-exposure, presumably due to clearance of the upper respiratory tract by mucociliary action followed by swallowing and excretion via the feces. The whole-body retention curves for six dogs followed for at least two years post-exposure could be described by 3-component exponential functions whose longest-term component corresponded to an effective half-life of retention that ranged from 350 to 780 days. Tissue distribution data obtained by serial sacrifice during the first two years post-exposure have demonstrated the relatively insoluble nature of Cs137 inhaled in this form. Highest concentrations of Cs137 were observed in lung and tracheobronchial lymph nodes with concentrations in muscle and liver being approximately three orders of magnitude lower. Comparison of these data with similar data for Sr90, Ce144 and Y91 in fused clay should promote a better understanding of the mechanisms of clearance and translocation of these isotopes inhaled in this form.

SUPPORTED BY U.S. Atomic Energy Commission

5.0430, TOXICITY OF INHALED 91Y CHLORIDE IN THE BEAGLE DOG
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This experiment is part of a long-term study of the biological consequences of inhaling radionuclides such as might be released from a nuclear accident. Beagle dogs were exposed by inhalation to 91YCl3, at levels presumed to result in biological damage and lifespan shortening. Clinical, hematological, biochemical and microbiological changes attributable to the radiation insult are being followed throughout the lifespan, and pathologic examinations are performed at death. Observed biological effects are related to radiation dose which has been obtained from whole-body counting, excreta collections and tissue-distribution measurements.

Forty-two dogs with 91Y burdens from 73 to 1330 muCi/kg were placed in four groups with mean initial body burdens of 12, 260, 560, and 920 muCi/kg. For comparison with observed biological effects, these same dogs were regrouped on the basis of retained 14-day body burdens, yielding groups with mean values of 31, 59, 140 and 270 muCi/kg. These dogs and 12 control dogs are being maintained for lifetime observation.

RESULTS: Eleven dogs within the highest exposure groups have died or were euthanized at 17 to 33 days after inhalation of 91Y, with changes related to severe bone marrow damage and associated pancytopenia. Two dogs died at approximately one year, with convulsive seizures that were presumed to be unrelated to the 91Y exposure. Thirty-five dogs that had initial body burdens of 73 to 800 muCi/kg and all 12 control dogs are surviving at 800 days or more after inhalation of 91Y. Serial observations are continuing on all surviving dogs.

SUPPORTED BY U.S. Atomic Energy Commission

5.0431, TOXICITY OF INHALED CE144 CHLORIDE TO THE BEAGLE DOG
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This experiment is part of a long-term study of the biological consequences of inhaling radionuclides such as might be released from a nuclear accident. Beagle dogs were exposed once by inhalation of Ce144Cl3 at levels presumed to produce biological damage and lifespan shortening. Clinical, hematological, biochemical and microbiological changes attributable to the radiation insult are being followed throughout the remaining lifespan, and pathological examinations are performed at death. Observed biological effects are related to radiation dose as obtained from measurements of whole-body burden, excreta, and tissue-distribution.

Fifty-five dogs that inhaled Ce144Cl3 and 15 control dogs have been placed in a longevity study and will be observed for their lifespan. These dogs have been placed in 6 groups based on initial Ce144 burden (group means 0, 14, 51, 130, 280, and 480 muCi/kg). These were regrouped on the basis of retained Ce144 at 14 days post-inhalation to yield groups with mean Ce144 content of 0, 5.2, 14, 40, 120, and 230 muCi/kg.

RESULTS: Studies on the tissue distribution of inhaled Ce144Cl3 indicate that Ce144 deposited in the lung is translocated at a moderately rapid rate to liver and skeleton. The pattern of distribution is such that significant radiation doses are accumulated to all three tissues. Sixteen dogs from the two highest groups have died; 8 at 21 to 44 days post-inhalation with signs attributed to severe bone marrow damage and associated pancytopenia; 2 at 138 and 144 days with radiation pneumonitis; 3 at 309 to 874 days with hepatic necrosis; 1 at 510 days with marrow aplasia, 1 at 375 days with pulmonary fibrosis, and 1 at 799 days with an osteogenic sarcoma. Serial observations are continuing on the surviving dogs.

SUPPORTED BY U.S. Atomic Energy Commission

5.0432, RADIATION DOSE PATTERNS ASSOCIATED WITH INHALATION OF ALPHA-EMITTING RADIONUCLIDES BY THE BEAGLE DOG
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Plutonium and the trans-plutonic elements increasingly become potential inhalation hazards as their uses are expanded. To help assess these hazards, we will study inhalation of three widely separated particle sized aerosols of Pu239 (activity median aerodynamic diameter (AMAD) of 0.5 micromillimeter, 1.5 micromillimeter and 3.5 micromillimeter) in the beagle dog, with particular regard to the influence these may have on dose distribution within lung tissue. Translocation from the lung to other organs versus particle size will also be studied. Limited inhalation exposures to the much shorter half- lived Pu238 will be conducted for comparison with the long-lived Pu239, to achieve some estimate of differences in tissue dose rate. In addition, experiments to determine the radiation dose patterns following inhalation of aerosols of two other alpha emitters, Am241 and Cm244, will be carried out with particle size distributions having AMAD's of approximately 1.5 micromillimeter. Results of these studies will be important in interpreting human exposure information associated with the nuclear energy industry, and in more accurately establishing maximum permissible levels for workers and the population-at-large.

RESULTS: At present a pilot inhalation study with Am241 in beagle dogs is in progress. The aerosol behaved as if it were somewhat soluble, with some material leaving the lung to enter primary locations in liver and bone. Body burden measurements are difficult with the low energy gamma emission from this radionuclide (60 keV), but a method has been developed to establish initial burdens by a combination of excreta analyses and whole-body scans. This information is presently accepted for publication in Health Physics. A study with soluble Cm244 is to be started shortly, to quantitate the dosage pattern after inhalation by beagle dogs.

SUPPORTED BY U.S. Atomic Energy Commission

5.0433, CHROMOSOME ABERRATIONS PRODUCED BY INTERNALLY DEPOSITED RADIOACTIVE MATERIALS IN THE CHINESE HAMSTER
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As part of the program to evaluate the biological hazards associated with internally deposited radioactive materials, experiments are being conducted on the changes observed in the chromosmes of the Chinese hamster following injection or inhalation of Sr90, Ce144 and Am241. These isotopes were selected because of their presence in nuclear reactors, long effective half-lives in humans and their site of deposition; bone for Sr90, liver and bone for Ce144 and Am241. They also provide a comparison of the effectiveness of protracted beta Sr90 and Ce144 and alpha (Am241) exposures. The characteristic isotopic localization exposes cell types with widely differing turnover rates such as bone marrow cells which have a short cell cycle with a rapid cell turnover and differentiation rate, and liver cells which seldom divide and are fully differentiated. Based on the chromosome changes observed in these organs following Sr90, Ce144 and Am241 exposures, models can be constructed to predict the radiation response of other organs. These experimental systems are being used to evaluate the influence of dose rates and cumulative radiation doses on tissues.

RESULTS: The accumulation of chromosome damage in the bone marrow followig injection with Sr90 is dependent on the radiation dose rate at the time of sacrifice. This is a reflection of the total dose accumulated from one cell division to the next. Cell division acts as a means of cell population repair. Following injection of Ce144 or Am241, the frequency of abnormalities in the liver cells increases with increasing total radiation dose but shows little dose rate effect over the range of rates studied. The slow rate of cellular turnover resulting in a lack of population repair is thought to contribute to this response. Am241 was found to be ten times as effective as Ce144 in producing chromosome aberrations.

SUPPORTED BY U.S. Atomic Energy Commission

5.0434, INITIAL DEPOSITION OF RADIONUCLIDE-CONTAINING PARTICLES IN THE LUNGS OF BEAGLE DOGS

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Two types of studies have been carried out to determine initial lung deposition patterns. The first utilized La140 labeled aerosols to study the effect that particle size has on localized deposition along the respiratory tract. The aerosols used had activity median aerodynamic diameters (AMAD's) ranging from 0.55 to 2.45 micromillimeters. The deposition patterns were measured in five beagle dogs. The second group of studies involved the autoradiographic localization of inhaled particles along the respiratory tract. Beagle dogs were exposed to aerosols of 90YCl3, 90Y-fused clay, 90Y oxide in ZrO matrix, Ce144-fused clay, La140 oxide and La140-fused clay. They were sacrificed immediately post-exposure, frozen and sectioned longitudinally at the midline. The lungs were also removed. Gross autoradiographs were made of the longitudinal sections and of the lungs, spread flat against the film.

RESULTS: Results of the first group of studies indicated that over the range of particle sizes, mean total body deposition ranged from 30 to 75%, mean pulmonary deposition between 20 and 40%, mean tracheobronchial deposition from 3 to 6% and nasopharyngeal deposition between 5 and 40%. The gross autoradiographic data from the second study also indicated deposition in these areas and, more significantly, a striated pattern along the pleural surface of the lung which resembled the rib formation of the thoracic cage.

SUPPORTED BY U.S. Atomic Energy Commission

5.0435, TOXICITY OF INHALED 90Y IN FUSED CLAY IN THE BEAGLE DOG

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This experiment is part of a long-term study of the biological consequences of inhaling radionuclides such as might be released from certain nuclear accidents. Beagle dogs were exposed once to an aerosol of fused clay containing sufficient 90Y to result in biological damage and lifespan shortening. 90Y in fused clay was selected as the aerosol due to its relative insolubility in the lung and its short effective half-life. Clinical, hematological, biochemical and microbiological changes attributable to radiation insult are being followed throughout their remaining lifespan and pathological examinations are performed at death. Observed biological effects are related to radiation dose using data from whole-body counting, linear scans, excreta collections and tissue distribution studies.

RESULTS: At present 51 dogs including 6 control dogs have been exposed to 90Y in fused clay or non-labeled fused clay aerosols. The clinical and pathological findings in these animals can be attributed to radiation damage of the lungs and to a lesser extent, the heart. Principal pathological findings have been pulmonary edema and hemorrhage, fibrosis of alveolar septa, erosion and concurrent regenerative hypertrophy of bronchiolar and alveolar duct epithelium, occlusive pulmonary vasculative lesions, focal adenomatous proliferation of alveolar duct epithelium and myocardial necrosis limited to the right atrium. The remaining dogs with initial lung burdens from 1.0 to 6.7 mCi Y90 are exhibiting no clinical signs at 45 to 200 days post- exposure. A dose-related depression of lymphocytes was the only significant hematological change observed. Terminal biochemical, blood gas and respiratory physiology data have been consistent with respiratory insufficiency. Survivors will be observed for lifespan shortening and the occurrence of radiation-induced neoplasms.

SUPPORTED BY U.S. Atomic Energy Commission

5.0436, TOXICITY OF INHALED 91Y IN FUSED CLAY IN THE BEAGLE DOG

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This experiment is part of a long-term study of the biological consequences of inhaling radionuclides such as might be released from certain nuclear accidents. Beagle dogs were exposed once to an aerosol of fused clay containing sufficient 91Y to result in biological damage and lifespan shortening. 91Y in fused clay was selected as the aerosol as an example of an energetic beta-emitter with a short to intermediate effective half-life in the lung. Clinical, hematological, biochemical, physiological and microbiological changes attributable to radiation insult are being followed throughout the dogs remaining lifespan and pathological examinations are performed at death. Observed biological effects are related to radiation dose using data from whole-body counting, linear scans, excreta collections and tissue distribution studies.

RESULTS: At present 32 dogs have been exposed to aerosols of 91Y in fused clay. The initial lung burdens of the dogs range from 100 to 2400 micro curie of 91Y. None of the dogs is exhibiting any detectable abnormalities at times ranging from 10 to 60 days post-exposure. Additional dogs will be exposed to similar aerosols in the future. All the animals will be studied closely as individuals to delineate the biological effects of this type of radiation exposure. It is anticipated that life-span shortening and radiation-induced neoplasms, particularly of lung, will be observed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0437, BIOMEDICAL EFFECTS OF EXPLOSIONS

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The Project is directed toward obtaining an improved understanding of the biomedical effects that result from human exposure to nuclear weapons. The approach is largely analytical in nature and deals with range-yield effects relationships for nuclear explosives and the development of appropriate biomedical criteria needed for assessing hazards and predicting both the number and nature of expected injuries. Revision of such criteria is based on a collection of data from Hiroshima and Nagasaki, full-scale field tests as well as literature surveillance for more recent laboratory data. Although past efforts have dealt with predictive capability for acute injuries as a function of range and yield for human beings exposed in the open, greater emphasis is currently being placed on injuries sustained in various types of protective structures and on more delayed effects.

RESULTS: Staff members participated in the Office of Emergency Preparedness Civil Defense Study resulting in the writing of a document entitled 'A Primer on Biomedical Criteria

for Nuclear Weapons Effects and Their Application to Casualty Prediction Models.' This served as the major biomedical input for this study. Preparations are underway for the revision of the Nuclear Bomb Effects Computer which will serve as a supplement to the revised addition of the Effects of Nuclear Weapons. Initial computational efforts suggest that slant range rather than ground range may be more meaningful in terms of expected effects on people from nuclear detonations.

SUPPORTED BY U.S. Atomic Energy Commission

5.0438, PHYSICO-CHEMICAL NATURE OF 95NB(V) OXALATE IN THE BEAGLE DOG BLOOD AFTER INJECTION OR INHALATION OF 95NB(V) OXALATE

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The objective of this study is to determine the physico-chemical nature of 95Nb(V) in Beagle dog blood after intravenous or inhalation exposure to 95Nb(V) oxalate. A polyvalent nuclide in blood may combine with (1) cellular fractions, (2) serum proteins, (3) low molecular weight compounds such as citrate and amino acids or (4) inorganic anions. Determination of the physico-chemical nature of 95Nb(V) in blood should provide general information on the behavior of a pentavalent ion in blood and, in conjunction with tissue distribution studies, this information may be used to obtain distribution kinetics data.

Beagle dogs were exposed to 95Nb(V) oxalate via inhalation or intravenous injection. Blood samples were taken from these dogs at various post-exposure intervals and fractionated into cells and serum. The 95Nb(V) activity in each fraction was determined using 'gel permeation chromatography'. The serum samples were fractionated to determine the 95Nb activity in protein fraction and non protein fraction. Dogs were sacrificed at 30 days post-exposure and tissue distribution was determined.

RESULTS: Most of the 95Nb (approximately 95%) has been found to be in the serum and approximately 80% of this fraction was bound to the serum proteins. There has been no difference in the percentage of protein bound 95Nb in the serum of dogs exposed to 95Nb by inhalation or injection. The serum protein binding 95Nb(V) is tentatively identified alpha-globulin. 'In vitro' studies, using 95Nb(V) oxalate and commercial serum proteins, are being performed to determine the formation constants of 95Nb(V) and serum proteins.

SUPPORTED BY U.S. Atomic Energy Commission

5.0439, THE EFFECT OF THE INHALATION OF RADIONUCLIDES IN 'INSOLUBLE' FORMS ON THE FATE OF INHALED BACTERIA IN MICE

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The objective of this study is to determine what effect the inhalation of radionuclides in relatively insoluble forms will have on the fate of inhaled bacteria in mice. It has been experimentally demonstrated in mice by other investigators that ethyl alcohol intoxication, injection of cortisone, starvation, influenza virus infection, inhalation of tobacco smoke, exposure to hypoxia or cold and acidosis will result in the inhibition of the clearance of bacteria from the lungs of mice. Diffuse silicosis does not inhibit the clearance of bacteria until anatomic lesions become severe. Mice in the present study will be exposed to the inhalation of Ce144, 91Y or 90Y in insoluble forms. At various intervals after the inhalation of the radionuclides mice will be exposed to the inhalation of aerosols of either Staphylococcus aureus, Proteus mirabilis or Streptococcus sp. The fate of the inhaled bacteria in the mice exposed to the inhalation of radionuclides will be compared to the fate of the bacteria in normal mice.

RESULTS: In a series of experimental infection studies recently completed to determine the effect of inhaled Ce144 in fused clay and Ce144O2 particles on the course and final outcome of influenza virus infection in mice little or no effect on the viral infection was observed. However, contamination of lung homogenates with Staphlococcus sp., Streptococcus sp. and Proteus mirabilis and to a lesser extent other bacteria occurred frequently in the mice that had inhaled Ce144 which were subsequently inoculated with influenza virus and to a lesser extent in the normal mice inoculated with virus.

SUPPORTED BY U.S. Atomic Energy Commission

5.0440, RADIATION DOSE PATTERNS FOLLOWING INHALATION OF BETA-EMITTING RADIONUCLIDES

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Studies of the radiation dose pattern of inhaled beta-emitting radionuclides is essential to the understanding of the biological effects from internal emitters entering the body via this route. Many studies have been conducted in the past, using the beagle dog, rats, mice, and hamsters. The aerosols inhaled have been both soluble and insoluble forms of many radionuclides of practical importance to the nuclear energy industry, and these have yielded greatly in physical half-life and energy. Thus, the dose rate and the localized total dose patterns have been greatly varied. Future studies utilizing Tm171 oxide, Ru106 tetroxide vapor, Co60, and, Zr95-Nb95 and Sb124 in graded forms of solubility from the oxalate to the oxide, are underway or will be initiated shortly. Both mice and beagle dogs will be utilized in these studies, with emphasis placed upon degree of solubility versus radiation dose pattern. Because the vapor form is of practical importance in high-temperature melt-downs associated with reactor releases, inhalation exposures to this form of aerosol will be emphasized.

RESULTS: Droplets of Zr95-Nb95 have been nebulized from a solution of the chelated oxalate form and have been passed through a heating column maintained at 100 degrees C, 250 degrees C, 600 degrees C, or 1100 degrees C. A group of mice has been exposed to each of the resulting aerosols and the ensuing tissue distribution pattern has indicated a sizeable differential translocation between the Zr95 and the Nb95 at the lower temperatures, but none has been evident at the higher temperatures. Studies on the fate of inhaled Tm171 oxide in the beagle dog have also recently been initiated to study the long-term retention characteristics.

SUPPORTED BY U.S. Atomic Energy Commission

5.0441, METABOLISM AND DOSIMETRY OF Y91 INHALED AS FUSED CLAY PARTICLES BY THE BEAGLE DOG

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This study is part of a long-term program to evaluate the biological consequences of inhaling radioactive aerosols such as might be released in certain nuclear accidents. Beagle dogs were exposed once by inhalation to an aerosol of 91Y entrapped in fused clay particles. A total of 30 dogs were exposed. The experimental procedures being used include serial whole-body counting, scanning, collections of urine and feces and serial sacrifices at 0 to 320 days post-exposure to evaluate the tissue distribution. These data are being evaluated to assess the spatial and temporal changes in radiation dose resulting from inhalation of 91Y in a relatively insoluble form. In addition, the data obtained from this continuing study in combination with those of a parallel longevity study (and parallel studies with Y90, Ce144 and Sr90 in fused clay) will aid in assessing the relative importance of variation in the rate of decrease of beta-radiation dose rate of the lung on the resultant biological effects.

RESULTS: In the first few days post-exposure a significant portion of the initial body burden, presumably that fraction deposited in the upper respiratory tract, was excreted in the feces. With time, small amounts of Y91 were translocated to tracheobronchial lymph nodes (presumably in an insoluble form) and to liver and skeleton (presumably in a soluble form).

SUPPORTED BY U.S. Atomic Energy Commission

5.0442, TOXICITY OF SR90 IN FUSED CLAY IN THE BEAGLE DOG

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This experiment is part of a long-term study of the biological consequences of inhaling radionuclides such as might be released from certain nuclear accidents. Beagle dogs were exposed once to an aerosol of fused clay containing sufficient Sr90 to result in biological damage and lifespan shortening. Sr90 in fused clay was chosen as the aerosol as an example of an energetic beta emitter with a long effective half- life in the lung. Clinical, hematological, biochemical, physiological and microbiological changes attributable to radiation insult are being followed throughout the dogs remaining lifespan and pathological examinations are performed at death. Observed biological effects are related to radiation dose using data from whole-body counting, linear scans, excreta collections and tissue distribution studies.

RESULTS: At present 12 dogs have been exposed to aerosols of Sr90 in fused clay. At 90 days post-inhalation exposure the 3 dogs with initial lung burdens of from 652 to 676 micro curie Sr 90 are showing clinical signs compatible with early radiation pneumonitis. No deaths have occurred. The remaining 9 dogs with initial lung burdens ranging from 39 to 552 micro curie 90 are showing no clinical signs at this early date. An apparent probably dose-related depression of circulating lymphocytes has been the only significant hematological alteration noted to date. An additional 24 dogs will be exposed to similar aerosols in the near future with further additions at later dates planned. Survivors will be observed for lifespan shortening and the occurrence of radiation-induced neoplasms.

SUPPORTED BY U.S. Atomic Energy Commission

5.0443, THERAPY FOR INHALED RADIONUCLIDES

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The removal of radionuclides from the lung and body tissues of aerosol exposed animals is the objective of this research. Inhalation of radionuclides during a nuclear accident is a real hazard. Lavage of the lungs using isotonic saline and other solutions is being examined as to its effectiveness in removing relatively insoluble and soluble beta- gamma emitters and also alpha emitting radionuclides. The medical risk of the lavage procedure itself is being evaluated, particularly in regard to the cardiovascular and pulmonary systems.

Beagle dogs are the experimental animals used in this work. dogs receiving selected radionuclides are given a nose-only aerosol exposure. Following exposure the dogs are lavaged at various times and the effective removal of the radionuclide evaluated. The pathological changes in the lungs and other tissues and the physiological events which occur during and following lavage are being examind to evaluate the medical risks of the lavage procedure itself.

It is anticipated that pulmonary lavage will be a procedure useful in removing inhaled toxic material to prevent disease that would otherwise occur if this material remained in the lung or other body tissues.

RESULTS: Results to date have indicated that a relatively insoluble radionuclide Sr95-Nb95 oxide can be removed in significant quantities up to 32 days post-exposure by the lavage technique. Ce144 given as relatively soluble Ce144Cl3 can be effectively removed up to five days post-exposure. The addition of the chelating agent DTPA, diethylenetriaminepentaacetic acid, to the lavage fluid greatly increases the removal of Ce144 by urinary excretion.

SUPPORTED BY U.S. Atomic Energy Commission

5.0444, LIPID COMPOSITION OF PULMONARY SURFACTANT, EXFOLIATED LINING CELLS AND TISSUE FROM BEAGLE DOGS

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These experiments are part of long-term studies of the biological consequences of inhaled radionuclides on the lungs of beagle dogs. Animals, exposed by inhalation to various radioactive materials and at a sufficient dose level, have developed lung lesions. Radiation effects on the lung tissue, the cells proximate to the alveoli and the surfactant are expected to be manifest in the lipid composition of these lung constituents. If the composition of the lipid components changes from that in normal beagle dog lungs, an altered lipid metabolism would be prime suspect.

RESULTS: The lipids from normal beagle dog lungs, pulmonary surfactant and exfoliated lining cells were quantitated by established procedures. The surfactant and cells were obtained by endobronchial saline lavage. Phospholipids accounted for more than 70% of the surfactant and cell lipids: phosphatidyl choline was the predominant phosphatide. Evidence has been obtained for the presence of phosphatidyl glycerol in beagle dog pulmonary surfactant (10% of phospholipid-P), exfoliated lining cells (7% of phospholipid-P) and lung tissue (3% of phospholipid-P). Cholesterol and its esters accounted for more than 60% of the neutral lipid fractions. Alkyl and alk-1-enyl glycerol ethers were quantitated in the neutral lipids and phospholipids from all samples.

SUPPORTED BY U.S. Atomic Energy Commission

5.0445, BIOCHEMISTRY OF PULMONARY CONNECTIVE TISSUE

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Pulmonary fibrosis has been observed in animals as a consequence of chronic pulmonary irradiation. In an effort to better understand the pathogenesis of pulmonary fibrosis, a quantitative estimation of the major components of connective tissue collagen and elastin is necessary. Lung tissue hydrolysates from normal dogs were prepared and amino acids quantitated by chromatographic elution using a modified Beckman 120B amino acid analyzer and mechanical integration. These methods yielded good resolution and acceptable integration of hydroxyproline and hydroxylysine, relative indicators of collagen, and desmosine, the relative indicator of elastin. The ability to measure these amino acids and thus obtain a quantitative estimation of connective tissue content of normal canine lung lends confidence to the use of this technique for measuring increased quantities of connective tissue associated with pulmonary fibrosis.

Since beta-glucuronidase is a central enzyme in the metabolism of the carbohydrate portion of fibrous connective tissue, a methodology for the measurement of this enzyme was developed for use on lung and other samples.

RESULTS: Measurements are in progress on right cardiac and diaphragmatic lobes of the lungs of these dogs. No meaningful differences between lung lobes have been observed. Twelve, 12-month- old, beagle dogs were exposed to Ce144 fused clay and six control dogs of the same age to the clay vector. The preliminary right apical lung lobe measurements of these dogs revealed no pronounced changes in animals sacrificed at two and four months post-exposure. Animals sacrificed at six months post-exposure had variable responses, two showed some increase of hydroxyproline and to a lesser degree hydroxylysine, suggesting modest collagen elevation, and two showed a slight increase of elastin. Measurements of beta-glucuronidase have been made on the right apical lung lobes of control dogs. Measurements will also be made on lung lobes of the dogs described in the previous study.

SUPPORTED BY U.S. Atomic Energy Commission

5.0446, THE PRODUCTION OF INSOLUBLE AEROSOLS OF FUSED CLAY CARRYING RADIONUCLIDES FOR USE IN INHALATION RESEARCH EXPERIMENTS

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In order to study the effects of inhalation of insoluble aerosols of fission products, experimental characterization and understanding is simplified through the use of a basic vector (or carrier) aerosol to which the radionuclide of interest has been added. In this study a method of producing insoluble aerosols of fused montmorillonite clay particles in the respirable size range into which both beta-emitting and alpha-emitting nuclides have been entrapped is being developed. This method involves the following basic steps: (1) clay preparation, (2) nuclide ion exchange, (3) aerosolization, (4) heat fusion, and (5) delivery to the inhalation apparatus. Step (1) involves preparing a clean and relatively stable water suspension of the clay. In step (2) the ion exchange properties of clay are used to replace some of the

exchangeable clay ions with ions of the radionuclide of interest. The exchanged clay is washed to remove the unexchanged portion of the nuclide. Step (3) involves aerosolization by atomization of a water suspension by ultrasonics or an air jet atomizer, and (4) the aerosol thus formed is allowed to pass through a heating column and maintained at 1150 degrees C where the clay particles are dried and fused into smooth spheres. In step (5) this aerosol of fused clay microsphere is carried to the aerosol apparatus for inhalation by the experimental animal. The latest efforts in this work are in the production of Y91, Pu239, and other transuranium nuclides aerosols of fused clay.

RESULTS: Aerosols of fused clay have been produced with Y90, Y91, Y88, Sr90-Y, Ce144- Pr144 and Cs137-Ba137 entrapped in the clay microspheres. For a clay suspension of concentration 8 mg/ml, the aerosol produced has a log-normal size distribution with count median diameter approximalty 0.9 mu m and geometric standard deviation approximately 1.8.

SUPPORTED BY U.S. Atomic Energy Commission

5.0447, THEORETICAL DESCRIPTION OF THE INTERACTIONS THAT OCCUR BETWEEN RADON DECAY PRODUCTS AND AEROSOLS

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The adsorption of radioactive materials to aerosols can be an important consideration for assessing the hazard associated with the inhalation of radioactive materials. The adsorption of radon daughters to aerosols is of particular interest since radon daughters, both attached to aerosols and unattached, represent an important hazard in the mining industry. Since unattached daughters deposit quite differently in the respiratory system than daughters which are attached to aerosol particles, it is important to know the adsorption characteristics and to be able to estimate the fraction of unattached decay products. An initial result of this work was a new attachment principle for the interaction of radon daughters to aerosols which is based upon particle surface area rather than classical diffusion relationships. Under development is an analog model of the interaction of radon daughters with aerosol particles and the walls of a cylindrical containment vessel (or mine drift) to demonstrate the effect of these competing interaction processes.

RESULTS: A new adsorption principle has been developed which predicts that the relative quantity of adsorbed radon daughters on different size aerosol particles is proportional to the surface area of the particles. This is based upon the concept that the Brownian motion of the aerosol particles cannot be ignored even though their diffusion relationships are relatively small, and the diffusion relationships for highly diffusible materials interacting with aerosols only apply for very high interaction rates, much higher than attained with naturally occurring levels of radon. A method of estimating the unattached fraction of each daughter based upon the new adsorption principle was also derived.

SUPPORTED BY U.S. Atomic Energy Commission

5.0448, GENERATION OF MONODISPERSE AEROSOLS OF INSOLUBLE FORMS FOR USE IN INHALATION EXPOSURES

O.G. RAABE, Lovelace Fdn. for Med. Ed., *Albuquerque, New Mexico* 87108 (AT(29-2)-1013)

Monodisperse aerosols of insoluble forms are needed in inhalation exposures to ascertain the effect of particle size on regional deposition and clearance and upon biological effects of inhaled radionuclides. Three methods of producing monodisperse aerosols are under study. These include: (1) use of the Fulwyler Ultrasonic Droplet Generator, (2) controlled condensation of volatile organic chelates of polyvalent metals, and (3) electrostatic droplet dispersion.

RESULTS: The Fulwyler generator has been used to produce some monodisperse aerosols which are larger than 1 micromillimeter diameter including aerosols of zirconium oxide. Equipment is being assembled for the electrostatic generator system. Preliminary experiments are being conducted with controlled condensation of volatile forms of Co, La, Ce, Zr, and Sb.

SUPPORTED BY U.S. Atomic Energy Commission

5.0449, DOSE-RESPONSE RELATIONSHIPS FOR INHALED ALPHA-EMITTING RADIONUCLIDES

R.G. THOMAS, Lovelace Fdn. for Med. Ed., *Albuquerque, New Mexico* 87108 (AT(29-2)-1013)

A major deficit in our understanding of the effects of inhaled alpha-emitting radionuclides relates to knowledge on the relative importance of number of particles deposited in the lung versus total muCi activity, in producing late effects. Several studies are planned in which beagle dogs will be exposed to aerosols of Pu238, Pu239, and Cm244 as insoluble oxides of different size distributions, achieving groups of dogs with graded levels of initial lung activity. Because of the wide range in specific activity of these radionuclides and with a varied number and size of particles, dogs with similar muCi activity lung burdens in the several studies will have total numbers of particles that vary by a factor of approximately 1000. The exposed dogs will be observed for their total lifespan using clinical, physiological, hematological, biochemical, and microbiological techniques to assess changes in health status that may be attributed to the radiation insult, and pathological examinations at death will be performed in combination with the foregoing procedures to assess the terminal disease state of the dogs. The observed biological effects will be related to radiation dose.

RESULTS: A preliminary study with inhaled Am241 in beagle dogs has indicated primary pathological effects in lung, liver, bone and bone marrow. Procedures for the exposure, long-term care and study of beagle dogs exposed to achieve graded lung burdens of Pu238, Pu239, Am241 and Cm244 when inhaled as oxides are currently being developed and evaluated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0450, THE ROLE OF THYMIC-DEPENDENT LYMPHOCYTES IN THE ACUTE RECOVERY FROM RADIATION INJURY

R.E. ANDERSON, U.S. Veterans Administration, Hospital, *Albuquerque, New Mexico* 87108

Results: As noted in the initial report, we are attempting to define (and influence) the role of thymic-dependent lymphocytes in the early recovery from radiation injury via a series of complementary experiments: progress in the past 12 months may be summarized as follows: 1) Recovery from radiation injury in neonatally thymectomized and/or splenectomized germfree mice - the results suggest that the initial portion of the peculiar biphasic response of the peripheral lymphocyte count to significant amounts of ionizing radiation is splenic-dependent. The rapid disappearance of these cells suggests that they are transients in the peripheral circulation and subsequently home to other lymphoreticular tissues. Although recovery of the peripheral lymphoid pool is somewhat sluggish in the absence of the spleen, restoration is possible in the absence of this considerable portion of the lymphoreticular system. 2) Effects of antilymphocyte serum in neonatally thymectomized mice - this study was undertaken to gain familiarity with antilymphoycyte serum - the results suggest that, in contradistinction to adult mice, the consequences of ALS administration to newborns are but slowly reversible and complete recovery may not be possible in the absence of the thymus. 3) Lymphoid regeneration following exposure to ionizing radiation and/or antilymphocyte serum - this portion of the study is in progress and is designed to compare immunologic recovery from ALS administration vs. irradiation in intact and thymectomized mice. 4) Restoration of thymic- dependent lymphocytes following exposure to 400 rad of ionizing radiation - this series of experiments is as yet in progress but preliminary results on day 14 post-exposure indicate a considerable discrepancy between recovery of the peripheral lymphocyte count vs. the production of thoracic duct (thymic dependent) lymphocytes, particularly in the absence of the thymus.

SUPPORTED BY U.S. Veterans Administration

5.0451, THE PATHOLOGY OF ACCELERATED AGING IN GERMFREE MICE
R.E. ANDERSON, Univ. of New Mexico, School of Medicine, *Albuquerque, New Mexico* 87106

The purpose of this project is to investigate the contribution of bacterial and viral infections and symbiotic presence to the evolution of the late effects of ionizing radiation in mice. It is specifically aimed to determine whether or not apparent and inapparent infections are related to the decreased longevity associated with the post-irradiation state. There is suggestive evidence that the presence of bacteria and/or viruses may greatly modify the direct effects of the physical agent; if the life-shortening effect of radiation of equal dose is significantly diminished in germfree as compared with conventional laboratory animals, such would constitute strong evidence that radiation does not, in fact, induce an acceleration of physiologic aging.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0452, COMMUNICATIONS - NUCLEAR RADIATION EFFECTS ON ELECTRONIC COMPONENT MATERIALS AND ELECTRONIC DEVICES
W.W. GRANNEMANN, Univ. of New Mexico, School of Engineering, *Albuquerque, New Mexico* 87106 (N00014-68-A-0158)

Technical Objective: This research is directly related to the support of Navy communication and surveillance systems incorporating electronic materials and devices which are vulnerable to nuclear radiation. There is a continuing need for materials and devices with greater resistance to radiation effects and also a need for understanding such effects in order to predict how devices will react in a radiation environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0453, MACROMOLECULAR RADIATION PATHOLOGY
S.W. JORDAN, Univ. of New Mexico, School of Medicine, *Albuquerque, New Mexico* 87106

A study is being made of the fine structural and macromolecular changes induced in a variety of cells by ionizing radiation. The changes to be investigated are those which occur directly as a result of irradiation or appear within a few minutes.

It is planned to use a wide range of dosage and modalities of ionizing radiation, concentrating especially on gamma ray doses between 100 and 1000 rads, especially with regard to nuclear effects, but also investigating the effect of massive irradiation on the order of 10 to the 4th power to 10 to the 6th power rads, delivered by a flash X-ray source.

Radiation damage to DNA molecules is being investigated by isolating DNA in thin protein films and visualization by electron microscopy (Kleinschmidt procedure).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0454, BASIC EFFECTS OF MICROWAVES ON BIOCHEMICAL PROCESSES
A. VANHEUVELEN, New Mexico State University, School of Arts, *Las Cruces, New Mexico* 88001

Electron paramagnetic resonance (EPR) and visible and near ultraviolet band spectra measurements will be used to monitor changes in biochemical processes caused by microwave radiation. The purpose of these studies is to determine if there are non-thermal effects of microwaves on biochemical processes. If non-thermal effects are found to exist, then it should be possible to determine: (i) the molecular basis for these effects (such as steric distortions of enzymes, mutations, polarization of dipolar molecules which are interacting, localized heating of enzymes.); (ii) the dependence of these effects on the intensity of the microwave radiation; and (iii) the dependence of these effects on the frequency of the microwave radiation. This information should be helpful in evaluating the value of present microwave dosimetry standards.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0455, TRANSFORMATION AND RECOVERY OF HAEMOPHILUS INFLUENZAE FROM ULTRAVIOLET AND X-IRRADIATION DAMAGE
B.J. BARNHART, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

An ultraviolet (u.v.)-sensitive (BC100) and an u.v.-resistant (BC200) mutant have been isolated from the transformable bacterium Haemophilus influenzae strain Rd. These mutants will be used to determine if there is a dependence of DNA replication and integration of transforming DNA on repair of photoproducts in the DNA. Alkaline sucrose gradients will be used to determine single-strand breaks, and a two-dimensional paper chromatographic isolation of u.v. photoproducts (pyrimidine dimers) will be used to follow actual excision of the photoproducts. DNA synthesis will be followed by incorporation of 3H- thymidine into the nucleic acid of irradiated cells. Integration of transforming 3H-DNA into 32P-labeled recipient cells will be determined by double-label counting of DNA fractions from a neutral sucrose gradient. Fractions representing both integrated and nonintegrated DNA will be assayed for single-strand breaks and pyrimidine dimers.

Results: The difference in abilities to reactivate u.v. damage is displayed by varying colony-forming abilities, host-cell reactivation of irradiated phage, and competent-cell reactivation of irradiated transforming DNA. BC100 lacks these reactivation capabilities, while Rd and BC200 have equal capabilities. BC200 has an enhanced survival because it lacks the post-irradiation lytic response characteristic of the parental strain, Rd. Post-u.v. filament formation previously observed for BC200 is also characteristic of BC100 and Rd, but filaments of the latter two strains exhibit cell lysis while BC200 does not. Results indicate that the lytic response of the wild type, Rd, is the result of derepression of a defective prophage which codes for the synthesis of a lytic enzyme.

SUPPORTED BY U.S. Atomic Energy Commission

5.0456, TRANSFORMATION AND RECOVERY OF HAEMOPHILUS INFLUENZAE FROM ULTRAVIOLETAND X-IRRADIATION DAMAGE
B.J. BARNHART, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Ultraviolet- (uv) sensitive and uv-resistant mutants of the transformable bacterium Haemophilus influenzae strain Rd are being used to determine the effect of uv-light on cell survival and on replication and recombination of DNA. Survival of bacteria following uv irradiation is largely dependent on DNA-repair processes, but other debilitating effects of radiation are frequently not considered to be significant factors leading to loss of cell viability. DNA-repair by the excision- repair process is monitored by detecting single-strand breaks in the backbone of the DNA double-helix in alkaline sucrose gradients and subsequent solubilization of uv-photoproducts (pyrimidine dimers) by quantitating DNA dimers using two-dimensional paper chromatography. DNA synthesis is followed both by incorporation of tritium-labeled thymidine into the nucleic acid of irradiated cells and by total DNA mass increase using the Burton diphenylamine reagent. The effect of uv on DNA recombinational events will be determined by assaying integration of irradiated transforming DNA into irradiated and unirradiated cells.

Results: Effects of uv light on cell morphology, DNA synthesis, and protein synthesis in uv-sensitive and uv-resistant mutants of H. influenzae strain Rd have been examined. Low doses of uv do not stop DNA synthesis in any strains but do slow the synthesis rate in a manner consistent with the model correlating the kinetics of post-uv DNA synthesis with the cell's ability to repair uv-induced DNA damage. Relatively low doses of uv induce lysis of the sensitive mutants and w- plus but not of the resistant mutant.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0457. IN VIVO MEASUREMENT OF PLUTONIUM LUNG BURDENS IN HUMANS

P.N. DEAN, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Evaluation of the lung burden of plutonium in chronically exposed plutonium process operators is needed for proper industrial medical control of this material. Urinary and fecal assays for plutonium are unreliable and primarily a measure of the systemic burden. Three types of detectors are presently being investigated for the in vivo measurement of plutonium in the lung. Several proportional counters have been constructed. The latest version consists of two 7 x 12 x 5- in. thick chambers utilizing internal anticoincidence sections for maximum background reduction. Inorganic crystal detectors consisting of thin crystals optically coupled to thick ones have been procured and are undergoing testing. By making the thin crystal of CsI (Tl) and the thick crystal of NaI (Tl), the difference in decay times of the two scintillators can be used in an anticoincidence arrangement to count only those events that occur in the thin crystal. This results in much lower backgrounds than can be obtained with single thin crystals. A large surface area (12 cm squared) Ge (Li) solid state detector has also been obtained for investigation of its possible application in this field.

Results: Calibration of the dual-crystal counter has been completed and routine counting of plutonium workers begun. As of May 1970, 200 workers have been counted: 16 had an average of 5 nCi plutonium-239, 13 an average of 1.4 nCi plutonium-238, and 12 an average of 0.22 nCi americium-241. The highest burdens measured were 16 nCi plutonium-239, 20 nCi plutonium-238, and 1.62 nCi americium-241. The minimum detectable amount is believed to be about 3 nCi plutonium-239 and 1 nCi plutonium-238. Developmental studies of the proportional counter have been stopped. Tests of the solid state detector are proceeding.

SUPPORTED BY U.S. Atomic Energy Commission

5.0458. GENETIC EFFECTS OF X-RAY EXPOSURE ON REPRODUCTION

J.F. DPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

If radiation-induced mutations resulting from exposure to consecutive generations of male progenitors are minor, heritable, and cumulative, they should result in population shifts in reproductive characteristics. Reproductive and litter characteristics are under investigation on progeny pairs of mice from 45 generations of x irradiated male progenitors. Comparative studies on irradiated and control lines should be completed this fiscal year and will terminate this program.

Results: Reproductive and litter characteristics data on progeny from X-irradiated male progenitors with 40 generations of exposure have been compiled but have not been analyzed at this time.

SUPPORTED BY U.S. Atomic Energy Commission

5.0459. COMPARATIVE METABOLISM OF RADIONUCLIDES BY MAMMALS - FACTORS WHICH ALTER NORMAL METABOLIC PARAMETERS

J.E. FURCHNER, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

One phase of metabolic studies is an attempt to alter the rate of radionuclide excretion. Factors such as diet, radiation, aging, ambient temperatures, water intake, physical activity, hormones, and complexing agents have been studied. In addition to being of practical importance to the field of radiation protection, these studies add to our knowledge of metabolism, nutrition, and excretion of specific radionuclides. Rodents, beagles, and monkeys are used in these studies. Whole-body measurements of radioactivity are made by means of large-volume liquid scintillation counters and, in some instances, by gamma-ray spectrometry using NaI (Tl) crystals.

Results: Beagle bitches with a cesium-137 body burden monitored before, during and after pregnancy showed an increased rate of cesium- 137 loss during pregnancy and a further increase in the rate of loss after delivery while suckling the litter. In the case of mice maintained on drinking water contaminated with cesium-137 and a synthetic diet, a 50 percent substitution of alfalfa for casein caused an increase by a factor of about 1.5 in equilibrium body burden compared to controls maintained on coventional synthetic and commercial diets.

SUPPORTED BY U.S. Atomic Energy Commission

5.0460. TISSUE REACTION TO DISCRETE, HIGH SPECIFIC-ACTIVITY PARTICULATES, WITH EMPHASIS ON TUMOR FORMATION IN THE LUNG

L.M. HOLLAND, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

It is proposed to study the rate of pulmonary tumor production from discrete particulate sources of plutonium isotopes lodged via intravenous injection in the lung capillary bed of hamsters and rats. In addition, attempts will be made to determine the probability of radiation-induced malignant transformation in vitro using primary tissue explant cultures. Results of both types of studies will be used in an effort to construct a computer model for evaluating tumorigenic risk to the public domain from exposure to high specific activity particulates (with emphasis on oxides of the plutonium isotopes) released accidentally to environment.

Results: The required techniques both for the whole-animal and cellular studies have been developed. A preliminary computer code has been written and generally applied to evaluation of probability of tumor formation as a function of number of particles, particle activity (dose per particle), and volume of tissue at risk.

SUPPORTED BY U.S. Atomic Energy Commission

5.0461. INFLUENCE OF HIGH LET RADIATIONS ON DIVISION DELAY AND SURVIVAL OF MAMMALIAN CELLS IN VITRO

D.F. PETERSEN, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Cycle-dependent duration of division delay and survival of a variety of established mammalian cell lines exposed to radiations of differing LET are being systematically investigated employing methods for synchrony induction and life-cycle analysis previously developed in this laboratory. The studies are preliminary to the eventual comparisons of negative pions with other high LET radiations and evaluation of therapeutic regimens designed to take advantage of precise energy deposition, potential age-dependent enhancement of radiosensitivity, and reduction of the effect of hypoxia on survival.

Results: The effects of 2-Mev neutrons, cobalt gamma rays, and 250-KVP X rays on division delay are qualitatively similar in terms of onset and recovery kinetics, but the delay per rad following exposure to 2-Mev neutrons is 3 times that observed after X-ray or gamma irradiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0462. FALLOUT CESIUM-137 IN A NORMAL POPULATION

C.R. RICHMOND, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Since 1956, a group of normal subjects has been monitored on a weekly (12 subjects) or a monthly (42 subjects) basis to determine whole- body burdens of fallout cesium-137. Estimates of the radiation dose due to inadvertent ingestion of fallout cesium-137 are made from these data. Models of the relation between body burden and contamination levels of food are tested with these data, as well as models describing the change of activity as a function of time in a normal population. A large- volume liquid scintillation counter with near 4 pi geometry is used to make the necessary whole-body radioactivity determinations. The presence of activities other than that of fallout cesium-137 and natural potassium-40 is monitored by periodic assay of subjects in a gamma-ray spectrometer.

Results: A data summary has been published. Models describing cesium137 activity in a normal population as parent-daughter growth and decay fit the activity in a normal population since the 1964 peak period. Dietary contamination data can be used to estimate population burdens, which are now decreasing ever more slowly.

SUPPORTED BY U.S. Atomic Energy Commission

5.0463, BIOLOGICAL RESPONSES TO RADIOFREQUENCY RADIATION
J.F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Present standards for exposure to radiofrequency or microwaves are set at 10 milliwatts/cm2. There is no evidence in the free world to indicate that this standard should be lowered; however, Russian reports claim effects at lower exposure levels. Essentially no biological information exists at the 200- and 800-MHz levels, which are the two frequencies to be used in the production of pi mesons. These two frequency levels will be investigated for possible biological effects in mice.

SUPPORTED BY U.S. Atomic Energy Commission

5.0464, GENETIC EFFECTS OF X-RAY EXPOSURE ON LONGEVITY
J.F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

The mutagenic nature of ionizing radiations and the effects and heritability of these mutations are subjects of general concern and interest, as evidenced by periodic press releases propounding new statistical evidence of the lasting effects of radiation from fallout on certain population segments. The genetic effects of progenitor X- ray exposure on longevity of their nonirradiated progeny are under investigation on mice with 40 and 45 generations of X-ray exposure to their male progenitors. Radiation-induced mutations, if heritable, should accumulate until such time as they result in an increase in incidence of diseases causing early death.

Results: Comparative investigations of growth and mortality rates in controls and mice with up to 35 generations of progenitor X irradiation failed to reveal radiation-induced and heritable genetic injury.

SUPPORTED BY U.S. Atomic Energy Commission

5.0465, RADIATION INJURY AND RECOVERY IN DOGS AND PRIMATES
J.F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Dose-rate effects studies in the medium to low dose-rate range (1 to 5 rads/hour) in dogs and primates are wanting and are essential to the establishment of acceptable levels of radiation exposure in emergency situation. Rhesus monkeys of both sexes and with different histories of gamma-ray exposure (0 to 1000 rads) are being studied to determine the repair rates, residual or irreparable injury, and total accumulated doses which may be feasible when the fractionation method and appropriate repair intervals are used.

Results: Investigations completed on dogs and monkeys to date indicate that the repair rate of the monkey is somewhat longer than the RT 50 of 28 days proposed for man.

SUPPORTED BY U.S. Atomic Energy Commission

5.0466, GENETIC INVOLVEMENT IN RADIATION SENSITIVITY
J.F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

The degree to which radiation resistance is genetically controlled in the various tissues and organs of the mammal has been the subject of much research. Two substrains of mice from one highly inbred RFM strain have been developed which have different radiation-resistance characteristics. Investigations are in progress to attempt a determination of the number of gene loci involved in this radiation- resistance factor and the primary organ involved in the radiation resistance difference between the two substrains.

Results: Two substrain populations of different radiation sensitivities have been developed. The resistance factor has been shown to involve primarily the hematopoietic tissues. Evidence to date indicates that a single gene locus may be responsible for the radio- resistance difference.

SUPPORTED BY U.S. Atomic Energy Commission

5.0467, THE RELATIONSHIP BETWEEN RADIATION SENSITIVITY AND OTHER PHYSICAL AND PHYSIOLOGICAL CHARACTERISTICS WITHIN ONE STRAIN OF MICE
J.F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

A major factor in understanding injury and repair kinetics of radiation exposure is the genetic nature and relationship between radiation and characteristics such as activity, life span, body weight, etc. A number of characteristics are now being investigated in two sublines of strain RFM mice with different radiation-resistance factors. Currently under investigation are reproductive characteristics and life span.

Results: An inverse relationship between radioresistance and activity has been demonstrated in two sublines of RFM mice with different radiation-resistance characteristics.

SUPPORTED BY U.S. Atomic Energy Commission

5.0468, DOSE-RESPONSE AND RECOVERY KINETICS FROM LOW-INTENSITY CONTINUOUS AND SUBLETHAL ACUTE GAMMA-RAY EXPOSURES WITH DOGS AND PRIMATES
J.F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Where dose-response data are available on the primate, they are largely at the acute lethal dose level or for exposures of short duration. Relatively few, if any, comparative dose-effect studies with dogs and primates have been reported where the comparisons were made simultaneously under the same exposure conditions. An on-going primate study is being done to test the resilience of bone marrow subjected to 100-rad gamma-ray exposures at 56-day intervals. Comparative dose- response and recovery investigations will be done with dogs and monkeys this fiscal year. The bone marrow will be the organ of primary interest. Thus, dose rates and/or fractions will be such that other vital organs will be affected to a lesser degree.

Results: Rhesus monkeys of both sexes have completed a 560-day fractionated gamma-ray exposure schedule designed to investigate residual effects and recovery capability of primate hematopoietic tissue. Four groups of monkeys with total gamma-ray doses of either 1000, 1500, 1750, or 2000 rads have demonstrated remarkable recovery capabilities when an optimum exposure and recovery time discipline is afforded to them.

SUPPORTED BY U.S. Atomic Energy Commission

5.0469, GENETIC EFFECTS OF PROGENITOR X-RAY EXPOSURE ON REPRODUCTION AND DEVELOPMENT IN PROGENY
J.F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Recent statistical studies have been used to demonstrate a direct relationship between radioactivity in or near mammalian germ cells and infant mortality and birth weight. An investigation to study the possible accumulation of radiation-induced genetic injury has been on- going for over ten years. Among end points being observed are reproductive fitness and progeny characteristics through weaning age. This program was formally terminated with the 45th generation. Data on the 45th generation are now being evaluated.

Results: Evaluation of comparative data on earlier generations was of a negative nature, resulting in disinterest and discontinuation of the program.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0470, GENETIC EFFECTS OF X-RAY EXPOSURE ON LONGEVITY
J.F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Longevity has been thought to be a useful end point as a measure of radiation-induced genetic injury in terms of an accumulation of minor mutations which eventually cause a reduction in life expectancy through an increase in the rate of killing diseases. An early report recorded by the United Nations Scientific Committee on the Effects of Atomic Radiation (1962) stated that longevity was inversely related to the total body dose of neutron exposure to the sire. Subsequent studies with genetic exposures of X and gamma rays and neutrons have not been able to confirm this early finding. Progeny mice from 45 generations of X- irradiated male progenitors (200 rads per generation) are under investigation to determine the validity of the life shortening effect hypothesis.

Results: Life span studies have been completed on progeny mice from male progenitors with 5, 10, 15, 20, 25, 30, 35, and 40 generations of X irradiation (200 rads per male progenitor per generation). No reduction in life span of mice from irradiated parentage has been observed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0471, LOW-INTENSITY GAMMA-RAY EFFECTS AND RESPONSE CAPABILITY OF MOUSE BONE MARROW
J.F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Past experience has demonstrated that, if the exposure dose rate of cobalt-60 gamma rays is selected properly, hematopoiesis can be blocked with a minimum of injury or effect to other vital body tissues and organs. Mice will be used in an investigation to (a) determine the optimum dose rate for selective bone marrow arrest, (b) compare the effects of equal total doses of gamma rays administered continuously at a low dose rate or fractionated at a higher dose rate (within the same time scale) on hematopoiesis, survival time, and cause of death (incidence of myeloid leukemia, etc.), and (c) estimate the 'so-called' irreparable injury component as it may be related to recovery rate of the hematopoietic tissue and accumulated gamma-ray dose.

Results: Studies have been done to establish optimum dose rate and recovery time exposure regimes. However, the results of these earlier studies were complicated by Pseudomonas infection in the mice under investigation. This problem has been remedied.

SUPPORTED BY U.S. Atomic Energy Commission

5.0472, RADIATION-INDUCED DIVISION DELAY AND RECOVERY
R.A. WALTERS, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Investigation of biochemical events associated with radiation- induced division delay and recovery is being continued in mammalian cells. Methods for synchrony induction and life-cycle analysis have been used to establish a terminal point of action of X rays in the life cycle coincident with the end of protein synthesis essential for division. These studies have been expanded to determine the relative distribution of cells in the life cycle after irradiation and the response of specific segments of the population to such radiation.

Results: In CHO cells, the duration of division delay is constant regardless of cycle position, and recovery requires protein but not DNA or RNA synthesis. Cells must be metabolically active to recover; conditions which enhance survival (e.g., incubation at 5 degrees C) prevent repair of the delay defect. DNA replication is completed at a dose-independent rate faster than recovery of division capability, indicating a lack of obligate coincidence between DNA replication and other events essential for division.

SUPPORTED BY U.S. Atomic Energy Commission

5.0473, PLACENTAL PROGESTERONE SYNTHESIS FEEDBACK CONTROL AND RADIATION SENSITIVITY
M. WIENERKENNEDY, Union College & University, School of Medicine, *Albany, New York* 12208 (AT(30-1)-3899)

Steroid synthesizing enzymes (delta5-3beta-hydroxysteroid dehydrogenase, 20 alpha-reductase and the series of enzymes which cleave the side chain of cholesterol) are being used as systems in which to observe the effects of X-irradiation on the placenta. The placenta is known to be radioresistant and progesterone, a steroid hormone which is synthesized via these enzymes, is believed to be essential for the maintenance of pregnancy. Human placentas are obtained at Caesarian section or therapeutic abortion. In vitro kinetic studies are performed on the above enzymes, using subcellular fractions of the placenta and various steroid substrates. Placental steroid metabolites are tested for possible feedback inhibition of the reactions. Similar studies are performed after the administration of X-irradiation, and the results compared with the unirradiated tissues in order to define more precisely the effects of irradiation.

Studies of a similar nature are planned on abnormal placentas and those from spontaneous abortions.

Results to Date: The radioresistance of the placenta has been confirmed in the above systems. Low levels of X-irradiation cause an apparent stimulation of enzymatic activity. Evidence has been found for a possible natural inhibitor which will be investigated for radiosensitivity.

SUPPORTED BY U.S. Atomic Energy Commission

5.0474, RNA SYNTHESIS IN MAMMALIAN CELLS AFTER RADIATION
R.E. BASES, Yeshiva University, School of Medicine, *Bronx, New York* 10461

Abstract: Ribosomal RNA synthesis in HeLa cells is depressed 30 to 50% immediately after 1000 rad; the rate of synthesis returns to normal or nearly normal levels within 24 hours.

The influence of radiation dose on depression of ribosomal RNA synthesis and the schedule of its recovery will be studied in detail. The quality of ribosomal RNA synthesized in irradiated cells will be tested by a) studying the participation of ribosomes from these cells in polypeptide synthesis in vitro and b) by studying the ability of their ribosomal RNA to hybridize with DNA from control and irradiated cells using the technique of competition hybridization with presaturation of HeLa DNA using appropriate RNA. Inhibition of post radiation repair by lucanthone will be correlated with the drug's action as an inhibitor of ribosomal RNA synthesis in HeLa cells. Combined treatment of an experimental mouse neoplasm by radiation and lucanthone will be studied in order to judge its possible future usefulness as an adjuvant in radiation therapy of human neoplasms, especially because lucanthone is a safe drug widely used for many years in man as a schistosomicide.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0475, MECHANISMS OF RADIATION INDUCED PULMONARY EDEMA
H.S. GOLDMAN, Yeshiva University, School of Medicine, *Bronx, New York* 10461

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Amer. Heart Assn. Inc. - New York, N.Y.

5.0476, A GENETIC, CYTOLOGICAL AND BIOCHEMICAL STUDY OF CELL CYCLE DEPENDENT CHANGES IN RADIATION SENSITIVITY IN YEAST
C.A. BEAM, City University of New York, School of Liberal Arts, *Brooklyn, New York* 11210 (AT(30-1)3998)

Coincident with the onset of budding, yeast cells display an anomalous increase in radiation resistance. It is not known whether this resistance is caused by protection against damage or repair of damage. Radiosensitive mutants have been isolated, and sensitive budding cells can also be produced by various physiological manipulations. The change from the sensitive to the resistant condition is being studied using cytochemical and ultrastructural analysis, and the molecular weight distribution of DNA from cells in various sensitivity states before and after irradiation is being determined.

Results: The radiosensitive mutants have been mapped, characterized, and shown to vary in their capacity for one kind of repair. Cytochemical studies show some differences between sensitive and resistant stages. Early ultracentrifuge CsCl runs seem promising.

SUPPORTED BY U.S. Atomic Energy Commission

5.0477, INVESTIGATION OF THE EFFECT OF TOPICAL CORTICOSTEROIDS ON THE APPEARANCE AND SEVERITY OF ACUTE RADIODERMATITIS

Y.L. LYNFIELD, U.S. Veterans Administration, Hospital, *Brooklyn, New York* 11209

On comparing aquaphor with 1% hydrocortisone in aquaphor ointment on 3 patients (5 portals), we found that the intensity of radiodermatitis showed no difference on 1 portal, aquaphor more intense than hydrocortisone ointment on 1, hydrocortisone ointment more intense than aquaphor on 3. However, the intensity of radiodermatitis on all 5 portals was greater than expected for the dose given, and we became suspicious that applying any grease early in radiotherapy might increase the intensity of the skin reaction.

Therefore, on 5 portals, aquaphor application was compared with no application. One showed slightly more reaction with aquaphor; 4 showed no difference.

Then, on 13 portals, 1% hydrocortisone in aquaphor was compared with no application. Reaction was equal on 9; less in the area treated with hydrocortisone on 4.

Having demonstrated that the application of 1% hydrocortisone in aquaphor applied immediately after each treatment does not increase the intensity of radiodermatitis; we now plan to retest the aquaphor alone and then return to our original protocol, comparing the two ointments with each other. This will probably take 2 more years.

SUPPORTED BY U.S. Veterans Administration

5.0478, RADIATION RESPONSE OF BACTERIAL RADIATION REPAIR SYSTEMS

A.K. BRUCE, State University of New York, School of Arts, *Buffalo, New York* 14222 (AT(30-1)-4171)

The initial damage brought about by radiations is approximately equal in all bacteria. The wide range observed in radiosensitivity is dependent upon the function of repair systems to convert potentially lethal damage to a viable state. While the damage caused by ionizing and ultraviolet radiations is qualitatively different, its repair appears to proceed in part through common pathways. This study will test the hypothesis that lethality results from radiation-induced damage to one or more components of the repair system. Measurements of the X- ray sensitivity of the pyrimidine dimer excision enzyme associated with repair of UV damage will be made. The systems will include whole cells (Escherichia coli and Micrococcus radiodurans), transforming DNA-M. radiodurans and T7-E. coli. The rate of dimer removal from cells, transforming DNA or phage will be assayed in control and X-irradiated cells. Repair and/or resynthesis of the repair enzyme will be studied by incubation of irradiated cells prior to presentation of the dimer- containing substrate. The possible role of endogenous sulfhydryl levels in the protection against ionizing radiation damage will be considered.

Results: Experimental procedures for the uptake of H3-thymidine by M. radiodurans, sucrose density gradient analysis of DNA, transformation of M. radiodurans, preparation of H3-transforming DNA, incorporation of H3-DNA, and dimer production and assay by paper and column chromatography have been developed and tested. The results indicate that the proposed experimental techniques necessary to carry out this project are both appropriate and adequate to yield the desired information.

SUPPORTED BY U.S. Atomic Energy Commission

5.0479, CELL KINETICS OF IRRADIATED SKIN

J.O. ARCHAMBEAU, Meadowbrook Med. Ed. Res. Fdn., *East Meadow, New York* 11554

The objective of this research is to quantify the changes produced by irradiation on the skin of swine. Earlier work has defined the evolution, time course and dose dependence of the moist reaction produced by increasing exposures. Current work has measured the changes in the prickle and basal cell population following increasing exposures. The basal (proliferative) cell changes show essentially an increase in cells immediately following irradiation, followed by a progressive decrease to a minimum value. This minimum value is dose dependent. If regeneration occurs, it is first documented at 17 to 21 days by finding islands of proliferative cells that increase in size over subsequent days. The rate of regeneration is dose dependent, as well as the time that regeneration is completed. The mitotic index varies following irradiation from a low of zero to high values in the regenerative islands of about 16 per cent. The tritiated thymidine labeling index varies from control levels to highs of 40 to 70 per cent.

The number of regenerating islands is dose dependent and a dose survival curve with a D sub zero of 354 rads has been established.

Ongoing work is determining cell parameters of the capillary epithelium prior to irradiation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0480, PHASE I. FISSION PRODUCT METABOLISM AND RESPONSE IN LABORATORY AND DOMESTIC ANIMALS: RADIATION EFFECTS ON REPRODUCTION AND EMBRYOGENESIS

C.L. COMAR, State University of New York, School of Veterinary Medicine, *Ithaca, New York* 14850 (AT(30-1))

A technique has been successfully established in our laboratory for the 'in vitro' culture of preimplantation mouse embryos. This technique is to be used to study: (a) implantation capability of irradiated embryos, (b) uptake of selected radionuclides by embryos, (c) preimplantation effect from paternally administered radionuclides, (d) effect of radiation-induced chromosome-breaking factors on embryo development.

Results: Radiation effects on embryos have been shown as follows: (a) The LD50 values, as measured by development to blastocyst, are approximately as follows: one-cell (3 hrs. post coitus), 90 rads: one- cell (13 hrs. post coitus), 160 rads; two-cell, 400 rads; four-cell, 500 rads; and morula, 300 rads. (b) There is little, if any, difference in radiation response between embryos irradiated or grown in vivo and 'in vitro'. (c) Morphologic abnormalities produced by radiation of embryos include fragmentation, disintegration, incomplete cleavage and cytoplasmic granulation. (d) Cleavage delay is produced by doses between 50 and 300 rads. Part 1 of 7.

SUPPORTED BY U.S. Atomic Energy Commission

5.0481, PHASE I FISSION PRODUCT METABOLISM AND RESPONSE IN LABORATORY AND DOMESTIC ANIMALS - SOME ASPECTS OF STRONTIUM METABOLISM

C.L. COMAR, State University of New York, School of Veterinary Medicine, *Ithaca, New York* 14850 (AT(30-1))

Prediction equations have been developed in this laboratory for the estimation of 90Sr body burdens at some given time based on the known burden at some previously time and the 90Sr/Ca ratio of the diet during the given period. These equations will be checked by controlled observations on pigs and rats at different ages. Human survey data will be used to test the degree of fit to the equations. These equations may provide information about the rate of skeletal strontium turnover and the Sr/Ca discrimination as a function of age.

A study is in progress to relate site of radiostrontium deposition with the degree of radionuclide concentration. More data is

needed to extend the time curves to get better estimates of the integrated radiation dosages. In addition to specific bone concentrations whole body counts will be made so further data for retention equations will be forthcoming.

Results to date: A prediction equation for 90Sr in the human population has been developed which takes into account the Ca and 90Sr balance; Sr/Ca discrimination; 90Sr balance; Sr/Ca discrimination; 90Sr turnover in bone; reutilization of 90Sr liberated from bone. Studies of 85Sr deposition have shown that teeth and ear bones both show high deposition of radiostrontium and high retentiveness. The correlation between such behavior and the site of incidence of strontium-induced bone tumors is high. Part 5 of 11.

SUPPORTED BY U.S. Atomic Energy Commission

5.0482, CONTROL OF FISSION PRODUCTS INGESTED BY LIVESTOCK
C.L. COMAR, State University of New York, School of Veterinary Medicine, *Ithaca, New York* 14850 (DAHC20-70-C-0391)

Technical Objective: Conduct experimental research with livestock and dairy to determine the effectiveness of various dietary supplements, feed types, and feeding schedules in reducing the concentration of ingested fission products of CS in meat, and SR and I in milk, and to evaluate the interaction of whole-body gamma irradiation on the effectiveness of these countermeasures.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0483, PHASE III - FISSION PRODUCT METABOLISM AND RESPONSE IN LABORATORY AND DOMESTIC ANIMALS - NEURAL AND BEHAVIORAL ASPECTS OF RADIATION
D.N. TAPPER, State University of New York, School of Veterinary Medicine, *Ithaca, New York* 14850 (AT(30-1))

Based on known neural and behavioral response to ionizing radiation three areas of work are planned: (a) behavioral assay of radioprotective agents in the rat and exploration of mechanisms of radioprotection (b) physiological studies in the rat of performance decrement following massive radiation doses and (c) effects of radiation on labile states of the spinal cord of the cat.

Results: It has been established that a protective agent can reduce the effectiveness of X-radiation in causing conditioned aversion behavior. The mechanisms and early reaction (within milliseconds) to taste stimuli have been explored. Techniques have been worked out for measurement of labile states of the spinal cord. Part 2 of 7.

SUPPORTED BY U.S. Atomic Energy Commission

5.0484, TOXICOLOGICAL STUDIES ON ANTIMALARIALS AND RADIATION COMPOUNDS
M.J. CARSON, Food & Drug Res. Labs Inc., *Maspeth, New York* 11378 (DADA17)

Technical Objective: To perform certain prescribed animal tests in order to obtain pre-clinical safety data prior to conducting phase I and II human clinical studies.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0485, STUDY EFFECTS OF RADIATION ON THE EYE
G.R. MERRIAM, Columbia University, School of Medicine, *New York, New York* 10032

No summary has been provided to the Science Information Exchange.

SUPPORTED BY John A. Hartford Found. Inc. - New York

5.0486, RBE OF MONOENERGETIC NEUTRONS
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The immediate research objective is an evaluation of the relative biological effectiveness (RBE) of neutrons as a function of the energy with close correlation between the physical pattern of energy deposition and the resultant biological effect. A resultant long term objective is an inquiry into the basic modes of action of radiation on the cell with particular emphasis on the effects of irradiation at low levels. The radiobiological data are combined with physical microdosimetry data in such investigations.

The biological material irradiated is varied and includes the spleen, thymus, and lens, as well as the reproductive and blood-forming organs of the mouse, Drosophila, bacteria, and various plants.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0487, FOLLOW-UP STUDY OF IRRADIATED TINEA CAPITIS CASES
R.E. ALBERT, New York University, School of Medicine, *New York, New York* 10016

This ongoing study continues in an effort to determine the nature and magnitude of late radiation injury among the population of 2600 irradiated children and 1900 non-irradiated children with tinea capitis treated at the Skin and Cancer Unit of the New York University Hospital between 1940 and 1958.

Resurvey of approximately 27% of the study sample has been completed to date. Resurvey of the remaining 73% of this population will be continued. The following areas are being evaluated as potential indicators of late radiation injury: illness and mortality, with physical and hospital confirmation; education; occupation; drug abuse and military service.

Data from this phase of the investigation will be collated with data previously obtained from the original survey, medical and laboratory evaluation, and psychiatric interview and psychologic testing, to provide a comprehensive longitudinal profile of the two samples.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0488, STATISTICAL ANALYSIS OF LONGITUDINAL GROWTH DATA ON ADOLESCENTS EXPOSED IN UTERO TO THE ATOMIC BOMBS, HIROSHIMA & NAGASAKI
B.S. PASTERNACK, New York University, School of Medicine, *New York, New York* 10016 (AT(30-1))

Since 1950 approximately 1600 exposed and control subjects who were in utero at the time of the atomic bombings (ATB) of Hiroshima and Nagasaki have been studied at ABCC. The PE-86 sample was drawn from the population of in utero children ATB who were either exposed or non- exposed (entering Hiroshima and Nagasaki between October 1945 and October 1955). Matching of subjects was carried out so that all available children exposed under 2,000 m were entered into the study. For each child exposed proximally an attempt was made to include a child exposed distally and one not-in-city ATB -- matched by sex, month of birth and economic status. Children at all stages of gestation were included.

The objectives of this research project are: a) obtain meaningful statistical estimates of biological parameters descriptive of adolescent growth b) determine, using these statistics, whether or not exposure to A-bomb ionizing radiation while in utero has resulted in impairment of growth during adolescence and, if so, c) determine whether or not a relationship exists between estimated radiation dose (computed at ABBC based on air dose curves and shielding information -- T65D) to the mother and the degree of impairment.

Results: During the past year a computer-programmed two stages estimation procedure was developed and applied to the estimation of a four parameter Gompertz-type growth curve (using the variable Standing Height) for each subject in the study. One hundred fifty-nine tables and 13 figures summarizing the results to date are presented. Analysis of exposure effects on growth patterns is now in progress.

SUPPORTED BY U.S. Atomic Energy Commission

5.0489, EFFECTS OF H3 THYMIDINE AS A DNA LABEL IN THE RAT LIVER
J. POST, New York University, Goldwater Memorial Hospital, *New York, New York* 10017 (AT(30-1))

Studies are continuing on the biological effects of radiation using 3HTdR-labeled DNA as the source. They concern the dose-dependent immediate and delayed changes induced in the replication kinetics of normal cells and of tumor cells. Slowing the passage of cells through DNA synthesis and their arrest in G2 are induced on all populations which have thus far been examined. Studies are to be completed upon the levels of incorporated radio-activity of coexistent cell populations in relation to the induced replication changes. The kinetic alterations induced by 3HTdR are being investigated among tumor cells. The model is the carcinogen-induced autogenous sarcoma of connective tissue in the rat. These experiments are designed to control tumor growth. Parallel studies are planned using iododeoxyuridine, since it alters cell replication in ways similar to that observed after 3HTdR.

Finally investigations are planned on the effects of other radioactively labeled macromolecular precursors upon the replicating kinetics of normal cells as part of investigations on the mechanism of action of 3HTdR labeled DNA in altering replication kinetics.

SUPPORTED BY U.S. Atomic Energy Commission

5.0490, INACTIVATION OF ENZYMES BY IONIZING RADIATION

E. SLOBODIAN, New York University, School of Medicine, *New York, New York* 10016

A study is being made of the effects of gamma irradiation on ribonuclease (aqueous). As the OH radical is an important intermediate in the aqueous irradiation effect, parallel experiments are carried out on enzyme samples inactivated by Fenton's reagent, a chemical source of OH radicals. Earlier work had already revealed the formation of new enzymically active and chromatographically similar products from both irradiated and Fenton's treated RNase A.

Recent studies have revealed that both modes of inactivation yield enzyme products which interact with iron in the medium, reducing some Fe III to Fe II, and forming strong complexes with both ions. The techniques of amino acid analysis, viscosity measurement, T-H interchange analysis, and CM-cellulose chromatography are being applied to the study of Fenton's treated samples.

An investigation will be made into the effect of the complexed iron on the characteristics of the enzyme product.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0491, RESPONSE OF LIVING CELLS TO HIGH INTENSITY PULSED ELECTRONS AND EXAMINATION OF OXYGEN DIFFUSION KINETICS IN CELLS

E.R. EPP, Sloan Kett. Inst. Cancer Res., *New York, New York*

Oxygen is a well-known sensitizer of living cells, both bacterial and mammalian, to the biological effects of ionizing radiation. In cancerous tissues, the presence of anoxic or poorly oxygenated cells, with their concomitant relative radioresistance, is believed to constitute a problem for successful radiotherapy, and various methods, including hyperbaric oxygen, have been suggested for circumventing or minimizing this effect. The mechanism by which oxygen increases cellular radiosensitivity and the nature of the primary lesions involved remain unkown. It is suspected, however, that short-lived chemical species reactive to oxygen are radiation-induced in critical molecules within the cell. Little is known about the nature of such species or their lifetime.

Using techniques recently developed in this laboratory involving high-intensity pulsed radiation, it is proposed to establish new upper limits to the lifetime of such species and to approach the problem of the actual measurement of oxygen diffusion times in cells. Comparison of diffusion time measurements with those theoretically derived from models will permit estimates of the effective diffusion coefficient for cells to be made.

It is also proposed to examine the role of water in influencing diffusion times by irradiating bacterial spores where the degree of water content can be accurately controlled.

Finally, it is proposed to examine the response of mammalian cells to pulsed irradiation under various degrees of oxygenation. Results in the literature are controversial and some suggest a basis for possible improvement in cancer radiotherapy through the use of high- intensity pulsed electron beams.

SUPPORTED BY Damon Runyon Cancer Research Fund - N.Y.

5.0492, THEORETICAL INVESTIGATION OF ELECTRON LET SPECTRA AND DOSE RELATIONSHIP FOR IONIZING RADIATIONS

J.S. LAUGHLIN, Sloan Kett. Inst. Cancer Res., *New York, New York* (AT(30-1))

The diffusion of available oxygen into cells immediately after high-intensity pulsed irradiation will be mathematically obtained. A model for a two stage diffusion process is considered, the first stage being diffusion of residual oxygen into critical cell sites from other non-critical areas, and the second being diffusion from the ambience into the cell. Time intervals for the onset of the first and second stage are obtained and numerical values of physical parameters such as cell membrane permeability and diffusion constant will be estimated. Motivation is provided by the increasing application of high-intensity pulsed radiation sources in radiobiology. The approach is mathematical, aided by pertinent experiment data from our laboratory.

Depth-dose distributions and energy and linear energy transfer (LET) spectra are obtained for a number of energies of neutrons incident on a water medium. The radiobiological effectiveness and oxygen enhancement ratio for an incident neutron spectrum will be calculated by the track segment method and compared with available experimental data in order to test the adequacy of LET at very high values as an indicator of biological action.

Results: a. The rate of diffusion of oxygen into cells after high intensity pulsed irradiation was mathematically obtained by means of a two-stage diffusion model. Significant diffusion begins at about 10 to minus the 5th power sec and saturation occurs at about 1 second after irradiation. b. Depth-dose distributions for monochromatic neutrons in water were compiled. Linear energy transfer (LET) spectra were obtained in the case of monochromatic neutrons incident on a water medium. Part 2 of 11.

SUPPORTED BY U.S. Atomic Energy Commission

5.0493, RADIATION MECHANISMS IN MAMMALIAN SYSTEMS

J.S. LAUGHLIN, Sloan Kett. Inst. Cancer Res., *New York, New York* (AT(30-1))

We propose to continue studies on the mechanism of action of radiation on living cells. Single strand breaks in DNA following irradiation will be determined in sublines of HeLa cells which differ in radio-sensitivity, under oxygenated and anoxic conditions. In addition, we plan to investigate whether nuclear membranes may be involved in the radiation response of synchronized cells.

We will continue studies on OER of cyclotron generated neutrons at different depths of the phantom, and we are planning studies of RBE and OER of neutrons generated from Cf252 sources.

Results: (a) It was found that RBE of cyclotron generated neutrons decreases with depth in a phantom. (b) Enzyme activity is not decreased after supralethal doses of irradiation, and irradiation affects the enzyme-producing pattern only by distorting cell cycling. (c) BUdR decreases survival of HeLa cells when given either before or after irradiation, indicating an indirect mode of sensitization. Part 3 of 10.

SUPPORTED BY U.S. Atomic Energy Commission

5.0494, SR-90 METABOLIC BALANCE STUDIES

E.P. HARDY, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

Cooperative studies on Sr-90 metabolism in adult males have been carried out with Dr. Herta Spencer of the Hines Veterans Hospital in Chicago since 1959. A metabolic ward for controlled diet and excretion measurements is under Dr. Spencer's supervision. Samples of diet and excreta collected over 6-day periods are analyzed at HASL for Sr-90. These investigations are carried out to determine the extent to which various dietary supplements either enhance the removal of deposited Sr- 90 from the body or inhibit the absorption of dietary Sr-90.

Results: The main effect of stable strontium given orally or intravenously was an increase in urinary Sr-90 excretion. Intravenously infused stable strontium increased the urinary Sr-90 excretion by a factor of 3 while orally administered stable strontium increased the urinary Sr-90 excretion only by a factor of 1.5.

SUPPORTED BY U.S. Atomic Energy Commission

5.0495, IRRADIATION EFFECTS ON DENTAL AND ORAL PROCEDURES

G. COHEN, U.S. Veterans Administration, Hospital, *New York, New York* 10010

Twelve long-term irradiated animals are still to be histologically assayed. Six received 240 KV and six received C60 through bilateral portals exposed to the maxilla and mandible.

Animals previously sacrificed following irradiation with the above modalities and with various time sequence surgical procedures performed, showed impairment of healing of extraction sites more so markedly in animals treated with ortho voltage. No sequestration of an entire mandibular body was noted.

SUPPORTED BY U.S. Veterans Administration

5.0496, EFFECT OF RADIATION ON GLUCOSAMINOGLYCANS IN BONE

K.I. ALTMAN, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620

The central theme of which the proposed project represents one aspect, concerns the effects of ionizing radiation and aging on the metabolism of connective tissue. The tissue of interest in this study is bone, i.e., the long bones of hind legs. Attention is to focused on glucosaminoglycans (GAG), a major class of constituents of ground substance. Because of known influence exerted by ionizing radiation and aging on the metabolism of this class of compounds, a study of the metabolic behavior of GAG as an integral part of connective tissue of normal bone is envisaged in relation to X-radiation and aging (physiological as well as 'radiologic').

Recent work from other laboratories indicates that the metabolism of GAG is intimately involved in the formation of callus during the healing of fractured bone and that the process leading to closure of the fracture is affected by exposure to x-radiation and by the age of the organism. We are,therefore, presented here with an opportunity for studying radiation and aging effects on a metabolically active system capable of synthesizing GAG.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0497, MECHANISMS OF PERMANENT AND DELAYED PATHOLOGIC EFFECTS OF RADIATION

G.W. CASARETT, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)49)

This is a multidisciplinary investigation in total-body X- irradiated rats of: a) the pathogenesis of 'permanent' and delayed damage of parenchymal, connective, and vascular tissues and of induction and/or temporal advancement of degenerative diseases, neoplasms, and aging changes in life-span shortening; and (b) post-irradiation treatments against these effects. Some previous findings include: (a) endothelial damage with plasmatic transudation through small vessel walls into organ parenchyma leads to increasing vascular and interstitial fibrosis (histohematic connective tissue diffusion barrier) additive with similar progressive changes of aging and to increasing blood pressure which contributes to degeneration and fibrosis of fine vasculature, and these progressive changes largely cause the subsequent premature degeneration of organ parenchyma leading to delayed effects; and (b) treatment of rabbits with epsilon amino-n-caproic acid (EACA) after skin irradiation reduces early plasmatic transudation, vasculo- connective tissue changes, and severity of delayed skin pathology, and treatment of rats with L, 3, 3, 5-triiodothyronine (T-3) after total- body irradiation prevents or reverses the increases in fibrillar connective tissue in organs caused by irradiation or natural aging. Current and continuing next year are more definitive, comprehensive life-term rat experiments on efficacy and mechanism of T-3 or EACA treatment against the late effects.

Results: In current experiments trends of data, including periodic quantitative or semiquantitative cytology, histology, histopathology, histochemistry, biochemistry (connective tissue, thyroid and adrenal hormones, electrolytes), O2 consumption and other metabolic factors, blood pressure and other hemodynamic factors, microcirculatory factors, microangiography, hematology, pathology (age-related disease incidence), auto-immune aspects of thyroid damage, and actuarial parameters, are confirming and strengthening previous findings, theory, and expectations. Experiments have not gone long enough in life-span for conclusions concerning delayed effects and treatments.

SUPPORTED BY U.S. Atomic Energy Commission

5.0498, EFFECT OF RADIATION ON PROTEINS AND RELATED COMPOUNDS

W.F. FORBES, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620

Various physico-chemical properties, such as amino acid analyses, carbonyl group concentrations and various spectral properties (electronic and electron spin resonance) both prior to and after irradiation, will be determined on collagen fractions obtained from skins of mice of various ages. Also the free radical species, obtained mainly from polynuclear hydrocarbons on heating, will be investigated as models to study interaction of free radicals with biological systems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0499, FATE OF RADIUM AND OTHER RADIONUCLIDES IN LIVING ORGANISMS

J.B. HURSH, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)49)

The objective of this program is to perform biological experiments on the intake, tissue distribution, and fate of radionuclides, and to produce data of use in the setting of maximum permissible levels in the air and water of the occupationally exposed personnel. Current emphasis is on various isotopes of lead. An important body compartment for concentration and storage of lead is the red cell. A considerable amount of research has been published on the mechanism by which lead is bound to the erythrocyte, but the problem is still unsolved. It is proposed that lead binding by the red cell be investigated including a study of the uptake, if any, by red cell ghosts and the effect of various levels of stable lead on the rate of uptake and the fractional distribution between cells and plasma. This is intended as an in vitro study and will use human blood. In addition, it is proposed that a study be initiated using beagle dogs who are to inhale labelled tungstic oxide. The deposition, rate of lung clearance, and excretion will be measured.

Results: The results of a study on Pb212 inhaled by man have been published in Journal of Applied Physiology, Vol. 28, 268. A paper entitled 'Tissue Distribution of Bi212 in Rats' has been published in Proc. Soc. Expl.Biol. Med., '131, 116. A paper entitled 'Oral Ingestion of Uranium by Man' has been published in Health Physics, 17, 619.

Dogs have been exposed to 210 Pb210 aerosol and sacrificed at 2, 11, and 31 days. The lung clearance of the lead aerosol showed half- times from 4-11 hours. Red blood cells, liver, and bone showed the highest Pb210 content on sacrifice. The urinary to fecal ratio of excreted lead was about 1.

SUPPORTED BY U.S. Atomic Energy Commission

5.0500, HEMATOPOIESIS IN NORMAL AND IRRADIATED ANIMALS

M. INGRAM, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)49)

The response to a suddenly increased demand for increased blood cell production may include production of non-standard or aberrant cells as well as increased production rates. Studies in progress are concerned with the application of such measurements in evaluating hematopoietic competence of normal animals (dogs, rats). They are also applied in comparing hematopoietic competence of normal animals with that of aged and irradiated animals. Normal young adult dogs, old and old dogs X-irradiated

many years earlier are subjected to severe acute blood loss. The erythropoietic, thrombocytopoietic and leukocytopoietic responses are evaluated with respect to production rates and the characteristics of the cells produced. Erythropoietin assays provide additional information about the erythropoietic response. (Possible 'thrombopoietin' assay systems are also being evaluated.) Age: volume: density relationships of blood cells produced by the various experimental groups following blood loss or irradiation are altered in different ways.

Results: Differences in the erythropoietic responses of young adult, old, and old-irradiated dogs have been demonstrated, although the groups appear not to differ significantly with respect to erythropoietin production. Aberrations in platelets and leukocytes produced after severe blood loss have also been demonstrated. Preliminary evaluation of assay systems for thrombopoietin, using animals made thrombocytopenic by various means have been completed and are being written up as a Ph.D. thesis and for publication.

SUPPORTED BY U.S. Atomic Energy Commission

5.0501, THE CELLULAR AND MOLECULAR BASIS OF RECOVERY FROM RADIATION INJURY

C.S. LANGE, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)49)

The aim of this project is to explain the mechanism(s) of organismal recovery from radiation injury in terms of stem cell repopulation and differentiation, which are studied in the animal, and cellular recovery and repair of sublethal damage, which are studied in culture. The ability to repair, and possibly the induction of sublethal damage have been shown to be limited to specific times in the cell cycle. Specific inhibitors of DNA, RNA, and protein synthesis are being used to determine the molecular mechanism(s) of repair in mammalian cells (HeLa). The planarian is a useful analog for mammalian cell systems such as bone marrow, liver, skin. By determining planarian survival curves and stem cell counts after dose fractionation, shielding, and stimulation of differentiation, the nature of the control system(s) which govern(s) repopulation is being studied. Isolation and identification of the tissue-specific differentiator hormones of the planarian is also being done to elucidate the mechanism of differentiation control and stem cell homeostasis.

SUPPORTED BY U.S. Atomic Energy Commission

5.0502, BIOLOGIC AND PHYSICAL ASPECTS OF AIRBORNE AGENTS

L.J. LEACH, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)-49)

A great variety of atmospheric pollutants enter the body through the respiratory system. Many are capable of producing disease or disability when deposited or accumulated in sufficient amounts in the lungs or after translocation from the lungs to sites deeper within the body.

The purpose of this project is to gather more information on inhaled materials primarily through animal experimentation.

Currently, the long-term biologic effects of inhaled uranium are being evaluated in dogs and monkeys that have been exposed daily to natural UO2 dust (5mg U/per cubic m) for periods up to 5 years and then held for as long as 6 years postexposure.

Studies are also being made to determine the health hazards associated with the inhalation of selected compounds from the lanthanum series. For example, single (1 day) and multiple (90 days) exposure of dogs and monkeys to an aerosol of europium oxide (Eu_2O_3) at 6.5 mg/per cubic m, mean concentration, have been completed. Exposed animals along with control groups were examined routinely for changes in general health, body weight, hematology and histology. Concentrations of Eu in tissues and excreta were determined by activation analysis.

The inhalation toxicity of lutetium oxide (Lu_2O_3) is presently under investigation.

Results: The most consistent findings in the UO2 exposed animals examined during the postexposure period were fibrotic changes in lungs and associated lymph nodes which probably reflect alpha radiation injury.

No animals died during the 3 month exposure to Eu_2O_3 aerosol. The treatment had no major effect on growth patterns or peripheral blood pictures of the test animals. The primary sites of Eu accumulation were the lungs and tracheobronchial lymph nodes. Fecal excretion appeared to be the main pathway by which Eu was cleared from the body.

SUPPORTED BY U.S. Atomic Energy Commission

5.0503, PHYSIOLOGIC DECREMENTS OF ELECTROMAGNETIC RADIATION EXPOSURE

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The neuroendocrine system which plays a major role in coordination and integration of body functions is susceptible to ionizing radiation. Quantification of radiation-induced functional alteration of this system is required. Although the thyroid gland was, in the past, considered to be fairly resistant to external X- or gamma radiation, it has become increasingly evident that exposure to a 'moderate' level of X-rays (100 R) can result in thyroid dysfunction and neoplasia. The relative radiosensitivity of this important endocrine organ has not been established. The numerous interacting factors such as mode of irradiation, total dose, dose rate, age of subject, relationship of other body systems which may be concurrently exposed to radiation or are affected because of their inter-dependence of reciprocal relationship with the thyroid, have to be worked out. Interpretation of the effects of radiation on the thyroid must be made in light of the functional interrelationships of this gland with the hypothalamic-hypophysial and other coordinating systems of the body. The dog exposed to various modes of X-irradiation such as to the upper-body, head or neck, is used as the biomodel to assess basic biologic reactions and possible health implicatons for man. These studies emphasize the need to examine the role played by neuroendocrine mechanisms in the radiation induced pathophysiology of the thyroid gland.

Results: Histopathology of the thyroid reveals a higher than expected incidence of neoplastic changes. Assay methods for thyroid stimulating hormone (TSH) and growth hormone (GH) in the dog are in various stages of development and refinement. The mouse bioassay for TSH has been standardized. The radioimmunoassay for human TSH has been standardized and the method will be applied to the dog as soon as a sufficient number of canine pituitaries is obtained for specific TSH extraction. Initial studies indicate that radioiodinated canine growth hormone cross-reacts with guinea pig anti-porcine growth antiserum.

SUPPORTED BY U.S. Atomic Energy Commission

5.0504, CELLULAR PARAMETERS OF RADIOSENSITIVITY

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The nucleus and chromosomes are primary targets for radiation- induced effects upon cellular reproductive integrity. The objective is to compare the relationships between nuclear and chromosomal size and radiosensitivity, particularly with polyploid (multiple sets of chromosomes) species; also, the factors involved in studying repair of irradiated chromosomes are under investigation. The proposed research has followed two avenues: (1) exposing series of polyploid plant species to ionizing radiation and scoring for survival, and (2) combining dose-fractionation experiments with multiple fixation studies to determine the relation between sensitivities (chromosome breakage) and cycle speeds of cells within the root meristem of 'Vicia faba'.

Results: Polyploidy per se does not appear to confirm radioresistance; rather, the smaller chromosome sizes of the resistant species correlates with their high radioresistance relative to the diploid species.

Single fixation times in studying dose fractionation effects on chromosome breakage can give false impressions about yield; multiple fixations indicate a heterogeneity of the cells with regard to radio- sensitivity and cycle speed.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0505, THE RADIOBIOLOGY AND TOXICOLOGY OF RADON AND OTHER RADIOACTIVE GASES

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The inhalation of radon and its decay products is believed to produce lung cancer in uranium miners. It is the purpose of this work with radon to examine the radiological effects which result from the inhalation of radon. These biological studies with radon include effects on life span, the hemopoietric system, histology, morphology and general pathology, with specific attention directed to the lung. Exposures to radon extend from single and multiple short time inhalations of radon only to continual inhalations of radon and its decay products over a wide range of concentrations of radon in air. Mice and a few rats have been used, and dogs are now being used.

Exposures to x-ray are used as reference irradiations. Some experiments, in studies of the hemopoietic system, have included combined radon and x-ray exposures.

A graduate student has begun a study of the effects of inhaled krypton-85, with guinea pigs, to differentiate the results of internal from external irradiations. Visiting scientists are studying chromosome aberrations in rats exposed to radon. The use of radon offers a unique opportunity to expose animals continually, by inhalation, to maintain a constant body burden of alpha-emitting isotopes but which, by virtue of a rapid elimination rate and short-lived decay products, reduces body content of radioactivity to a negligible amount on termination of exposure.

Results: Morphological changes in trachea and lung of mice occassioned by continual exposure to radon are repaired within a few weeks following termination of exposure. Late effects appear in the region of the terminal bronchiales. The lungs of dogs at 6 months and 1 year past exposure to doses from 200 to 3000 working-level-months have shown only tenuous changes in morphology. Other dogs will be examined at 2 and 3 years past exposure. Exposures now in progress will deliver doses of about 12,000 working-level-months to dogs.

SUPPORTED BY U.S. Atomic Energy Commission

5.0506, CLINICAL RADIATION RESEARCH CENTER

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The aims of this program are the systematic delineation of the fundamental cellular and tissue responses, and mechanisms, in vivo in normal and malignant neoplasms of various kinds and levels of radiosensitivity, during and after radiation exposure in various temporal modes; and the application of this knowledge to the discovery of physical, physiologic, and chemical means for the most efficient use of radiation and adjunctive agents in the destruction of cancer and sparing of normal tissues. The coordinated multidisciplinary parameters include cell and tissue growth rate and survival, tumor metastatic incidence and potential, histopathology, histochemistry, biochemistry, cytokinetics, cell viability, cellular ultrastructure, cell physiology, vasculogenesis, microangiography, vascular and circulatory physiologic responses, oxygen influences, oxygen determinations in tissues, and other special techniques as required. Currently being maintained in serial passage (transplantation) in the Syrian hamster cheek pouch for these studies are 3 types of Syrian hamster sarcomas, 4 types of Syrian hamster carcinomas, 1 polyoma virus transformed Syrian hamster sarcoma, and 2 human carcinomas. Studies of carcinogenesis and cancer induced by DMBA in hamster cheek pouch and by subcutaneous implantation of teflon in hamsters, have been initiated. Other transplantable and induced tumors will be added for these studies.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0507, MODIFICATION OF RADIATION INDUCED PULMONARY FIBROSIS

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The research objectives of this project are directed toward a more complete understanding of the effects of primary pulmonary irradiation in the dog. During the past five years we have carefully defined the syndrome of pulmonary radiation effects in terms of dose time intervals, clinical course, hemodynamic abnormalities, alterations in blood gas exchange, and changes in thoracic roentgenograms. Correlations between these changes and pathologic changes have been made. We now propose to evaluate this syndrome further by (a) estimating the magnitude of increased pulmonary parenchymal metabolism; (b) studying the efficacy of (1) pharmacologic interventions such as triiodothyronine and cortisone, and (2) physical conditioning; (c) an investigation of the magnitude of impaired myocardial performance; and (d) an ongoing electron microscopic study of the primary nature of the radiation reaction, i.e. vascular or epithelial.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0508, ACUTE RADIATION EFFECTS OF WHOLE-BODY X-IRRADIATION IN ANIMALS AND SUITABLE THERAPY

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An effect being investigated is the finding that a circulating toxic material is produced during the irradiation of animals. It comes mainly from the muscles. After isolation from tissues or urine and then injection into a normal test rabbit, it will reproduce much of the initial radiation shock-like syndrome, and it also enhances the later hemorrhagic effects. There is a small normal excretion in laboratory animals and humans. Present objectives include determining the chemical nature of the material, its manner of production, and its physiological significance and mode of action in the irradiated animals.

Another effect is the high incidence in the second week post irradiation of peptic ulcers in rabbits and general stomach lesions in guinea pigs which in both species lead to internal bleeding and death. The etiology of these hemorrhagic effects is a prime objective, and the role of the toxic material in this connection is being defined. For example, the ulcers have a higher concentration of the toxic material than the rest of the mucosa and the material is a vasodilator. Antacids and anticholinergic drugs are useful therapy measures and protective agents are being tried.

RESULTS: On irradiating part of the rabbit's stomach through small ports, the dose necessary to produce ulcers in the mucosa increases with diminishing port size.

A chemical protective agent has been employed which is able to inactivate the toxic material in vitro and also in vivo, as evidenced by lowered tissue levels in irradiated animals. Rabbits thus protected show no shock effects or early death for 1300 R, and the mortality due to the stomach lesions is markedly reduced. Similarly, the LD 50% for guinea pigs has been raised from 330 R, for controls, to about 430 R.

SUPPORTED BY U.S. Atomic Energy Commission

5.0509, DYNAMIC ASPECTS OF SKELETAL METABOLISM

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This is a continuation of a long-term research project exploring the major factors involved in calcium homeostasis, i.e., the entry and egress of calcium into and from the skeleton and the interrelationships of hormones (parathyroid and others) and vitamins (vitamin D and related sterols). Specific, but interrelated aspects of the study are: 1) blood-bone exchange of bone-seeking isotopes in man and 2) calcium deposition, resorption and transfer in special experimentally adaptable systems (hen and egg).

Results: Calcium transport by the isolated chick chorioallantoic membrane has been studied in great detail. Particular attention has been directed toward the bioenergetics of the process and the morphological aspects of active calcium transport.

The electron probe microanalyzer has been used to elucidate the mechanism of calcium compartmentalization characteristic of the tissue.

SUPPORTED BY U.S. Atomic Energy Commission

5.0510, MORPHOLOGICAL AND CYTOLOGICAL STUDIES OF LUNG RESPONSES TO INHALATION AND IRRADIATION

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The research is designed to define the pathological effects of various inhaled particulates on lung structure and to correlate such effects with chemical and radioactive measurements. The study is being conducted to obtain basic morphologic information concerning short and long term toxic effects and pulmonary clearance mechanisms, of a general as well as specific nature, related to materials encountered as environmental or industrial inhalation hazard . After single or multiple exposures to aerosols of various, generally isoluble materials, the lungs of exposed animals are examined by light and electron microscopy and by autoradiography when indicated. Structural alterations are also studied at different time intervals after external thoractic X-irradiation in order to separate chemical and radiation effects of inhaled radioactive materials. Rats and dogs are the test animals being used while aerosols of the rare earths europium and lutetium, natural uranium and radioactive isotopes of plutonium (Pu238 and Pu239) are generated in special chambers for inhalation exposure.

Results: Despite an early inflammatory and macrophage response in the lungs and ultimate storage in pulmonary interstitial tissues and lymph nodes after 3 months of daily europium inhalation, no obvious, adverse reaction had occurred within 1 year. In 13 dogs exposed to an aerosol of natural UO2 for 5 years, slight fibrosis of lungs and pulmonary lymph nodes and epithelial proliferative lesions in the lungs ranging from focal alveolar metaplasia to frank adenocarcinoma, developed during post-exposure periods of from 12 to 84 months. No such lesions occurred in 5 control dogs. In monkeys, subjected to similar experimental conditions, no tumors occurred, but pulmonary and lymph node fibrosis was marked. Dose related pulmonary and hematopoietic effects of inhaled plutonium-238 and 239 have been worked out over a considerable range of initial dose and post-exposure time and results are to be published.

SUPPORTED BY U.S. Atomic Energy Commission

5.0511, RADIATION EFFECTS IN CROSS-LINKING IN POLYMERIC SYSTEMS

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Technical Objective: Mechanistic studies will be made in the areas of radiation-induced graft polymerization and cross-linking. Extension of knowledge in types of polymerization, and cross-linking in polymer- monomer systems, should lead to improved properties sought by the Army for the thermoplastic materials such as those used in electronic apparatus, mechanical goods, rifle stocks and containers for ammunition and other supplies.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0512, BEHAVIORAL AND NEURAL EFFECTS OF RADIATIONS AND TOXINS

J. GARCIA, State University of New York, School of Arts, *Stony Brook, New York* 11790

This research deals with behavioral effects of illness induced by X-rays and toxins. Previous research has indicated that when animals ingest a distinctly flavored fluid and become ill even hours later, they will learn to avoid that flavor in a single trial. Present research indicates that this long interval between tasting the substance and the subsequent illness state is spanned by a central (memory) mechanism and does not depend upon lingering remnants of the meal. Wet food, as opposed to dry food with water separate is a sufficient cue when followed by illness induced hours later. Taste signals followed by illness reinforcement appear to be a necessary condition for this 'long interval' conditioning. Taste followed by peripheral pain of shock is not effective with long delays. Smell, as well as visual and auditory signals, followed by illness appears to be ineffective also. We have evidence that taste-illness learning is not controlled by the same central neural mechanisms as buzzer-shock learning. Septal lesions will disrupt buzzer-shock associations but they actually improve taste illness associative learning. Amygdaloid lesions disrupt both types of conditioning. We are now exploring gustatory projection areas to locate lesions which will disrupt taste-illness association but leave buzzer- shock learning intact. In this way, we hope to learn the organization of differential neural control of the internal and external environments.

During the next year we expect to extend our behavioral research to other species, particularly monkeys to test for the associative bias we demonstrated in the rat.

SUPPORTED BY U.S Dept. of Hlth Ed. & Wel. - P.H.S.

5.0513, RADIATION DAMAGE IN TROPICAL RAIN FOREST TREES

UNKNOWN, State University of New York, School of Forestry, *Syracuse, New York* 12224 (NYZ-WPE-019)

PROGRESS: Data collected over a three year period have been analyzed and reduced to a thesis.

SUPPORTED BY New York State Government - Albany

5.0514, SURVEILLANCE - RADIATION EFFECTS IN GASES, LIQUIDS, METALS AND SEMICONDUCTOR MATERIALS

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Technical Objective: This research is directly related to Navy communication and surveillance systems incorporating electronic materials and devices which are vulnerable to nuclear radiation. There is a continuing need for materials and devices with greater resistance to radiation effects in order to predict how devices will react in a radiation environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0515, OPTIC LENS OF MAN - INCIDENCE OF MINUTE, DISCRETE SUBCAPSULAR OPACITIES WITH AGING OR FOLLOWING IRRADIATION

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Whereas interest in the effect of ionizing radiation upon the lens of man has been usually directed toward gross lesions which reduce visual acuity, the question arose as to whether minute measurable changes occurred as have been found in the mouse, with aging or irradiation. This information might pertain not only to the relation of aging and irradiation, but also to the significance of low level occupational or incidental exposure in man.

Laboratory employees exposed to very low levels of radiation and metastatic cancer patients maintained on cytotoxic drugs were utilized to develop a workable method of lens examination and opacity scoring. It was found that the same instrument and technique could be used as have been employed in experiments utilizing mice. It is intended to examine persons both unexposed and exposed to ionizing radiation of known physical characteristics, towards elucidation of the relation of aging to irradiation in the human lens, and to the extent possible, to correlate lens changes in the irradiated individuals with the radiation physical factors.

Results: Examination of Marshall Island residents in February- March, 1969, included 80 unexposed persons and 41 exposed to 175 r of whole-body gamma rays from fallout caused by the 1954 nuclear detonation at Eniwetok. Minute discrete opacities were found to increase steadily with age in non-irradiated males, while normal females showed a rapid rise during adolescence and a slower increase thereafter. Among the irradiated persons, only females who had been adolescent at the time of the fallout exposure revealed an incidence of minute discrete opacities suggestively higher than their non-irradiated peers.

SUPPORTED BY U.S. Atomic Energy Commission

5.0516, BIOENERGETIC MECHANISMS INVOLVING FREE RADICALS - RADIOMIMETIC MECHANISMS AND IRRADIATION STUDIES RELATED TO AGING
D.C. BORG, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

Continuous flow apparatus for electron paramagnetic resonance (EPR) spectrometry of labile free radicals in liquid at X-band and Q- band will be further applied to radiomimetic chemical reactions (due to hydroxyl radicals produced by Ti(III) /H2O2) that form transient free radicals from biochemical substrates. Purines, pyrimidines, and other componets of nucleic acids will be studied to determine mechanisms of free radical attack and to relate these to natural and radiation- accelerated aging effects on somatic DNA.

Hydrogen and deuterium atom bombardment and irradiation of powders and crystals of some of the same materials will be continued to assist in free radical identification and to correlate some radiation effects in static solid samples with flow-system observations of reactions in liquid.

Results: The radiomimetic chemical system's action on several amino acids gave complex EXP spectra. Analyses indicated multiple free radical fragments, including prodcts that had undergone hydrogen abstraction and deamination, which is comparable to results from radiolysis.

Atom bombardment of dry samples of purines and pyrimidines permitted description of the radiation damage centers in several cases. Much work was done with 9-methyl adenine and 1-methyl thymine.

SUPPORTED BY U.S. Atomic Energy Commission

5.0517, KINETICS OF HEMATOPOIETIC STEM CELL PROLIFERATION FOLLOWING X-IRRADIATION
A.L. CARSTEN, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

The objective is to relate changes in marrow stem cell activity to mortality following uniform or non-uniform radiation exposures; also to elucidate the kinetics of stem cell proliferation and differentiation and their influencing factors. Changes in stem kinetics related to age, strain, and sex are investigated. The relationship of depth dose, marrow distribution and mortiality is being examined following various geometry exposures in mice and monkeys.

Changes in marrow stem cell numbers with age of male mice have been measured out to 103 weeks of age, and related to recovery to 65 weeks following a maximum sublethal whole body dose of 525 rads. The observations on the viability of stored marrow have been extended to determination of resultant colony morphology as well as numbers. Comparative data on marrow distribution in mice, monkeys, dogs and man have been compiled.

SUPPORTED BY U.S. Atomic Energy Commission

5.0518, COMPARATIVE STUDY OF THE EFFECTS OF X-IRRADIATION ON THE ELASMOBRANCH BRAIN
A.L. CARSTEN, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

The differing morphology and reaction to physical injury of the elasmobranch brain has led to the study of the effects of gamma irradiation on the role of the astrocyte, its metabolism and modification following irradiation injury. In addition, changes in the blood brain barrier permeability are also examined. Studies include histological and electron microscopic examinations of animals as early as 24 hours following gamma exposures in the 1,000 to 30,000 rad range made with a 1 cm cross section beam. Similar measurements are being made on animals as late as 16 months post exposure with the same beam geometry at dose levels of 1,000 - 5,000 rads. A number of cats and rats received identical exposures to the forebrain or cerebellum, and were used for comparative studies with the sharks.

Results: Whereas the rats and cats exhibited the well documented pattern of irradiation necrosis and attendant loss of function, the exposed sharks showed only the most minimal changes. No abnormality with regard to mobility, behavior or growth could be detected in any sharks. The only discernible changes in the irradiated region were a slight subcutaneous edema in animals sacrificed at 5 to 9 days following 30,000 rads and a slight local darkening of the skin at 4 to 9 days following 30,000 rads and a slight local darkening of the skin at 4 to 16 months in animals receiving 5,000 rads. Studies of vascular permeability using labeled proteins indicated the same pattern of response, i.e., no abnormal vascular permeability in the irradiated region of the shark brain in contrast to the increased permeability in the mammals.

SUPPORTED BY U.S. Atomic Energy Commission

5.0519, PATHOGENESIS OF EARLY AND LATE EFFECTS OF X-IRRADIATION ON THE RAT AND MONKEY FOREBRAIN
A.L. CARSTEN, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2))

The ultimate aim is to correlate structural change and functional alteration in the mammalian brain following X-irradiation. Functional integrity is evaluated by EEG analysis of the visual evoked response or visual acuity in the monkey, and by maze running ability in the rat. Rhesus monkeys received 3500 rads limited to either the right visual cortex in EEG tested animals or both visual cortices in the visual acuity tested animals. In addition one-half of the EEG tested animals underwent pre-irradiation surgery to eliminate the hemispheric connections in the optic chiasms and corpus callosum. Rats received forebrain exposures of 2,500 to 5,000 rads followed by testing of maze running ability at 4 to 36 weeks post exposure. Both monkeys and rats are sacrificed at various times post exposure for complete light and electron microscopic evaluation.

Confirmation of a decreased EEG amplitude in the right irradiated hemisphere with a later bilateral depression is complete. Monkeys have undergone surgical section to separate the right and left hemispheres and irradiation. Animals receiving 3,500 rads to both visual cortices showed no decrement in visual acuity until 90 days, after which these animals showed a rapidly developing reduction in visual acuity leading to functional blindness within approximately 60 days. Forebrain irradiated rats (3,500-5,000 rads) show an earlier period of learning decrement (15-30 days post exposure) followed by a return to more normal patterns of learning when examined some weeks later. Histopathology on the rats indicates the type of radiation necrosis previously reported.

SUPPORTED BY U.S. Atomic Energy Commission

5.0520, LYMPHOCYTE MIGRATION AND KINETICS IN EXPERIMENTAL ANIMALS
A.D. CHANANA, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

Extracorporeal irradiation of blood (ECIB) and lymph (ECIL) destroys circulating lymphocytes without direct radiation damage to hemopoietic organs. These techniques enable development of quantitative methods for the study of normal and malignant lymphopoiesis. ECIB and/or ECIL will be combined with: (1) in-vitro or in-vivo isotopic labeling of cells; (2) sampling of blood from individual organs; (3) isotopic labeling of individual organs in situ, and (4) sizing of lymphocytic population of blood and lymph. It is hoped to clarify the magnitude of lymphocyte recycling from blood to lymph; life span, mobilization and production rates of normal and leukemic lymphocytes; mechanisms controlling lymphocyte production; stem cell capabilities of lymphocytes; influence of lymphocyte destruction on new cell production; routes of migration of thymic lymphocytes to other organs and magnitude of this migration; and role of lungs and spleen in lymphocyte homeostasis.

Results to date: Lymphoid cells proliferating in the thoracic duct of the calf represent two populations. The cells with more basophilic cytoplasm have shorter DNA synthesis and generation times. The mitotic time of these cells was not altered by prior

ECIB. The newly synthesized thymic lymphocytes enter the circulation via the thymic vein and thymic efferent lymphatics and the newly synthesized lymph node cells enter the circulation via the efferent lymphatics. Labeled thymic lymphocytes were observed in the thoracic duct lymph. Size distribution analysis of blood and thoracic duct lymphocytes of the calf did not reveal any significant differences.

SUPPORTED BY U.S. Atomic Energy Commission

5.0521, THE LONG-TERM TURNOVER OF RADIONUCLIDES IN MAN

S.H. COHN, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

The sensitivity, precision and accuracy of the whole-body counter permits the measurement of the long-term biological turnover of various elements in man using low levels of tracer. Knowledge of these turnover rates is required for the assessment of the radiation hazard to man from 90Sr, 137Sr, 137Cs and 65Zn. In a current study, the long-term turnover of both chronically-administered 85Sr and a single intravenously- administered dose are compared over one-year periods. Mathematical models representing the turnover data are developed with the aid of a digital computer to permit extrapolation over a lifetime. At late times after administration, the tracer data reflect the turnover rate of the slowly-exchanging or 'stable' bone compartment. From these data it is possible to derive the function describing the rate of loss of Ca from bone to plasma.

Results: A stochastic model (within a compartmental analysis) using the likelihood function was formulated to fit long-term strontium retention data. This model is an analytical representation of a system having a unique outcome, within a probabilistic range, for a given set of values.

SUPPORTED BY U.S. Atomic Energy Commission

5.0522, INFLUENCE OF AGE AND RADIATION EXPOSURE ON HUMAN LYMPHOCYTE RESPONSE TO PHYTOHEMAGGLUTININ (PHA)

R.A. CONARD, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-1))

The effect of age and radiation exposure was studied in phytohemagglutinin stimulated blood cultures in 40 Marshallese who had been exposed to fallout radiation and in 130 unexposed Marshallese. Similar 'in vitro' studies were carried out studying the effects of X- radiation on PHA-stimulated lymphocytes in 15 subjects at BNL. Electronic sizing was used in both of these studies to determine the percentage of transformation of lymphocytes in culture.

Results: Percentage response of lymphocytes to PHA stimulation in culture decreased progressively with increasing age. Response in the exposed population however was about the same as in the unexposed population. 'In vitro' irradiation of PHA-stimulated lymphocytes showed the greatest effect to be on cell division whereas the transformational ability of the lymphocytes was less impaired. These studies have been completed and are being published.

SUPPORTED BY U.S. Atomic Energy Commission

5.0523, MEDICAL STUDIES OF THE PEOPLE OF THE MARSHALL ISLANDS ACCIDENTALLY EXPOSED TO FALLOUT

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Annual medical surveys of the Marshall Island people who were accidentally exposed to radioactive fallout in 1954 are conducted by Brookhaven National Laboratory in conjunction with the Trust Territory of the Pacific Islands. The most important late effects noted in this population has been growth retardation in some of the exposed children and during the past 5 years the development of thyroid abnormalities in 21 out of 82 exposed people of Rongelap Island. These latter abnormalities are believed to be a result of exposure to internal radioiodines absorbed at the time of the fallout. Seventeen out of the 21 lesions have occurred in persons less than 10 years of age when exposed. Surgical exploration of the thyroid has been carried out in 19 Marshallese people in the U.S.

Results: As a result of the 1969 (15 year) survey 5 Marshallese thyroid cases were brought to BNL for study and later surgery at Cleveland, Ohio. Of the 5 cases, 3 proved to be malignant lesions. In addition to the 3 cases of thyroid cancer 15 benign nodules and 2 atrophic glands have been detected in the exposed Rongelap people. Correlation of growth retardation with thyroid injury has been apparent in some of the children and supplemetal thyroid hormone therapy appears to be beneficial.

SUPPORTED BY U.S. Atomic Energy Commission

5.0524, BIOLOGICAL MECHANISMS OF NATURAL AND RADIATION-INDUCED AGING

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Aging in mammals is considered a result of a complex series of biological reactions, each of which is due to a different cause. Probably most of them involve changes in the nucleus of one or more somatic cells, so mutations, broadly defined, are implicated. Radiation causes mutations and thus accelerates aging. It is a powerful tool for the determination of specific factors involved in the reactions, and especially the role of recovery mechanisms. Mutations are scored in mice either as visible chromosome aberrations or as the per cent tumor incidence under rigidly defined conditions. Age-associated changes in DNA and RNA are being studied by both biochemical and molecular biological methods.

Results: Studies have confirmed and extended the above theories of aging. All somatic cells undergo mutation at roughly the same rate throughout life, and if they do not undergo division (e.g., liver) the mutations accumulated at a constant rate. If they continually divide (e.g., bone marrow) the aberrant cells are selected against and the aberrations remain at low levels. Even without division chromosome breaks may be repaired over a period of many months but the point mutations responsible for cancer are never healed. In the human, most degenerative diseases require cellular changes involving about 6 sequential steps for induction, at least one of which is a mutation in a somatic cell.

SUPPORTED BY U.S. Atomic Energy Commission

5.0525, RECOVERY OF IRRADIATED MAMMALIAN CELLS

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The purpose of this work is to learn the mechanism whereby mammalian cells can repair radiation damage related to the division process. Since repair mechanisms may be the reverse of, or at least closely related to, mechanisms of damage registration, the objective is also elucidation of how radiation kills cells. This study is undertaken, to begin with, because lethality is one of the main biological effects of radiation but also because an understanding of radiation damage/repair processes is essential to the improvement of the treatment of cancer with radiation. Experimentally, cultured mammalian cells are used because they facilitate quantitative measurements and because in general their radiation properties are similar to the stem cells of essential cell renewal systems in the body as well as malignant cells undergoing uncontrolled growth in tumors. In addition to the effects of radiation by itself on colony formation, the influence of drugs which can affect radiation damage or repair are also studied to help in the understanding of the radiation problem.

Results: At the level of cell survival, we have found that sublethal damage can be repaired and that lethal and sublethal damage differ only in degree. To find a molecular basis for these results, we have studied damage/repair at the level of single strands in DNA. As found also by others we observe that cells repair single strand breaks rapidly. However, they also have an ability to repair a second form of damage which is related to DNA in a larger organizational structure. Radiation resolves this structure and during a repair interval, cells reverse the effect of radiation.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0526, THE GENETIC EFFECTS OF IONIZING RADIATION IN DROSOPHILA MELANOGASTER
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Mature Drosophila sperm will be irradiated with a mixed dose of neutrons and X-rays in an attempt to detect interaction between chromosome lesions produced by X-rays and similar lesions produced by neutrons. If such an interaction can be detected, the rejoining distance between chromosome lesions can be calculated. At present only upper limits of this distance can be estimated. The finding of such an interaction will also eliminate one of two models that explain observed linear dose-response curves for neutron-induced chromosome exchange and translocations.

Recently Savage has proposed a new hypothesis for chromosome exchange that differs fundamentally from the generally accepted hypothesis of Wolff. Mature 'Drosophila' sperm of various karyotypes will be irradiated and their translocation frequecies determined to test these two hypotheses.

Mature Drosophila sperm were treated with several doses of 0.68 Mev neutrons or X-rays and the frequency of translocations, recessive lethal mutations, and dominant lethal mutations measured. It was found that: translocations increase linearly with increasing neutron dose; translocations induced by X-rays increase with a power of the dose greater than 1; the RBE for translocations varies from 4.0 at low dose to 2.2. at high dose; both X-ray-induced and neutron-induced recessive lethal mutations increase linearly with dose; the RBE for recessive lethal mutations is 1.8; the neutron survival curve has no shoulder; the X-ray survival curve has a slight shoulder; and the RBE for the straight portion of these curves is about 3.6.

SUPPORTED BY U.S. Atomic Energy Commission

5.0527, INTERACTION OF THERMAL AND RADIATIVE PROCESSES IN BIOLOGICAL SYSTEMS
H.A. JOHNSON, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-1)GEN-16)

The existence of the interaction of thermal and radiative processes in biological systems is well known but very little is known of the mechanisms involved. It is planned to thermally inactivate enzymes, both crystalline and in solution, in the presence of ionizing radiation in order to measure changes in the activation energy for protein inactivation which may be brought about by the presence of ionizing radiation, and to determine the extent to which thermolabile sites on a molecule correspond to radiation labile sites.

Specifically, horseradish peroxidase in solution and in the form of dry crystals is to be irradiated in the high intensity radiation laboratory in water jacketed vessels which are carefully temperature controlled. The enzyme will then be tested for specific action on hydrogen peroxide using colorimetric tests. Arrhenius plots of rate of inactivation and temperature will give the resultant activation energy. With a knowledge of the dose to an enzyme molecule, it should be possible to estimate what fraction of the absorbed dose appears at a thermolabile site and contributes to the thermal inactivation.

A theoretical relationship between thermal and radiation effects at the molecular level has been derived. (Rad. Res. 32; 663, 1967).

Small doses of radiation (100r) greatly decrease the stability of peroxidase in solution. The radiation induced change in activation energy for thermal inactivation has been measured. The influence of radiation dose, quality of radiation, and enzyme concentration on this phenomenon have been determined.

SUPPORTED BY U.S. Atomic Energy Commission

5.0528, HEMOGLOBIN BIOSYNTHESIS
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Emphasis in this work is upon the regulation of heme and globin synthesis and associated processes such as the direct incorporation of plasma iron into heme and the metabolism of non-heme protoporphyrin. Search for regulatory factors involves tests for effects of irradiation, drugs, and other materials on the syntheses and processes. At present, particular attention is being paid to normal hemoglobin heterogeneity, a phenomenon common to all animal species, but little understood. The main experimental system employed is the Pekin duck erythrocyte which synthesizes considerable hemoglobin in the circulation and 'in vitro' and has a conveniently short life span. The erythrocytes of the adult animal contain two distinct and readily separable hemoglobins.

Results: The two adult duck hemoglobins were found to differ in amount within the erythrocytes, in amino acid compositions of the constituent globin, and in rate of synthesis 'in vitro'. Limited evidence for segregation of the hemoglobins within different erythrocytes was obtained. The system giving rise to one of the hemoglobins is more affected by irradiation of the animal than the other.

SUPPORTED BY U.S. Atomic Energy Commission

5.0529, EXPERIMENTAL RADIATION CARCINOGENESIS
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Certain effects of radiation at the animal level can reasonably be assumed to depend directly on the radiation response of only a single critical cell type - for example, the acute hemopoietic syndrome on the response of the hemopoietic repopulating or stem cell, and radiation- induced leukemia on the delayed response of a cell type as yet unidentified. In such instances it appears feasible to relate, by means of a mathematical model, the animal and the cellular dose effect curves. In general, account must be taken not only of the primary radiation response of cells of the critical type, but of the proliferation which they initiate, and the animal's requirement for, or sensitivity to, their progeny. Of use in the analysis are; the theory of random variables and stochastic processes, Fourier transforms, computer simulation, and the theory of competing risks. Plans for future work are concerned with: 1) radiation-induced leukemia, 2) effects of dose protraction on the width of the animal dose-survival curve as well as on the mean lethal dose, and 3) extension of a presently-completed model of the hemopoietic syndrome and comparison of it with new data as it becomes available.

Results to Date: Progress to date includes: 1) the above-mentioned model of the hemopoietic syndrome and comparison with published data on the mouse; 2) a theory of the effect of nonuniformity of dose distribution on the hemopoietic syndrome; 3) partial completion of a theory of an effect of dose protraction on the width of the animal dose- survival curve when the mean lethal dose is not affected; and 4) partial completion of an analysis of published data on the incidence of three classes of radiation-induced leukemia in mice, utilizing the theory of competing risks, on which a model is to be based.

SUPPORTED BY U.S. Atomic Energy Commission

5.0530, CORRELATION OF RADIORESISTANCE WITH HEMOPOIETIC PARAMETERS IN MICE
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The curve of acute (30-day) mortality vs dose for animals dying of hemopoietic failure postirradiation, may be characterized by the median (50%) lethal dose, the LD50' and a parameter measuring curve 'width', such as the difference LD84 minus LD16. Expression of each of these in terms of mean values and variances of hemopoietic cellular parameters affords a mathematical model, the experimental testing of which is expected to provide further insight into the cellular basis of animal radioresistance. Some of the required cellular parameters may be measured relatively directly, while others must be estimated from measurable quantitites. Measurements are expected to include, for example, blood counts, blood volume determinations, assay of bone marrow for repopulating capacity, and the effect on this

capacity of different doses of radiation to the donor and to the recipient. A study is in progress with a radiosensitive strain of mice and a moderately radioresistant one, which seeks to account for the difference in radioresistance in terms of the model. As further data become available for comparison, extension and modification of the model may be required.

Results to date: Preliminary work has been completed on female mice of two strains chosen for comparison and housed together from age 5 weeks. A satisfactory magnitude and reproducibility were found for the difference in LD50, 30 days, of X-ray at 17 weeks, the age chosen for comparison. Additional LD50, 30-day, values at 14 and 20 weeks of age showed an acceptable rate of change in this age range. Values of the LD50, 5 days, determined at 17 weeks were found to be greater than the corresponding 30-day values by at least 450 R, confirmatory evidence for a relatively pure hemopoietic syndrome for each strain following doses in the 30-day lethal range.

SUPPORTED BY U.S. Atomic Energy Commission

5.0531, EXPERIMENTAL RADIATION CARCINOGENESIS

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The objective is to study basic mechanisms of radiation carcinogenesis using primarily the relatively large and relativey rapid mammary neoplastic response of the female rat to ionizing radiation. This particular model has been selected for studies of radiation carcinogenesis because a large body of data concerned with the neoplastic response of rat mammary tissue has been accumulated, the model system lends itself to meaningful experimentation, and the animal model appears to be reasonably close to the human situation. In general, young, female rats are exposed to a single sublethal dose X-radiation and the development of mammary neoplasia is followed for a one-year period. These data serve then as a base line for comparison with data obtained by experimental radiations. Experimental radiations include: fractionation and protraction; various dose-rates; and various qualities of LET.

Results: An experiment completed, indicated that 400 R of X- irradiation given in 2 equal fractions at intervals of 0, 2, 6,or 24 hours produced incidences of mammary neoplasia that were not different among the 4 irradiated groups. Incomplete data from experiments not yet finished suggest that exposure at 24 days of age produces a mammary neoplastic incidence somewhat smaller than when animals were exposed to the same dose at 42 or 84 or 225 days of age. Other incomplete experiments suggest that mammary neoplasia can occur in transplanted mammary tissue that was irradiated 'in vitro', and that the Lewis strain is somewhat less sensitive than the Sprague-Dawley strain.

SUPPORTED BY U.S. Atomic Energy Commission

5.0532, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS

H.H. SMITH, Brookhaven Natl. Lab., *Upton, New York* 11973

Studies on the effect of neutron irradiation on seeds (part of a coordinated program of research on the use of neutrons in seed irradiation).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0533, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS (ABBREV)

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The general objective of this research is to investigate the relative biological effectiveness (RBE) in plants of radiations of different linear energy transfer (LET). The materials irradiated are dry seeds of various plant species, particularly maize and Arabidopsis, and the main irradiations used are fast (fission) neutrons, and other high LET radiations, the effects of which are compared with those of 250 kVp X rays (low average LET). The responses measured are the frequency of induction of specific nonlethal somatic mutations, tumor formation, isozyme multiplicity and various criteria of cell lethality. Results have shown a maximum RBE at LET's of 72 to 174 KeV/mu; these RBE's are generally high (around 30 to 100 depending on dose and other factors) and the sensitive sites damaged to produce these effects are of the order of thickness of DNA molecules.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0534, RADIATION CYTOGENETICS OF HIGHER PLANTS

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The purpose of these investigations is to compare the relative biological effectiveness (RBE) of different types of ionizing radiations on cytogenetic systems of higher plants. The effects of monoenergetic neutrons, mesons, high energy protons, and heavy ions (He4 to Ar40) are being compared with the better known effects of X and gamma rays. The materials used are primarily special genetic stocks of maize and 'Arabidopsis', but are being extended to include a wide variety of plant species. The main procedures followed are to irradiate dry seeds under rigidly controlled environmental conditions and to observe the frequency of induced nonlethal somatic mutations as well as various criteria of cell lethality. Current emphasis will be on developing a mathematical model for the relation between a specific locus somatic mutation and cell lethality in maize which will take into account the number of cells at risk, the fraction of the genome involved in the mutation, the number of chromosome breaks causing cell lethality and the multiplicity of breaks attributable to a neutron.

Results: Results with Arabidopsis seeds irradiated with accelerated heavy ions and scored for tumor induction, growth inhibition, and somatic mutation showed the same variation pattern in RBE throughout the range in LET (from 2 to 1890 KeV mu. The RBE maximum, which reached 30, was highest at 72 to 174 KeV mu. Cross section analysis indicated that the sensitive sites for the 3 effects studied each had effective thicknesses of a few angstrom units to a few tens of angstrom units, which is consistent with a DNA target.

SUPPORTED BY U.S. Atomic Energy Commission

5.0535, RESPONSE OF PLANTS TO DECAYING RADIATION

A.H. SPARROW, Brookhaven Natl. Lab., *Upton, New York* 11973

Technical Objective: To determine the effects of selected simulated fallout decayed radiation doses on survival and yield of a number of important agronomic crop plants.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0536, PREDICTIONS OF RADIOSENSITIVITY IN HIGHER PLANTS

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The amount of radiation that can be tolerated by an organism is determined by many factors. The purpose of this work is to determine experimentally the radiation sensitivities of many species and to relate these to nuclear or chromosomal factors in such a way as to enable the prediction of radiobiological responses of other plant species to various amounts, dose rates and kinds of radiation. An index of nuclear and chromosome volumes, chromosome numbers, DNA content, duration of mitotic cycle and energy absorption per chromosome for many species of plants and animals is being assembled.

Results: Radiation sensitivity, as measured by chromosome aberration, mutation rate, survival, growth inhibition, yield and pollen abortion, has been related to interphase chromosome volume and DNA content per chromosome. From the regression lines obtained, predictions can be made of the radiosensitivity of herbaceous or woody plants if the interphase chromosome volume or DNA content per chromosome is known. Woody forms are more sensitive than herbaceous forms of similar chromosome size and, in general, gymnosperms tolerate less exposure to radiation than angiosperms. Many gymnosperm species have predicted or actual LD50s below 1000 R and as a group are much more sensitive than most angiosperms. Predicted LD50s and/or doses required to reduce yield by 50% have been obtained for several

hundred species of higher plants including many species of economic importance. Plants vary in sensitivity with stage of development. Dry seeds of any given species are most resistant, immature growing plants intermediate and reproductive stages the most sensitive. Effects on somatic cells are more uniform and easier to predict than effects on reproductive (meiotic) stages.

SUPPORTED BY U.S. Atomic Energy Commission

5.0537, RADIOSENSITIVITY OF ANTIBODY RESPONSES ELICITED WITH COMPLEXES OF ANTIGEN AND ANTIBODY

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Sublethal doses of cobalt-60 ionizing radiation as low as 100 to 400 rads increasingly repress and/or abolish antibody responses in mice and render animals more susceptible to infection. It is the purpose of this study to develop more effective means for successful immunization of irradiated animals. Our previous findings have demonstrated enhanced primary antibody responses in both normal and irradiated mice (400 rads) when immunization is accomplished with fluid tetanus toxoid (FTT) in complex with specific mouse antibody. Emphasis will be directed to the immunogenicity of complexes of FTT and IgG globulins prepared from specific mouse, rabbit and human antitoxin. A continuing phase of the study deals with the radiosensitivity of primary and secondary antibody responses to various types of ionizing radiations. An average RBE of 2.5 for 2.2 Bev protons was found for primary antitoxin responses and an RBE of 1.5 was obtained for secondary responses in comparative experiments with X- and gamma-radiations. In view of these findings, it would be desirable to extend these experiments to include the effects of fission neutrons on antibody responses to FTT, as commonly used in man, and to FTT given in complex with specific antibody.

Results: Irradiated mice (400-500 rads) recovered their capacity to respond to antigenic stimulation earlier (8-10 days) when FTT was given as a complex formed in antigen excess or at equivalence. When the same amount of FTT, as well as 10 times the dose, was given alone it was not possible to achieve primary immunization in irradiated animals. Enhanced primary antitoxin responses were also obtained when mice were primed with an FTT complex formed at equivalence and radiation (400 rads) was delivered one hour prior to a second injection of FTT on days 3, 6, 9 and 12 after primary immunization. In general the irradiated animals produced higher titers of antitoxin than control animals.

SUPPORTED BY U.S. Atomic Energy Commission

5.0538, RADIATION RECOVERY MECHANISMS OF G1 AND G2 CELLS IN THE MITOTIC CYCLE OF PISUM ROOT MERISTEMS

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The meristematic and embryonic cell long recognized as highly radiosensitive continues to remain enigmatic as to the basis of the hypersensitivity. At present, it is clear that two major functions of a dividing cell are affected. These are mitosis and DNA synthesis. The guiding hypothesis of the project is that ionizing radiation affects the mechanisms responsible for the regulation of mitosis and DNA synthesis and damages DNA itself. This implies the possible existence of two types of recovery mechanisms: one concerned with regulatory mechanisms and another with DNA repair. Recent evidence has demonstrated that the radiosensitive regulatory mechanisms are active before the onset of either DNA synthesis or mitosis and therefore take place in the G1 and G2 periods of the cycle; DNA repair presumably may take place throughout most of interphase. Most experimentation is conducted with excised pea root meristems in which DNA synthesis and mitosis are absolutely controlled. Analyses are performed primarily on the cellular and molecular levels utilizing radioisotopes, autoradiography, scintillation counting and density gradients.

Results: Experiments with G2 cells showed (1) that their capacity to complete one postirradiation mitosis and (2) that mitotic delay recovered in the absence of progression through the mitotic cycle. The kinetics of recovery suggested that each parameter reflected damage to different cellular systems. Inhibition of scheduled DNA synthesis with 5-fluorodeoxyuridine did not, while hypoxia did, prevent recovery from irradiation damage.

SUPPORTED BY U.S. Atomic Energy Commission

5.0539, ENVIRONMENTAL BIOLOGY - EFFECTS OF IONIZING RADIATION ON TERRESTRIAL ECOSYSTEMS

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Two principal field experiments have been established to provide comparative data on radiation effects from different ecosystems: one an herbaceous field characteristic of the early stages of succession following land abandonment; the second a forest, late in the succession. Structure is measured through a detailed inventory of the plant populations, an inventory which includes various estimates of plant condition and growth. This inventory, used with correlations to predict weight of plant parts, provides an estimate of living and dead standing crop at any time. Detailed studies of function use these data.

Results: From this work it is clear that: (1) there is a difference of between 5- and 10-fold in the sensitivity of field and forest, the forest being the more sensitive; (2) that this difference indicates a general trend, at least within the eastern part of North America: the early stages of plant succession are radioresistant, later stages more sensitive; (3) that this difference in the sensitivity of plant communities to radiation may parallel other environmental gradients, an observation that suggests a relationship between certain aspects of the ecology of plant: and their susceptibility to radiation; (4) that diversity is a more sensitive index of radiation damage to a plant community than any index incorporating abundance or density; and (5) that gradients of radiation intensity tend to sort species in natural communities according to several characteristics including stature (low-growing plants being resistant), chromosome size, and ploidy.

SUPPORTED BY U.S. Atomic Energy Commission

5.0540, ENVIRONMENTAL INTERACTIONS

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Effects of ionizing radiation on estuarine organisms are influenced by environmental conditions. Thus, our investigations of the effects of ionizing radiation fall into two categories: (1) the effect of interactions between radiation, temperature, and salinity on osmoregulation of the blue crab, Callinectes sapidus; and (2) the effect of continuous low levels of gamma irradiation on the survival, population growth, and physiology of estuarine organisms. The blue crabs used in these experiments will be subjected to a range of temperatures (12-28 degrees C.), salinities (5-35 p.p.t.), and radiation doses (5,000-40,000 Rads). Two types of experimental procedures will be used. First, the survival of crabs at various temperature-salinity- radiation combinations will be tested. Second, the effects of temperature-salinity-radiation combinations on osmoregulation will be followed. The osmoregulatory capabilities of the crabs will be determined by measuring levels of inorganic ions and free amino acids in the hemolymph. The effects of continuous low-level irradiation will be tested using three types of communities: (1) fouling community succession on a solid substrate, (2) estuarine microcosms, and (3) unicellular algal populations. All of the experiments will be designed so that the dose rates will range from 4.0 to 0.11 R/hr. The actual procedure for each community will vary with the community which is being investigated.

Results: The investigation of the influence of environmental factors on the radiation response of estuarine organisms has demonstrated that salinity and temperature interact with radiation to affect the survival and physiological balance of the estuarine fish, the mummichog. It also has been established that there is a wide range of radiation sensitivities among decapod crustacea (LD50-40 days for grass shrimp, 215 Rads, and for blue crabs, 42,000 Rads). Part 2 of 3.

SUPPORTED BY U.S. Atomic Energy Commission

5.0541, THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)
D.W. ENGEL, U.S. Dept. of the Interior, Bureau of Commercial Fisheries, *Beaufort, North Carolina* 28516

Ionizing radiation has always been a part of the natural environment; however, the advent of the atomic age has increased the amount of radioactivity in the environment. The marine environment is subject to possible radioactive contamination from the growing numbers of reactors as well as from fallout and waste disposal. Though it is known that marine organisms tend to concentrate radionuclides, very little is known about the effects of ionizing radiations on these organisms. A more complete understanding is needed of species sensitivities to radiation and specific physiological effects of acute and chronic exposures. This information will aid in predicting effects from radioactivity in the environment and in applying controlled irradiation to eradicate undesirable species or to breed desirabie species that are more resistant to environmental stresses. The purpose of this project is to describe the effects of acute and chronic doses of radiation from both internal and external sources on the physiology of marine organisms.

The effects of radiation may be death or alteration in some physiological or metabolic activity. In this investigation, LD-50's will be used to describe species sensitivity to radiation under varying conditions; while blood components, hematopoietic tissues, and respiration rates of whole organisms of tissues will be used as indices of radiation effects.

Sources of radiation will be by Cobalt-60 irradiators, an X-ray machine, labeled food, and administered radionuclides. Standard hematological and manometric techniques will be used to measure the various parameters. The marine teleost fishes used in this project will include Opsanus tau, Paralichthys sp., Pomatomus saltatrix, and Scomberomorus maculatus. The project will also encompass representatives of other groups of marine organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

5.0542, EFFECTS OF IONIZING RADIATION ON PLANT SPECIES, POPULATIONS AND ECOSYSTEMS
J.F. MCCORMICK, Univ. of North Carolina, Graduate School, *Chapel Hill, North Carolina* 27514 (AT(40-1))

The objectives of this project are to analyze the effects of gamma and beta radiations upon natural communities and upon populations of species which dominate these ecosystems. Herbaceous old fields have been exposed to gamma radiation for one month during each of four seasons in order to estimate the influence of season on radiation sensitivity. Results of a summer exposure of a pine forest to the same 9200 curie 137Cs source have been published. Results of a similar study in a tropical rain forest have been accepted for publication. The sensitivity of dominant species of these ecosystems (pine seedlings, old field weeds, palm trees) has been analyzed in the controlled environment laboratory and results are ready for publication. A study of radiostrontium cycling in a pine forest was also completed. Studies of the effects of beta radiation and simulated fallout upon a natural community have been initiated. Investigations of community structure, factors controlling structure, and community metabolism including carbon, energy, and water budgets have been completed. These natural granite outcrop communities were exposed to simulated fallout and beta radiation in the summer of 1969.

Results to date: Herbaceous old field communities are among the most radiation resistant terrestrial ecosystems. Radiation sensitivity varies with season and ecological factors greatly modify radiation sensitivity as estimated in the laboratory. The rain forest is more resistant to radiation than temperate forests studied. The pine forest is the most sensitive forest system studied and most coniferous forests would be destroyed in the event of a nuclear war.

SUPPORTED BY U.S. Atomic Energy Commission

5.0543, RECOVERY OF A PINE FOREST FOLLOWING EXPOSURE TO IONIZING RADIATION
J.F. MCCORMICK, Univ. of North Carolina, School of Arts, *Chapel Hill, North Carolina* 27514 (AT-(40-1)-3299)

In August, 1964 a 12 year old forest of loblolly and slash pine at the Savannah River Plant was exposed to 9200 curies of Cs137 for one month. All pines which received 3000R or more were killed and trees less than 5 ft. tall were killed by 500R or more. Herbaceous weed species invaded the opened forest area immediately and succession has followed an apparently normal pattern but at an unusually fast rate ever since. During the next year it is proposed to initiate quantitative analyses of community composition, tree growth, and analysis of seed and seedlings from irradiated parent trees.

Results: Approximately 3000 trees are identified with tags and pre and post radiation growth data are available. We have published the descriptions of damage produced and initial recovery during the year following irradiation of the forest. Now we wish to examine recovery during the subsequent 5 years. Part 1 of 6.

SUPPORTED BY U.S. Atomic Energy Commission

5.0544, RECOVERY OF A TROPICAL RAIN FOREST FOLLOWING EXPOSURE TO GAMMA RADIATON
J.F. MCCORMICK, Univ. of North Carolina, School of Arts, *Chapel Hill, North Carolina* 27514 (AT-(40-1)-3299)

In 1964 studies of seedling diversity and abundance were initiated in the El Verde forest with the idea that quantitative analyses of seedling populations would be a sensitive measure of radiation effects and more importantly, would serve as a means of predicting and measuring recovery since it would be seedlings which would produce the post radiation forest. It was predicted that 'Palicourea riperia' would be an important ground and shrub species following radiation as well as normal successional species such as 'Cecropia.' Permanent quadrats and sampling areas corresponding to the grid established for other studies have been censused three times since irradiation.

Results: The recovery pattern is as predicted. The canopy is dominated by 'Cecropia' and the shrub layer is a dense population of 'Palicourea'. It is unfortunate that the research papers describing these changes and the predictions were not permitted to be published or were delayed in publication. Part 2 of 6.

SUPPORTED BY U.S. Atomic Energy Commission

5.0545, RECOVERY OF A NATURAL PLANT COMMUNITY FOLLOWING EXPOSURE TO BETA RADIATION FROM SIMULATED FALLOUT PARTICLES
J.F. MCCORMICK, Univ. of North Carolina, School of Arts, *Chapel Hill, North Carolina* 27514 (AT-(40-1)-3299)

A natural plant community was exposed to beta radiation in the form of yttrium-90 coated fallout particles of 44 micron diameter. Specific activity was 4.74 mc/g and 10g/sq ft was evenly dispersed over granite outcrop communities measuring 20 sq ft in area to give average doses of 7000 rads over the following month. Community structure changed considerably due to death of terminal buds, reduced internode elongation and compensatory acceleration of lateral shoot growth in the dominant species 'Viquiera porteri'. Community metabolism did not change due to homeostatic adjustments in the physical structure of the community. Reproduction was affected via reduced and delayed germination of seed from apparently mutant flower heads. Species density, distribution, biomass, growth, diversity and reproduction will be analyzed during the next year in order to understand ecosystem recovery.

Results: A combination of beta bath and beta contact dose of 7000 rad inhibited reproduction, altered physical structure, but did not affect metabolism in a natural plant community exposed to 10 g/sq ft of simulated fallout particles having a specific activity of 4.74 mc/g. Part 3 of 6.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0546, GENETIC EFFECTS OF ACUTE BETA IRRADIATION FROM SIMULATED FALLOUT PARTICLES UPON NATURAL POPULATIONS OF VIGUIEPA PORTERI
J.F. MCCORMICK, Univ. of North Carolina, School of Arts, *Chapel Hill, North Carolina* 27514 (AT-(40-1)-3299)

Natural populations of 'Viguiera porteri' grown in the North Carolina Botanical Garden were treated with simulated fallout particles with a mean diameter of 44 microns and a specific activity of 4.74 mc/g. Beta bath doses and contact doses from the yttrium-90 coated particles averaged 7000 rads and reached maximum levels of 11,000 - 13,000 rads over one month. Two types of aberrant flower heads resulted, one apparently the result of somatic cell death and the other the result of a mutation in bud primordia. Seed from the latter type exhibited delayed and reduced germination. These seeds are being planted and two succeeding generations of these populations will be examined for mutant and aberrant growth and reproduction. All populations, those from normal flowers and seeds, those from heads which suffered somatic cell death, and those from apparently mutant flower heads are being grown in the North Carolina Controlled Environment Laboratory.

Results: Results revealed that the only seed which suffered delayed or reduced germination were those from flowers with more than the normal number of ray flowers. This aberrant type occurs with 3% frequency in normal populations and 60% frequency in the populations exposed to 7000 rads of beta radiation from fallout particles. Time required to germinate was doubled and percent germination was reduced by 30%. Part 4 of 6.

SUPPORTED BY U.S. Atomic Energy Commission

5.0547, THE NATURE OF RADIATION SENSITIVITY IN PINES
J.F. MCCORMICK, Univ. of North Carolina, School of Arts, *Chapel Hill, North Carolina* 27514 (AT-(40-1)-3299)

The radiation sensitivity of pine species can not be explained on the basis of the 'target theory' or 'nuclear volume' theory as can the radiation sensitivity of most plant species and many animal species. As in man, the response of pine species to radiation is a response to a complex set of conditions rather than to a single isolated stimulus. The hypothesis is presented that pines suffer from both the direct effects of radiation and simultaneously from indirect effects due to the production of ozone in air by ionizing radiation. Factorial analysis of pine species responses to varying levels and combinations of ozone and gamma radiation are underway. Pines are not only one of the most radiation sensitive groups of plants, but they are also one of the most ozone sensitive plant species.

Results: Results are limited to literature review, acquisition of equipment, design of the test system and formulation of the hypothesis offered above. Experimental results will be obtained within the following year. Part 5 of 6.

SUPPORTED BY U.S. Atomic Energy Commission

5.0548, EFFECTS OF GAMMA RADIATION ON HERBACEOUS SPECIES IN A NORTHERN HARDWOOD FOREST
J.F. MCCORMICK, Univ. of North Carolina, School of Arts, *Chapel Hill, North Carolina* 27514 (AT-(40-1)-3299)

Field census data and results of laboratory germination and growth studies are being used to describe the population dynamics of two important herbaceous species in the northern hardwood forest, 'Cornus canadensis' and 'Aster macrophylla.' Actuarial life tables and survivorship curves, similar to those insurance companies use to establish insurance rates, will be constructed in order to quantitatively describe population vitality and to predict future vitality. Following irradiation of the experimental site near Rhinelander, Wisconsin, the same type of data will be obtained to measure changes following irradiation. Reproduction, growth and metabolism are characteristics of particular importance which are being analyzed in the field, in the controlled environment laboratory and in the gamma field at Rhinelander.

Results: Both species reproduce asexually from underground stems as well as sexually. Sexual reproduction is primarily in open disturbed environments similar to conditions expected following irradiation. Asexual reproduction predominates. Both species should be important in ecosystem recovery from 5 months irradiation in 1971. Both species should increase in sexual reproduction following destruction of the forest canopy and both should survive in the irradiated forest due to the protected nature of underground meristems. Part 6 of 6.

SUPPORTED BY U.S. Atomic Energy Commission

5.0549, COMPARATIVE EFFECTS OF TWO RADIATION EXPOSURE REGIMES
D.G. WILLHOIT, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

The cell cycle parameters of intestinal crypt cells of mice are to be characterized for testing a dose-fractionating and dose-rate model developed previously on this project. Indications are that dose fractionation effects on animal survival time are compatible with a model based on intracellular repair and cell progression. Dose-rate effects, likewise, can be explained by a three component model consisting of terms for single-event inactivation, multiple-event inactivation, and repopulation due to cell division. Studies of dose- rate and dose fractionation on spleen colony formation are to be studied also to provide additional data to test the models.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0550, THE EFFECT OF RADIATION ON MUCOSAL PHOSPHOLIPASE ACTIVITY
F. BERNHEIM, Duke University, School of Medicine, *Durham, North Carolina* 27706 (AT(40-1))

The objective of the proposed research will be to investigate the effect of cytostatic agents and X-irradiation on the eosinophilic leukocytes of the bone marrow and intestine and to correlate these effects with variations in the phospholipases (lecithinase, phospholipase B) of these tissues. The background for this approach comes from the observation that a direct relationship between the number of the eosinophilic leukocytes and the enzymes exists for the spleen, uterus, peritoneal fluid and bone marrow of the rat. In the latter organ a relationship to the maturation process of these cells is indicated. Drugs to be used singly or in combination include bone marrow depressants, corticosteroids, epinephrine, protein synthesis inhibitors.

Results: A quantitative relationship between the number of eosinophilic leukocytes and the content in phospholipase B has been established for the spleen, uterus, peritoneal fluid and bone marrow of the rat. In these organs, a sharp decline in phospholipase activity and eosinophilic leukocyte population occurs after administration of cytotoxic drugs or exposure to 600 r whole body X-irradiation. The dependence of tissue levels of the enzyme upon the state of activity of the bone marrow is indicated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0551, STUDIES OF RADIATION PRODUCTS IN MATTER
W GORDY, Duke University, Graduate School, *Durham, North Carolina* 27706 (DA)

Technical Objective: To study the structure and properties of stable molecules and undamaged crystals and other materials. This research is concerned with analyzing the structure of single damaged molecules and understanding the series of events that lead to damage by ionizing radiation. This information is basic toward the understanding of radiation tolerance and operation of Army materiel ranging from electronic devices to prolonging the shelf life of food.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0552, ENERGY LOSS CHARACTERISTICS OF RADIATION IN MATTER

P.J. WALSH, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The objective of this research is to experimentally determine the range and energy loss characteristic of alpha particles in tissue and to investigate the relationships between these energy loss characteristics and the biological effects of alpha particles. The mechanisms of energy loss by alpha particles in tissue are fairly well understood, however, the connections between these energy loss mechanisms and the subsequent biological effects are not well understood.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0553, DNA REPAIR IN LYMPHOCYTES

A.T. HUANG, U.S. Veterans Administration, Hospital, *Durham, North Carolina* 27705

Over the past two years we have been very interested in the study of chronic lymphocytic leukemia leukocytes because of their increased lymphocyte counts with a normal DNA replication rate. Previously, we have demonstrated that in 15 patients with chronic lymphocytic leukemia studied for cellular DNA repair, a 16-fold enhancement of repair was found as compared to that of 9 normal individuals. This work was presented at the American Hematology Society meeting in Cleveland, Ohio in December 1969.

In collaboration with doctors R.B. Setlow and W.L. Carrier of Biophysics Section, Biology Division, Oak Ridge National Laboratory, we have further defined that the increased repair is due to an increased rate of excision of the DNA lesions by the leukemic lymphocytes.

This year, we propose to investigate the repair from damage caused by ultraviolet light at 254 nm and from X-ray and chemical agents. We will measure the rate of removal pyrimidine dimers from the UV- irradiated DNA as a measurement of DNA repair in various leukemias to compare with the normal lymphocytes. We will measure the recovery of the lymphocytes from X-ray and chemical damage by measuring the changes in molecular weight through alkaline sucrose gradient sedimentation. Currently, with the use of the blood cell separater, we were able to obtain leukemic lymphocytes in large amounts. The cells obtained through this method will be used in the assay and purification of the UV-specific endonuclease. This particular enzyme is essential for the initiation of DNA repair which has been purified in bacteria but not mammalian cells.

SUPPORTED BY U.S. Veterans Administration

5.0554, RADIATION GENETICS AND RADIATION RESISTANCE IN PEANUTS

D.A. EMERY, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607 (AT-(40-1)-1747)

Three investigations are in progress designed to improve mutation breeding methodology through (a) evolutionary plant breeding techniques using re-irradiation and bulk populations to enhance natural selection, (b) demonstrated comparisons of yield potential in large hybrid populations including both pre and post hybrid treatments with irradiation and (c) the early estimation of heterosis and combining ability in macro-mutant and macro-mutant x control hybrid populations exposed to a range of temperature treatments. The cultivated peanut is the test organism. Experiments will be conducted in both the field and phytotron.

RESULTS: Test populations have been developed to evaluate the progress via natural selection in the control and irradiated bulk populations of diverse lines of cultivated peanuts. Statistically significant interactions between macro-mutant and temperature were noted when seven macro-mutants and the unirradiated control were exposed as seedlings to temperatures ranging from 22 degrees C to 34 degrees C. Interrelationships among the 12 characters used in the assessment have also been determined.

SUPPORTED BY U.S. Atomic Energy Commission

5.0555, FUNDAMENTAL INVESTIGATIONS IN RADIATION POLYMER CHEMISTRY

V.T. STANNET, Univ. of North Carolina, School of Engineering, *Raleigh, North Carolina* 27600 (DA)

Technical Objective: Polmerization and copolymerization studies at high dose rates will be conducted. The proposed research has promise of contributing information needed by the Army both in the field of polymer chemistry and in radiation chemistry. Specifically, new materials may be generated and the behavior of materials exposed to radiation will be studied, such research should provide information on the stability of the properties of materials exposed to radiation.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0556, TIME-RADIATION DOSE RELATIONSHIPS TO BIOLOGIC DAMAGE

R.L. WITCOFSKI, Wake Forest University, School of Medicine, *Winston Salem, North Carolina* 27103

We are attempting to determine whether there is a time-dose relationship in the response of a biologic system to radiation delivered by clinically important radionuclides. The use of ever shorter half- lived radionuclides in nuclear medicine is based on the concept that a somewhat larger amount of short-lived radionuclides can be given to patients than is possible with longer-lived radioisotopes yielding both better diagnostic tests and less total radiation dose. The regenerating rat liver was proposed as a model system to test the effectiveness of these radiations. Replicate experiments using closely matched untreated animals have demonstrated great variability among animals killed at the same time as well as variability between experiments when DNA synthesis and mitosis were studied. A dose of 500 rads during the early stages of regeneration only reduced the levels of DNA synthesis whereas it completely inhibited mitosis. A dose of 250 rads results in reduction in levels of mitosis but does not completely inhibit mitosis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0557, BIOLOGICAL EFFECTS OF LOW VELOCITY ELECTRONS

G.S. SPERTI, Inst. Divi Thomae, *Cincinnati, Ohio* 45206

The previous studies on the effects of 100-1000 volt electrons on the activity of trypsin (on TAME as substrate) will be extended to try to determine the nature of the 300 volt activation (using electrophoresis, thin layer chromatography, and spectroscopy) with particular attention to the two components observed in the trypsin. The inactivation at higher voltages will also be studied, particularly in terms of breakage of disulfide bonds, and compared with ultraviolet inactivation. The relative sensitivity to electron bombardment of sulfhydryl-dependent enzymes (such as glyceraldehyde-3-phosphate dehydrogenase) will also be investigated in view of the fact that trypsin and catalase, which have been studied, are not sulfhydryl- dependent.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0558, STUDIES ON THE MECHANISM OF THE EFFECT OF IONIZING RADIATIONS ON THE OLFACTORY SYSTEM

G.P. COOPER, Univ. of Cincinnati, School of Medicine, *Cincinnati, Ohio* 45221 (AT(11-1)-1669)

Three experiments are proposed which are aimed at identifying the radiation-produced olfactory stimulus and at examining possible deleterious effects of X-ray and ozone on other mucous membranes of the respiratory tract: (1) In experiments with rats response of olfactory bulb neurons to X-ray, ozone, and odor will be compared to determine whether ozone or a similar agent is the radiation-produced stimulus. (2) The spatial-avoidance test, in which rats show a preference for the shielded, unirradiated half of a test chamber, will be used to determine (a) whether olfactory

stimulation serves as a conditional stimulus, (b) whether the olfactory stimulus is a neutral one or is noxious, and (c) whether ozone in the test chamber will mask the effects of X-ray so that rats fail to condition. (3) In experiments with guinea pigs, the known capacity of ozone to potentiate histamine-induced respiratory distress and death will be used to advantage. Animals will be exposed to X-ray, ozone, or X-ray and ozone to determine whether the effects of x-ray and ozone are similar and if so whether their effects are additive.

The response of olfactory bulb neurons to X-rays is constant for nasal oxygen concentrations from 100 per cent down to about 2 per cent. Below 2 per cent the response diminishes significantly. Responses to odor are little affected by changes in nasal oxygen concentration.

Lightly anesthetized and unanesthetized rats show immediate acceleration of respiratory rate upon exposure to X-rays. Olfactory stimulation by X-rays is mainly responsible since rats with olfactory bulb ablations do not respond.

SUPPORTED BY U.S. Atomic Energy Commission

5.0559, HUMAN EYE LASER THRESHOLDS FOR AIR FORCE OPERATIONAL PERSONNEL
K. ROWE, Univ. of Cincinnati, Childrens Hospital, *Cincinnati, Ohio* 45229 (F41609-69-C-0052)

Technical Objective: Air Force safety criteria for the several laser systems proposed or in use are based on animal test data. Additional confidence in procedures for extrapolating this data to air crews is required. This effort will provide the needed information by conducting R more than D to determine energy levels of laser radiation necessary to produce minimum threshold retinal lesions and permanent functional damage in human eyes for the establishment of air force safety criteria.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0560, RADIATION EFFECTS ON CELL AND POPULATIONS DYNAMICS OF U-12 FIBROBLASTS
H.L. FRIEDELL, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (W-31-109-ENG-78)

The population dynamics of synchronized strain U-12 mammalian cells is being investigated from the point of view of the various activities of single cells, such as division, division failure, division delay, giant cell formation or cell death and the time distribution of these activities after low doses of ionizing radiation, measured through the use of time lapse photomicrography. Detailed population growth curves are being determined in order to obtain population measures of the radiation induced division delay, population doubling time, population deficit and fate of synchrony decay which can be compared with the averages of observations on individual cells. Studies on the effect of the shape of the interdivision time distribution on the log phase population doubling time are also being continued. Part 3 of 16.

SUPPORTED BY U.S. Atomic Energy Commission

5.0561, INVESTIGATIONS OF THE BIOLOGICAL EFFECTS OF RADIATION - A MULTI-DISCIPLINE APPROACH
H.L. FRIEDELL, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (W-31-109-ENG-78)

This is a broad, multi-disciplinary program of biomedical research aimed at the achievement of a better understanding of radio-biologic phenomena and the development of improved methods in nuclear medicine.

It includes studies in radiation physics, radiation biophysics, radiation biochemistry, radiation biology, modification of radiation response, and nuclear medicine. Major emphasis centers on the study of cell replication and the manner in which replicative activity is affected by ionizing and ultraviolet radiation.

A continuing effort is devoted to the development of new instruments for use in nuclear medicine, dosimetry, and radiological research. Part 1 of 22.

SUPPORTED BY U.S. Atomic Energy Commission

5.0562, RADIATION RESPONSE OF THE CELL MEMBRANE
H.L. FRIEDELL, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (W-31-109-ENG-78)

It is proposed that high doses of ionizing radiation can affect directly the permeability of the cell membrane to different molecules and ions, such as Na and K ions, while small doses (approx. 200 R) can affect the timing of a scheduled change in the state of the membrane; the effect of small doses is presumed to be the result of an altered rate of progression through the cell cycle in irradiated cells.

Synchronized mouse lymphoblasts (strain L5178-Y cells), which display cyclic oscillations of intracellular sodium and potassium, will be exposed to a large range of doses of ionizing radiations at different times during the cell cycle. The membrane permeabilities to Na and K ions will be observed following irradiation and compared with those in unirradiated cells. Part 7 of 16.

SUPPORTED BY U.S. Atomic Energy Commission

5.0563, COMPARISON OF RADIATION AND OXYGEN EFFECTS ON CELLS
H.L. FRIEDELL, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (W-31-109-ENG-78)

According to some investigators ionizing radiation and increased levels of oxygen have similar effects on biological materials, therefore, radiation studies will be combined with oxygen toxicity studies to determine whether there is a correlation between the morphological alterations caused by high levels of oxygen and by radiation. Work is now in progress to compare the effects of radiation and oxygen on cells using such parameters as nuclear and cell morphology, nucleolar morphology, generation time, and inhibition of the mitotic process. Part 12 of 22.

SUPPORTED BY U.S. Atomic Energy Commission

5.0564, THE RELATIONSHIP OF RADIATION SENSITIVITY TO ALTERATIONS IN THE DNA OF B. SUBTILIS
H.L. FRIEDELL, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (W-31-109-ENG-78)

We have previously detected two types of spores occurring during the sporulation-germination process of B. subtilis. These spore types differ in density, heat resistance, germination rate, and the properties of their DNA. We plan to investigate the order of appearance of the two spore types and study the changes in spore DNA structure and function with time during the sporulation process. Sensitivity of the two spore types to UV- and ionizing radiations will be correlated with changes produced in the spore DNA by the radiation.

We also plan to study the fate of irradiated donor DNA in the B. subtilis transformation system. Uptake into receptor cells, subsequent degradation, and recombination with receptor DNA will be determined and compared to results with non-irradiated donor DNA. The success of this investigation will depend largely upon our ability to obtain highly competent cultures of B. subtilis. Part 9 of 16.

SUPPORTED BY U.S. Atomic Energy Commission

5.0565, TRANSCRIPTION OF RNA & TRANSLATION OF ENZYMES DURING MITOTIC CYCLE OF PHYSARUM POLYCEPHALUM & RADIATION EFFECTS (ABBREV)
H.L. FRIEDELL, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (W-31-109-ENG-78)

We wish to demonstrate the synthesis of unique messenger RNA fractions at various times during the mitotic cycle of Physarum by use of hybridization competition experiments. So far, we have been unsuccessful in these attempts, possibly because of non-specific annealing of RNA fractions to regions of the DNA other than that from which they were transcribed. Conditions of hybrid formation will be varied to eliminate such non-

specific annealing if it occurs. If the synthesis of unique RNA fractions can be detected, we plan 1) to study the relationship of this synthesis to other cyclic events, 2) to determine whether irradiation inhibits the synthesis of one or more of these fractions, and 3) if such an effect can be related to the delay in mitosis caused by irradiation.

The time of transcription and translation of various specific step enzymes will also be determined throughout the mitotic cycle by measuring the effect of timed addition of inhibitors of RNA and protein synthesis on the increase of enzymatic activity. The plasmodia will then be exposed to ionizing radiation before, during, and after the transcription and translation processes with the objective of identifying the site of radiation damage. Part 11 of 16.

SUPPORTED BY U.S. Atomic Energy Commission

5.0566, PHASE 1 - FISSION PRODUCT METABOLISM AND RESPONSE IN LABORATORY AND DOMESTIC ANIMALS - FISSION PRODUCT STUDIES

F.W. LENGEMANN, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (AT(30-1))

The general objectives are to develop data relevant to coping with problems that may arise from radioactive contamination of the environment from any possible source. The main areas of study include: (a) expansion and refinement of models for prediction of intake commitments of radionuclides from milk (these are based on experimental data from cows, (b) metabolism of cesium and cerium in laboratory animals (c) prediction equations and metabolic patterns for strontium 90, (d) maintenance and ongoing evaluation of literature relative to environmental contamination.

Results: A generalized estimate of potential harm to man can be made based on the concept of the 'critical factors' and knowledge of metabolism and movement or environmental radiocontaminants in the biosphere. The need has become apparent, however, to consider special local conditions and attempt to estimate effects at low levels that may not be directly observable. Part 4 of 7.

SUPPORTED BY U.S. Atomic Energy Commission

5.0567, RADIATION-INDUCED MITOTIC DELAY

R.C. RUSTAD, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (W-31-109-ENG-78)

We have previously demonstrated that radiation damage to either the cytoplasm or some more sensitive component of the mitotic apparatus leads to division delay of sea urchin eggs and that gamma-ray damage to sperm is expressed differently in whole eggs and nucleate and enucleated half-eggs. Prefertilization and postfertilization recovery from gamma- ray damage leading to mitotic delay is inhibited with puromycin. Furthermore, we have discovered that prefertilization stimulation of protein synthesis 'cures' gamma-ray induced mitotic delay. Experiments will be performed to discriminate between the possibilities that this 'cure' reflects the synthesis of enzymes for recovery ('repairases') or the completion before fertilization of radiation-sensitive mitotic events. In addition, we will continue using puromycin to study the role of protein synthesis in the recovery from radiation damage during the mitotic cycle with special reference to 'unscheduled DNA synthesis' in HeLa cells. Part 4 of 16.

SUPPORTED BY U.S. Atomic Energy Commission

5.0568, STUDY OF THE LATENT EFFECTS OF GAMMA IRRADIATION ON HUMAN ENAMEL

R.L. MOSS, U.S. Veterans Administration, Center, *Dayton Ohio* 45428

The purpose of this study was to accumulate experimental evidence of the in vitro effect of controlled gamma radiation on extracted human teeth.

Progress: From contributing VA Hospitals, specimen have been collected from fourteen patients who were treated with gamma radiation therapy for neoplastic disease in or adjacent to the oral cavity. Specimen consist of assorted dentition taken from the patients several months post-radiation therapy. Most patients had clinical symptoms of 'radiation caries.'

Investigation for post-radiation enamel deterioration is made by immersion of specimen into a solution of radioactive isotope (S35) and gentian violet dye. Teeth are mounted in bioplastic and planoparallel serial sections are cut. Selected sections are submitted for auto- radiographs to determine isotope penetration into the enamel. Other sections are examined macroscopically to visualize dye penetration into the enamel. Autoradiographs and photographs of the specimen have been assembled.

Macroscopically, loss of peripheral surface layers of enamel is evident in many specimens. Dissolution of enamel surfaces is seen in areas that are not characteristically susceptible to the normal caries process. Structural alteration appears as a fairly uniform zone of surface porosity as demonstrated by both isotope and dye penetrations. Equivalent penetration is not seen in active carious lesions.

It is suggested that the surface porosity results after the elution of calcium and phosphorus from the hydroxapatite structure. Elution of these ions has been shown in a previous study of in vivo gamma irradiation of teeth.

Proposed direction of research: Project to be terminated. Manuscript in preparation.

SUPPORTED BY U.S. Veterans Administration

5.0569, EFFECT OF PH ON CALCIUM AND PHOSPHORUS DEMINERALIZATION OF IRRADIATED TOOTH ENAMEL

R.L. MOSS, U.S. Veterans Administration, Center, *Dayton, Ohio* 45428

Summary: This is a continuation of an ongoing study of the latent effects of irradition on human teeth. Data has been collected which demonstrates an alteration in the integrity of the enamel surface following exposure to gamma radiation. Laboratory investigation of postradiation enamel deterioration was made by immersion of specimen into radioactive isotope (S-35) and crystal violet dye. Autoradiographs and macroscopic photographs were made of serial planoparallel sections. Physical alteration of peripheral layers of enamel structure could be demonstrated in this clinical material.

Data was reported which indicated that in vitro radiation of teeth produed increased rates of enamel demineralization. It was shown that 250 KVP, 5000 r delivered in a single dose caused negligible changes in calcium and phosphorus elution rates over a 12-month period. Five- thousand r delivered in fractionated doses caused calcium and phosphorus elution at high rates.

Alteration of the pH in the postradiation oral environment has been implicated as contributory to the process of tooth deterioration. This project has been designed to study the in vitro effects of pH environments upon irradiated specimen. Calcium and phosphorus demineralization rates will be determined over a twelve-month period. Specimen will be compared with control and previous data for evidence of structural alteration.

Methods and Materials: A random specimen pool has been collected of 80 unerupted teeth. These were frozen in demineralized water immediately after extraction. Since the teeth have not been in an oral environment, the enamel surface diffusion layers are presumed to have equivalent mineralization-demineralization rates.

At conclusion of demineralization studies, selected specimens were immersed for 24 hours into a radioactive solution (S-35) and crystal violet. Specimens were embedded into plastic matrix and serial sections were cut for penetration studies by autoradiography and for macroscopic examination.

SUPPORTED BY U.S. Veterans Administration

5.0570, CHARACTERIZATION OF SOIL & VEGETATION TO SERVE AS A BASIS FOR FUTURE EVALUATIONS OF RADIOACTIVE CONTAMINATION EFFECTS (ABBREV)

F. HAGHIRI, Ohio Agric. Res. & Dev. Center, *Wooster, Ohio* 44691 (AT(11-1))

Studies on the effect of soil and crop management practices on the removal of Sr 90 by runoff, leachate water and plant uptake under field conditions will be continued. Effect of paraquat

on Sr retention by organic matter and isotopic equilibration of Sr 90 sorganic matter and Sr ion will be studied. Effect of burning of vegetation containing Sr on the chemical behavior of Sr ion will be investigated. The ashing is to simulate forest fire and burning of crop residues. The ratio of inorganic anions to organic anions Sr will be determined and the various anions associated with Sr will be identified. The availability of Sr from ashed and dried plant materials in the soil to plants will be determined by using Stanford-Dement technique. In addition the movement of the Sr, from both ashed and dried plant sources, in the soil profile will be studied.

SUPPORTED BY U.S. Atomic Energy Commission

5.0571, EFFECTS OF PRENATAL AND EARLY POST-NATAL IRRADIATION

W. FRIEDBERG, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma*

Radiation sensitivity appears to be greatest during prenatal development and in the young. The proposed research will provide information useful in assessing the risk to the embryo, fetus and child of injury from solar flare radiation.

Relative effects of fission neutrons (high LET) and 250 KV X-rays (low LET) will be compared. The neutron source will be the Oak Ridge National Laboratory Health Physics Reactor (DOSAR). X-irradiation will be carried out in Oak Bidge and the Civil Aeromedical Institute. Initially, we plan to expose pregnant mice to single acute radiation doses of neutrons or X-rays in the range 1-100 rads on specific days after conception. Effects of fractionated irradiation will be investigated in later studies. Anomalies in the embryo and fetus, litter size and growth and development after birth will be studied. Tissue samples will be collected at selected times before and after birth for histological evaluation.

Mouse embryos at the one-cell stage of development were exposed to fission neutrons. This was accomplished by irradiating pregnant mice at about 0.5 day after mating. A few days before the end of the gestation period the embryos were examined and compared with nonirradiated controls. Results obtained to date indicate that as the neutron absorbed dose was increased from 2 to 5 to 10 to 20 rads, prenatal survival decreased. In this range, survival appears to be an exponential function of radiation dose with a D37 of 19 rads and an extrapolation number of 1.05. D37 is the radiation dose that will reduce a cell population to 37 percent on the exponential portion of a survival curve. Implantation of the mouse embryo occurs about 4.5 days after fertilization of the ovum; a resorption mole is the remains of an embryo that died within a few days after implantation. From the number of resorption moles and the total number of dead embryos, we conclude that more than 92 percent of the postimplantation deaths occurred before about day 10 in the 19 day gestation period. The data indicate that both preimplantation and postimplantation deaths increase with increase in radiation dose. Very few live embryos were seen with gross anomalies; two embryos with exencephalia (brain hernia) were found among the sham-irradiated controls.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

5.0572, RESPONSE OF CELLS TO MAGNETIC FIELDS AND X-RAYS

G.D. ADAMS, U.S. Veterans Administration, Hospital, *Oklahoma City, Oklahoma* 73104

The general problem under investigation is the elucidation of effects which a constant magnetic field may have on biological systems, and particularly as a modifier of radiation injury.

In the first series of experiments, HeLa cells in culture constituted the biological system and the scoring was on the basis of individual cells to maintain proliferative capacity -- to grow to clones of at least 50 cells in 10 days. Generally, the magnetic field in the absence of radiation has small deleterious effect, yet was a protective agent in the presence of radiation. Precise quantitation has been difficult for technical reasons. Further experiments along this line are temporarily suspended a) to palliate the technical difficulties and b) to search in other biological systems for other remarkable duality in the behavior of magnetic field and radiation combinations. Preliminary results were reported to IVth International Congress of Radiation Research, Evian, France,. July 1970.

A new series of experiments has been started involving Swiss Webster mice as the biological system. Longevity and histopathologic changes are scored. All mice are irradiated and we study the effect of adding magnetic field during exposure, or of the chemical radiation modifier L-cystein, or of both together. Addition of magnetic field elicits a few earlier deaths but yet acts as a partial protective agent for a whole population. The L-cystein experiments are equivocal, in part due to the difficulty in obtaining the drug usable form. Preliminary results from these experiments were to be reported at the annual meeting of the Radiation Research Society, May 1971.

SUPPORTED BY U.S. Veterans Administration

5.0573, ULTRAVIOLET INDUCED BIOCHEMICAL CHANGES IN SKIN

M.A. EVERETT, U.S. Veterans Administration, Hospital, *Oklahoma City, Oklahoma* 73104

Experimental procedures done at the VA encompassed some limited column chromatography and the actual C-14 counting.

It has been found that cis urocanic acid (UCA), formed from trans UCA in solution and in vivo by UV irradiation, is effectively excreted unchanged in the urine when administered by feeding or by intraperitoneal injection.

It has been shown that UV irradiaton of trans UCA in frozen solutions forms a dimeric product. The isomeric configuration of the dimer formed is dependent on the pH of the solution that is frozen for UV irradiation. When administered by intraperitoneal injection, the dimer formed from alkaline (pH 8.0) solutions is promptly and efficiently excreted in the urine by rats, whereas the dimer formed from solutions that are pH 5.9 is excreted largely by the liver via the bile duct into the feces. The efficiency of extraction by liver appears to be a genetic trait.

Current degradative studies have indicated that the dimers formed from UCA do contain a cyclobutane moiety as anicipated by analogy to the photochemistry of other gamma substituted acrylic acids.

The 'alkaline dimer' has all the trans configuration in the 1,3

$ series, while the 5.9 dimer has a cis-trans-cis configuration and belongs to the 1,2 series. As yet a procedure has not been found which will distinguish in vitro the 'alkaline dimer' from the '5.9' dimer, even though rats or guinea pigs excrete them by different routes.

SUPPORTED BY U.S. Veterans Administration

5.0574, ULTRAVIOLET INDUCED BIOCHEMICAL CHANGES IN SKIN

J.H. ANGLIN, Univ. of Oklahoma, School of Medicine, *Oklahoma City, Oklahoma* 73104

Isolation, purification and characterization of a long wavelength UV absorbing chromophore from irradiated skin and hair as well as studies concerning fluorescence emissions from periodic group IB mercaptides be continued.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0575, EFFECTS OF RADIATION ON PERMEABILITY AND ENZYMES OF SKIN

R.L. OLSON, Univ. of Oklahoma, School of Medicine, *Oklahoma City, Oklahoma* 73104 (AT(40-1))

We are investigating the penetration and distribution of various exogenous substances in normal and irradiated human skin. Relationships of these substances to lysosomes have been evaluated by electron microscopic histochemical techniques employing acid phosphatase and aryl sulfatase reactions. Lysosomes are being studied in acute and chronic skin injury in subjects of varied complexion and races. The effect of abnormal keratinization, found in chronic ultraviolet damaged skin, upon epidermal enzymes and permeability will be studied.

Results: We have described the intercellular circulation of macromolecules, epidermal phagocytosis of macromolecules, the

presence within epidermal lysosomes of acid phosphatase, the relationship of lysosomal enzymes to keratinization, the dispersal of lysosomal contents following ultraviolet injury, dyskeratosis in chronic ultraviolet damaged skin and other aspects of epidermal change following ultraviolet injury.

SUPPORTED BY U.S. Atomic Energy Commission

5.0576, RADIATION CHEMISTRY, PHOTOCHEMISTRY AND EXCITED STATES OF A) OXYANIONS, B) D.N.A
M. DANIELS, Oregon State University, Graduate School, *Corvallis, Oregon* 97331 (AT(45-1))

Objective: (1) To study the free radical reactions and transient species in the radiolysis and photolysis of oxyanions, to determine the mechanism of the 'direct effect' in aqueous solution, to investigate the role of excitation processes and energy transfer in the 'direct effect,' and the mechanism of U.V. photolysis. (2) To investigate the mechanisms of gamma radiolysis and U.V. photolysis of D.N.A. and related compounds.

Background: The aqueous anion systems are sufficiently simple to allow the possibility of complete accounting, and also exhibit strong 'direct effects.' The correlation of dilute solutions radiolytic studies with U.V. photolytic work may allow the detailed elucidation of the mechanism of the 'direct effect.'

The investigation of the radiolysis and photolysis of D.N.A. is fundamental to understanding the radiobiological effects involving D.N.A. It is proposed to examine the nature and role of various excited states and transient species by a) emission and b) flash photolysis studies.

Procedure: The radiolysis and photolysis of N03 ion will be investigated by standard procedures;O18 techniques will be developed.

Short-lived emission of pyridine components of D.N.A. will be quantitatively investigated and correlated with absorption spectra studies. Fluorescence behavior will be correlated with photochemical behavior and flash photolysis results.

SUPPORTED BY U.S. Atomic Energy Commission

5.0577, NEURAL DETECTION OF IONIZING RADIATIONS
D.J. KIMELDORF, Oregon State University, School of Science, *Corvallis, Oregon* 97331

There is reasonable evidence to indicate that the nervous system can respond to very small doses of ionizing radiations. No receptor is known for which ionizing radiation is the adequate stimulus, but radiation may be an effective stimulus for several receptor systems. Evidence for this point of view, however, is limited. Most of this work has been done in animal species that possess highly differentiated and complexly organized nervous systems. The present study is intended to provide a better basis for interpretation of ionizing radiation as a physiologic stimulus through a phylogenic study of prompt behavioral and neural reactions to small doses, their relative sensitivity, and the probable mechanisms through which these reactions occur. The study of mechanisms for biodetection in simpler systems can provide information that is instructive regarding the extent to which the efficiency of detection is dependent on the degree of neural organization and receptor specialization. Selected species will be exposed to ionizing radiation (X-rays, beta rays, gamma rays) under highly controlled conditions. Prompt reactions to exposure will be identified and analyzed from videotape recordings and assessed quantitatively by coupling with transducers and related sensor systems. Estimates of threshold intensities and dose will be derived from these data. Biodetection in responsive organisms will be investigated by several concurrent methods used to identify the receptor mechanisms. These involve exposure of specific sites, electrophysiological investigation of neural pathways, isolation of neuromotor systems, and comparisons with the action of other stimuli for the same response. The manner in which representative organisms of several phyla are informed about their own exposure can establish the systems that might, under certain conditions, serve usefully as biodetectors for the presence of ionizing radiations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0578, UV MICROBEAM STUDIES OF MITOSIS
A.S. BAJER, Univ. of Oregon, Graduate School, *Eugene, Oregon* 97403 (AT(45-1))

The work combines studies in vitro with subsequent use of electron micrcroscope. The purpose of this final stage of research is to show that microtubules (MTs) are damaged within seconds after UV microbeam irradiation. It appeared that MTs disappear shortly after irradiation. However, a low depth of focus (about 2-3 microns) makes it difficult to pinpoint vertically the irradiated region due to variable optical conditions and UV absorption. Therefore, the following experiment will be done: bridges will be produced in metaphase on chromosome arms close to kinetechores. When such chromosomes begin to be stretched in anaphase, one of the kinetochores (and/or kinetochore fibers) will again be irradiated, the cell fixed, and the region located in electron microscope. Several experiments in vitro were already done. In these experiments, the kinetochore fiber is inactivated and non-disjunction follows. Efforts will be made to irradiate only a selected chromosome without affecting the others. Due to variation in chromosome arrangements in different cells, selection of appropriate cells for studies in vitro appear especially time consuming.

SUPPORTED BY U.S. Atomic Energy Commission

5.0579, RADIATION EFFECTS ON NUCLEIC ACIDS AND PROTECTION
G.J. KOLLMANN, Albert Einstein Medical Center, *Philadelphia, Pennsylvania* 19141

The proposed project involves continued study on he mechanism of protection of nucleic acids against the effects of ionizing radiation.

The 'in vitro' synthesis of RNA with irradiated and control templates will be further investigated. Radioactive precursors labelled with C-14 atom will be used to establish the overall syntheses. The results obtained will be compared to experiments carried out with P-32 labelled (Beta, Gamma) positions precursors. Both experiments will be conducted with control and irradiated templates. The ratios of P-32 to C-14 in the resulting polymers will indicate the effects of radiation on the initiation vs. the propagation steps. The experiments described above will then be carried out with protected and unprotected DNA templates, with bis(2-guanidoethyl) disulfide (GED) used as the protective agent.

The effects of radiation on DNA synthesis 'in vitro' will be investigated in the presence and the absence of protective agent. The results of these experiments will then be contrasted against the results obtained with the RNA syntheses. It is anticipated that this line of investigation will indicate at least part of the damage suffered by DNA, when irradiated, and whether effective protection against such damage can be achieved.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0580, RADIATION EFFECTS ON ERYTHROCYTE SODIUM AND POTASSIUM
B. SHAPIRO, Albert Einstein Medical Center, *Philadelphia, Pennsylvania* 19141

Earlier studies have shown that radiation induced alteration of erythrocyte permeability is accompanied by oxidation of membrane sulfhydryl groups. How this chemical change alters the K-Na barrier in the cell membrane is unknown. It can be partially reversed by reducing the disulfides formed. To further study this phenomenon, labelled agents which bind covalently to the erythrocyte membrane will be applied as markers before and after radiation. The membrane will then be dissolved and components separated. Membrane components affected by radiation will be studied for their identity and the nature of the radiation induced change. It is hoped that this information will help to elucidate the mechanism of radiation damage to cell membranes.

5. RADIATION

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0581, IN VITRO EFFECTS OF IONIZING RADIATION ON GERMINAL EPITHELIUM OF HUMAN TESTIS & ON STEROID BIOSYNTHESIS OF LEYDIG CELLS
E. STEINBERGER, Albert Einstein Medical Center, *Philadelphia, Pennsylvania* 19141 (AT(30-1))

The objective of this study is to investigate the effect of ionizing radiation on human testicular tissue grown in vitro in the form of organ culture or cell culture. From animal studies, as well as from rather limited investigations in man, it is known that ionizing radiation at certain dose levels affects the spermatogonial germ cells primarily. The in vitro system developed in our laboratory we hope will permit us to define with greater precision the exact cell type affected directly by the radiation, the progression of damage and possible recovery. The effect on the germinal epithelium will be studied cytologically; the effect on Leydig cells and Sertoli cells will be evaluated from the viewpoint of their ability to synthesize steroid hormones, and also their ability to synthesize protein. The conventional radiochemical techniques for steroid studies and protein studies will be employed.

Results: The techniques necessary for this study have been set up. A number of cultures of human testes have been exposed to different doses of ionizing radiation. Cytologic and biochemical studies of these cultures are in progress.

SUPPORTED BY U.S. Atomic Energy Commission

5.0582, EFFECT OF IONIZING RADIATION ON THE DISTRIBUTION OF DEOXYRIBONUCLEASES AND PHOSPHATASES IN SUBCELLULAR FRACTIONS OF GUINEA PIG EPIDERMIS
J. TABACHNICK, Albert Einstein Medical Center, *Philadelphia, Pennsylvania* 19141 (AT(30-1))

After 3000 rep beta-irradiation (90Sr-90 Y) to guinea pig skin, assay of epidermal homogenates showed increases in lysosomal enzymes occurred after cell death (Radiation Res. 32, 293, 1967); thus, we have turned our attention to 'activation' of nonlysosomal hydrolases as a possible cause of radiation cell death. Our major objective is to elucidate the mechanism(s) for the early increase in extracellular epidermal DNase I after radiation injury (Radiation Res. 23, 594, 1964), or other skin trauma (J. Invest. Dermatol. 46, 555, 1966). Histologic changes indicate that the enzyme originates either in the epidermis or the blood via damaged peripheral capillaries, or both. Of five possible mechanisms considered, evidence to date suggests that either a release of preformed enzyme from epidermal cell organelles or an increase in the rate of DNase I synthesis are the two most likely possibilities. Experiments are planned to determine which of the two plays a major role. These findings should give some clue regarding possible 'activation' of this critical enzyme in other irradiated tissues where free DNase I inhibitor is a complicating factor.

SUPPORTED BY U.S. Atomic Energy Commission

5.0583, RADIOBIOLOGY RESEARCH PROGRAM
A.D. CONGER, Temple University, School of Medicine, *Philadelphia, Pennsylvania* 19122

1). Radiation damage to taste buds and acuity: A. Fine structure of radiation damage to taste buds: It is already known that radiadion causes loss of taste buds and cells and of taste acuity, probably by damage to the neurotrophic function of the taste nerves. Electron microscope study of the fine structure change in buds (loss of nerves, cells, and taste cell tips) after irradiation will be made. B. Effect of genetic neural defects on taste structure: Various neurological mutants, mostly myelin deficiencies, in mice will be examined to see if they cause also a deficiency in taste structure, and perhaps even enhanced radiosensitivity for taste bud loss.

2). Micro radiography of the microcirculation: A special contrast medium (30% lead oxide of micron-size particles in 10% gelatin, which is rapidly lethal) injected under controlled pressure in mice gives good filling of the capillary bed without leakage. High resolution microradiography reveals the vascular bed. This method will be used to study radiation damage to the circulatory bed in various body areas.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0584, STUDIES ON UV RADIATION CARCINOGENESIS IN MICE
P.D. FORBES, Temple University, School of Medicine, *Philadelphia, Pennsylvania* 19122

The work to be supported during this project period has as its aim the further clarifaication of several conditions and events leading to radiocarcinogenesis. Ultraviolet radiation is causally involved with the origin of some experimental and human skin neoplasia, but many basic questions about the mechanism remain to be answered. A number of problems are open to experimentation, and this project is designed to investigate the following: 1. What are the dose and dose- rate parameters for experimental carcinogenesis? What is the significance of erythema and inflammation in pre-malignant changes? 2. Regarding action spectra: How effective are different wave lengths? What are the physical limitations of penetration, absorption? What are the anatomic and physiologic contributions of epidermis and dermis in carcinogenesis? 3. How effective are pigmentation and other inherited factors in influencing the course of U.V. -carcinogenesis? 4. Can U.V. radiation act as one of the agents in 2-phase carcinogenesis (initiator, promoter, or both?)

In addition, efforts will continue in relating radiation effects on skin carcinogenesis and such cell proliferation models as hair growth and epidermal turnover time.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0585, THE BIOLOGICAL EFFECTS OF ENVIRONMENTAL RADIATION
F. URBACH, Temple University, School of Medicine, *Philadelphia, Pennsylvania* 19122

The program on 'Biologic Effects of Environmental Radiation' consists of a supporting Core Project and several projects in Innstrumentation (design of light sources and measurement devices, U. V. Photography, action spectra); Photochemistry (of bilirubin and chemical carcinogens); cutaneous biology amd Animal Models); (Radiation and Genetics of Animal Models); environmental Photobiology (therapeutic uses of light, study of phototoxic and photo allergic agents); and Ultra Violet Light and Skin Cancer (effect of UVL on benign and malignant tumors, Genetics and Epidemiology of skin cancer in man).

These projects are coordinated and support each other with man power and specialized equipment.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0586, PROBLEMS IN RADIATION EMBRYOLOGY
R.L. BRENT, Thomas Jefferson University, School of Medicine, *Philadelphia, Pennsylvania* 19107 (AT(30-1)-2071)

The purpose of this research project is to determine whether the mammalian embryo is more sensitive to the tumorogenic and life shortening effects of X-irradiation than is the same organism when irradiated after parturition (mouse). Secondly, the importance of dose rate will be evaluated with regard to determining the rate of recovery of irradiated embryos during the postnatal period. Thirdly, the extent and persistence of radiation induced biochemical and physiological alterations will be evaluated in the adult animal following their production at specific times during gestation in the rat fetus. Fourthly, the relative importance of oviduct irradiation and zygote irradiation will be investigated. Fifthly, studies concerned with variations and discrpancies in the response of the mouse and rat embryo will be continued. Lastly, attempts will be initiated to irradiate the yolk sac without irradiating the embryo or chorioplacenta.

SUPPORTED BY U.S. Atomic Energy Commission

5.0587, MECHANISM OF CREATINURIA IN IRRADIATED RATS

T.R. KOSZALKA, Thomas Jefferson University, School of Medicine, *Philadelphia, Pennsylvania* 19107

Our broad research objectives are (1) to elucidate the mechanisms underlying the creatinuria observed experimentally in myopathic states resulting from radiation exposure, and (2) to determine the role played by hormones and creatine storage in body compartments in influencing creatinuria.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0588, ADAPTIVE SPECIALIZATIONS IN LEARNING AND MEMORY

P. ROZIN, Univ. of Pennsylvania, School of Arts, *Philadelphia, Pennsylvania* 19104

It is the thesis of this project that there are genetically programmed specializations in learning and memory, relevant to the particular type of behavior or functional system involved and the species under consideration. In this system, research on specific hungers, poisoning, and radiation-induced aversions suggests two major specializations: (1) mechanism allowing a taste CS to be associated with an internal (interoceptive) US with long CS-US intervals (of the order of at least one-half hour); (2) a tendency for gustatory and olfactory cues to be associated with interoceptive USs, as opposed to visual auditory cues.

This research will involve (1) a confirmation of the existence of these mechanisms; (2) an attempt to define how they operate (in either 'physiological' or 'behavioral' terms); (3) a study of the phylogenetic generality of the mechanisms and how they vary in different species in accordance with differences in feeding requirements, food availability and food habits of each species; (4) examination of the existence and role of these specialized mechanisms in human feeding; (5) an extension of the general notion of specialized or 'pre programmed' learning to areas other than feeding, notably the areas of human memory and cognition; and (6) a consideration of alternative solutions to the problem of identification of beneficial or harmful foods, in terms of social communication or inheritance of adaptive food preferences.

SUPPORTED BY U.S. National Science Foundation

5.0589, CORRELATION OF LIFETIME HEALTH & MORTALITY EXPERIENCE OF AEC & CONTRACTOR EMPLOYEES WITH OCCUPATIONAL RADIATION EXPOSURE (ABBREV)

T.F. MANCUSO, Univ. of Pittsburgh, School of Public Health, *Pittsburgh, Pennsylvania* 15213 (AT(30-1)-3394)

A 1-year (1965) feasibility study determined availability of amounts and kinds of data for a radioepidemiologic study of atomic energy workers in selected AEC facilities. A 5-year pilot study was then initiated to begin a limited study of these and develop methods for extension to all AEC contractor facilities. This would be statistically necessary to study the presence/absence of effects on human populations of low-level occupational radiation exposures received by atomic energy workers. Previous reports discussed in detail project objectives, design and data abstracting procedures. All personnel and radiation data at Hanford are now on magnetic tape. Radiation exposure data for the three Oak Ridge facilities is on tape and the personnel data will be completed during the next year. Other environmental and job identification data have also been taped during the past year. Deaths are being identified through the Social Security Administration and death certificates will be requested from the states to determine causes of mortality. Ultimately, various statistical tests will be carried out to detect the presence or absence of any correlation between occupational exposure to radiation and/or other agents and differential and total mortality rates.

SUPPORTED BY U.S. Atomic Energy Commirsion

5.0590, RADIATION CHEMISTRY AND RADIOBIOLOGY OF MEDIUM EFFECTS

J. SCHUBERT, Univ. of Pittsburgh, School of Public Health, *Pittsburgh, Pennsylvania* 15213 (AT(30-1)-3641)

The objectives of the proposed research are to investigate the chemical changes produced in irradiated media and selected foods, especially those associated with carbohydrate fractions, and to correlate these chemical changes with their concomitant biological manifestations. The latter include growth rate of 'S. typhimurium' and cytogenetic changes in mammalian systems. We have identified glyceraldehyde and erythrose, which in the presence of O2 and/or H2O2, are the biological damaging agents produced upon radiolysis of sugars. Only aldehydes capable of forming peroxylactones, especially upon heating in aqueous solution, produce chemical and biological effects manifested by irradiated sugars. We propose to investigate: (1) The total carbonyl yield in irradiated carbohydrate; (2) Identification and quantification of the individual carbonyls; (3) The cytogenetic, antibacterial, mutagenic, and chemical effects of the peroxide adducts of carbonyls, especially with and without autoclaving and in the presence and absence of H2O2; (4) Quantitative comparisons of the action of irradiated sugar solutions with the amounts and kinds of carbonyls formed; (5) The chemical changes induced in DNA and its components by irradiation as related to the chemical properties of the carbonyl- peroxides and the peroxide adducts.

SUPPORTED BY U.S. Atomic Energy Commission

5.0591, RADIATION CHEMICAL STUDIES ON HEMOCYANINS

J. SCHUBERT, Univ. of Pittsburgh, School of Public Health, *Pittsburgh, Pennsylvania* 15213

Hemocyanins are non-heme oxygen-carrying proteins present in the hemolymph of terrestrial and marine invertebrates. In addition to their oxygen-carrying properties, hemocyanins also exhibit catalytic and peroxidatic activities. The objectives of the proposed research are to extend our previous investigations on the mechanisms by which ionizing radiation perturbs or destroys the three properties of hemocyanins. These various activities of hemocyanins are linked to the protein-bound copper, but the specific amino acids to which the copper is attached are unknown. Methods we have employed and will utilize include: (1) the use of OH and e super minus aq scavengers (2) the circular dichroism spectral change: (3) differential manometer and stopped flow methods for measuring rates of the catalytic reaction; (4) NMR and ESR for characterizing the active sites; and, (5) absorption spectra. We have shown that the radiation-induced inactivation and reactivation of the oxygen carrying activities of hemocyanins involve redox reactions of the protein-bound copper with radiolytic products of water. We have measured by competition kinetics the rate of reactions of the OH or e super minus aq interacting with copper moiety. Our proposed investigations on hemocyanin include: (1) the mechanisms responsible for the effects of ionizing radiation; (2) radiolytic reconstitution; (3) radiation-induced changes on the biological and chemical properties; (4) the nature of the active sites; and, (5) reaction kinetics of the OH radical and hydrated electron e super minus aq. The proposed investigations, overall, are intended to clarify many factors, known to be important in both the fundamental and practical aspects of radiobiology and oxygenation reactions. These include the oxygen effect; electron transport processes; protective and sensitizing mechanisms and effects of radiation on the secondary and tertiary structure of oxygen-carrying proteins.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0592, RADIOECOLOGY OF SMALL VERTEBRATE SPECIES UNDER NATURAL ENVIRONMENTS

C.A. TRYON, Univ. of Pittsburgh, School of Arts, *Pittsburgh, Pennsylvania* 15213 (AT(30-1)-2579)

The objective of the project is to determine the individual and population characteristics of suitable vertebrate species under natural environments of different stress and to utilize these

characteristics to gauge the effects of sub-lethal exposure to gamma rays.

Basic procedure is to livetrap and mark all the individuals composing given small mammal populations of known extent. By repeated recapture of these individuals throughout their life span, various structural and functional characteristics of both individuals and populations under the varying stresses of natural environments can be attempted. Two species, the pocket gopher (Thomomys talpoides) and the eastern chipmunk (Tamias striatus) have proven to be suitable for this procedure. Work will continue with both these species by exposing new members of marked populations to gamma rays. Investigation will also continue with the ecological energetics of both species.

Results: The large amount of data on free-ranging animals generated by this project and a similar one conducted by Dr. D.S. Snyder, University of Mass., have been entered and compiled for the UMASS remote access system. Data consist of population characteristics, individual life tables, morphometry, metabolic rates and blood characteristics. Gamma exposure has apparently changed the age composition, individual life expectancy and population turnover under natural conditions.

SUPPORTED BY U.S. Atomic Energy Commission

5.0593, CYTOGENETICS OF POST-IRRADIATION AND VIRAL LEUKEMIA

N. WALD, Univ. of Pittsburgh, School of Public Health, *Pittsburgh, Pennsylvania* 15213

The objective of this research project is to provide information leading to a better understanding of the interrelationship between radiation, cytogenetic abnormalities, and virus in leukemogenesis. The study subject to be utilized for this purpose is the RF/UN mouse which develops a high incidence of granulocytic leukemia on radiation exposure. A virus-like agent has been demonstrated in such leukemic animals and the disease has been transmitted by cell-free passage of materials from irradiated primary animals to normal recipients. Consistent abnormal chromosome markers and modal shifts have been observed in both irradiated leukemic animals and in animals developing leukemia after injection of material from the irradiated primaries. In addition, sequential changes of both markers and modal numbers over many transfer generations have been found. These appear to relate to alterations in the clinico-pathologic nature of the leukemia. It is therefore proposed to continue to seek evidence in this mouse leukemia system for: a) a relationship between consistent bone marrow chromosome aberrations and post-irradiation primary and passaged leukemia; b) a relationship between variations in the chromosome aberrations on passage, and the clinico-morphologic characteristics of the disease; c) a cause-effect relationship between the consistent chromosomal aberrations and the occurrence of leukemia; and d) a predictive relationship between the early peripheral blood count and chromosome changes induced by radiation, and the subsequent development of leukemia.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0594, GAMMA RAY EFFECTS ON DICTYOSTELIUM DISCOIDEUM

R.A. DEERING, Penn. State University, Graduate School, *University Park, Pennsylvania* 16802

The cellular slime mold, Dictyostelium discoideum, is an excellent model system for studying differentiation and development. Here we are investigating the effects of gamma irradiation on the macromolecular metabolism and development of this organism. In initial studies, it was found that the vegetative amoeboid cells are extremely resistant to gamma rays. In one phase of the work, the molecular processes responsible for this resistance are being sought. Toward this end, several mutants have been isolated which are more sensitive to gamma rays than the NC-4 wild type parent strain. The most sensitive has a D10 of 4 krad as compared to 300 krad for the wt. Experiments are now under way to determine the fate of DNA single strand breaks produced by the gamma rays, in thre resistant and sensitive strains. Since all results so far indicate that the resistant strains possess very effective 'repair' mechanisms, we will also try to isolate and identify possible enzymes responsible for this repair. In another phase of this work, gamma ray effects on development are being investigated in terms of numbers and viability of spores produced after irradiation at various stages. This will be done for resistant and sensitive strains. Eventually, it is our aim to use radiation as a tool to tell us something about the molecular events underlying differentiation in D. discoideum.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0595, BASIC ASPECTS OF THE ACTION OF RADIATION ON MICROORGANISMS

E.C. POLLARD, Penn. State University, School of Science, *University Park, Pennsylvania* 16802 (AT(30-1)-2804)

The long-range aim of this project is to characterize the site(s) and the nature of radiation action on microorganisms. The findings of the past will be followed up and related to yet other organisms and systems. For example, evidence for a marked repair-type process in E. coli C is being studied. Sucrose gradient studies on post irradiation RNA will be pursued in relation to the biphasic dose response. Also we propose to separate cells by sucrose gradient sedimentation to see if we can discover populations of cells corresponding to the all-or-nothing pattern. We can now study the reassociation of residual DNA and thereby shed light on the question of whether a defective prophage protects from degradation or simply switches the DNA to phage DNA. With the poly U polyphenyl alanine system we intend to test the effect of radiation on ribosomes and of irradiated medium on the synthetic process. By studying the sensitivity of E. coli B sub s-1 for phage T4 growth we hope to find a convenient way to observe the effect of radiation on ribosomes. We intend to carefully test the statistical cross section relation super S colonies equals super S DNA degradation plus super S DNA synthesis plus suber S trans plus super S p phage plus super S unbal in the hope of arriving at a rationale for radiation action.

Results: Messenger RNA half-life is increased after irradiation. There is a polar effect in the lac operon after irradiation, probably due to ribosome damage. There are two phases to the synthesis of post- irradiation RNA - a low dose and a high dose reduction. Rifampicin, which binds to the RNA polymerase, potentiates DNA degradation and sometimes increases colony-survival sensitivity. We have found that irradiated B. subtilis spores do not undergo DNA degradation, but if irradiated while germinating degradation appears.

SUPPORTED BY U.S. Atomic Energy Commission

5.0596, PHYSIOLOGICAL AND PATHOLOGICAL STUDIES ON ANIMALS EXPOSED TO EXTRAORDINARILY LOW FREQUENCY (ELF) RADIATION FIELDS

J.Z. KENDRICK, U.S. Navy, Air Development Center, *Warminster, Pennsylvania* 18974

Technical Objective: Study the effects of ELF on the physiological function of animals exposed to radiation fields proposed for certain communications facilities of the USN.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0597, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS

A. MICKE, Univ. of the Philippines, *Quezon City, Philippines*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0598, STUDIES ON RADIATION-INDUCED HERITABLE LESIONS IN SOMATIC CELLS

M. KOPEC, Inst. of Nuclear Research, *Warsaw, Poland*

This research project is designed to carry out investigations into the qualitative and quantitative characteristics of radiation induced heritable lesions in mammalian cells. Preliminary experiments indicate that high proportions of cell populations surviving irradiation with doses of 100-300 rads bear sublethal but heritable lesions, which manifest themselves in reduced proliferative

capacities of the damaged cells. For a certain dose range the surviving populations seem to contain constant proportions of normally growing cells and cells growing at rates below the normal one.

Studies on the growth kinetics of murine leukemic lymphoblast (L 5178 Y) cell populations irradiated with doses of X-rays ranging from 5 to 1000 rads are planned for establishment of quantitative relationships between dose of ionizing radiation absorbed by cell population and occurrence of heritable lesions. Particular attention will be given to estimation of the lowest doses inducing heritable lesions which affect proliferative activities of the cell populations, and of the highest doses after which individual cells can still proliferate normally. Verification of the conclusion, drawn from the available data, that the composition of the surviving cell population is dose independent in a certain dose range, may be of great importance for understanding of the mechanisms involved in the induction of the heritable lesions. Comparison between induction of heritable lesions in diploid, aneuploid and tetraploid sublines of the cell population, isolation of pure heritably damaged cell lines, comparison of the duration of individual cell cycle phases in normally growing and heritably damaged cells, and biochemical comparison of these two cell populations are planned for exploring the nature of the radiation induced inheritable lesions in somatic cell populations. Good understanding of qualitative and quantitative relations governing occurrence and repair of these lesions is indispensable for proper interpretation of phenomena occurring in higher organisms after irradiation, in particular the late effects.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0599, FOLLOW-UP STUDY OF THOROTRAST PATIENTS

J. DASILVAHORTA, Hospital De Santa Maria, *Lisbon, Portugal*

In our previous research (Grant no. RH00039) we have found that about 2400 persons have received 'Thorotrast', mainly by systemic route, from 1930 to about 1955, and we have been trying to trace them and learn the possible undesirable effects of that contrast drug. We have been able so far to trace about 50% of them and to follow them up since reception of the drug until the present moment or until death. The main results of our investigation have been regularly reported in some detail to the grant authorities and published in 'The Lancet', July 31, 1965, pp. 201-205 and in the 'The Annals of New York Academy of Sciences', 145: 676, 1967; 145; 700, 1967; 145: 776, 1967; 145: 811, 1967 and 145: 830, 1967. At the moment we have still 351 Thorotrast patients alive whom we are following up with increasing frequency and detail, since they are nearing extinction. Since 1966 we have been following also a group of control cases (patients injected with a non-radioactive contrast drug) and have been able so far to trace about 660 of such cases. We consider the number of controls traced still very low and need to increase our efforts and methods to trace more of them, in order to make valid comparison of results. A renewal of the present grant for a period of at least 2 years is badly needed for this end and also to study more thoroughly the Thorotrast cases and new aspects of these cases, such as their lung, bone and haematologic pathology. They represent a unique population which we hope to use to establish information about the dose-effect relationship between radiation to the bone and osteosarcoma, to the lung and lung cancer and to the haematopoietic system and leukemia and other malignant blood dyscrasias. In view of the renewed interest of the Thorotrast cases, because of the relevance of lung cancer in both these cases and the uranium miners and also on account of the expected increasing use of nuclear energy of which thorium would constitute an important source, it seems urgent that both pathological and epidemiological studies be continued while the patients are still alive.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0600, VIRUS PROJECT

J. CHIRIBOGA, U.S. Atomic Energy Commission, Div. of Med. Sci. & Radiobiol., *San Juan, Puerto Rico* 00935 (AT(40-1))

Radiation Activation of Latent Viruses in Wild Arthropods and Vertebrates.

A. Effect of gamma irradiation on the infection of mice and rats with coxsackie virus.

Adult white mice are normally resistant to coxsackie virus infection, but when these animals were exposed to whole body gamma radiation and immediately inoculated with coxsackie virus type A10 the blood and organs showed a consistently high concentration of virus, which varied directly proportional to the radiation dose. Similar experiments using adult wild rats (Rattus rattus), adult albino rats and adult hooded rats showed the same results as those obtained with the mice, except that the viremia lasted for at least 8 days in the irradiated rats.

B. Activation of coxsackie virus by radiation.

Active coxsackie virus was isolated from groups of animals (mice and rats) that were inoculated with the virus and later irradiated with gamma rays. No virus was isolated from the non-irradiated group. The active virus was either present in very low concentration, thus escaping detection, or it was in a 'latent' state and was activated by the irradiation.

C. Isolation of virus from immune animals after gamma radiation.

Adult mice could be immunized with coxsackie virus by inoculating intraperitoneally. The animals developed neutralizing antibodies. No active virus was isolated from these animals. When the animals were irradiated 60 days after the last inoculation, active virus was isolated from the spleen and pancreas. Several experiments were performed in order to determine if antibodies must be present in the animal in order to be able to recover active virus by radiation from previously immunized animals. The results could be summarized as follows: a. Active virus was isolated from irradiated immunized animals with antibody present in the serum. b. No virus was isolated from non- irradiated immunized animals with antibody present in the serum. c. No virus was isolated from irradiated immunized animals with no antibody present in the serum. d. No virus was isolated from immunized animals that showed no antibody present in the serum, whether or not they were irradiated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0601, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS

F. KOO, U.S. Atomic Energy Commission, Puerto Rico Nuclear Center, *San Juan, Puerto Rico*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0602, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS

C. CHENG, Natl. Tsing Hua University, *Hsinchu, Republic of China*

The methods for neutron dose measurement in a standard neutron irradiation facility for research reactor using barley seeds as the biological dosimeter are discussed, and the results are compared with those obtained by other reactor laboratories in order to obtain an accurate and reproducible set of data.

Dry seeds of rice varieties IR-20, IR 22, Taichung Native 1 and Tainan 5 will be subjected to 3 doses of neutron treatment and one dosage of 30 Kr X-ray irradiation as check.

The treated seeds as well as the untreated ones will be sown in greenhouse in February 1971, and the surviving seedlings transplanted by means of a single seedling planting.

Field notes will be taken on the performance of seedling growth, percentage of survived seedling, seed-setting, chlorophyll ueficiency and other biological effects, in addition to the cytological studies of chromosomal aberrations.

The N1 materials will be transplanted in the field in July 1971. Every treated lot of a single variety will be grown with at least 1000 plants.

Rice plants which differ from the parental varieties either in morphological characters or physiological performance will be harvested and seed samples of these plants sent to the quality-testing laboratory of the Taichung DAI S for determining protein content.

5. RADIATION

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0603, EFFECTS OF RADIATION ON MIGRATORY ORIENTATION OF SALAMANDERS
C.R. SHOOP, Univ. of Rhode Island, Grsduate School, *Kingston, Rhode Island* 02881 (AT(30-1)4175)

The objective of this study is to determine the effects of artificially induced ionizing radiation on the orienting ability of the salamander, Ambystoma maculatum. In addition, knowledge will be advanced relative to the basic ecology of amphibians. This investigation will provide information of the individual and population attributes of reproductive potential, larval survival and net juvenile production, age and sex composition, population size, growth rates survival and longevity of adults, dispersal, and interchange between populations, and importance of larval salamanders to pond ecosystem.

Breeding ponds are fenced, and traps along the inner and outer faces of the fences catch animals as they are migrating to and from the ponds. Additional fences and traps at some distance from the ponds provide information on routes of travel. These procedures allow an annual census of the breeding populations, facilitate the correlation of directional movements of migrants to and from breeding ponds, and allow definition of juvenile production. Preserved samples from other ponds and laboratory studies of aging and reproductive behavior support the field studies.

Results: Migrating animals show a marked preference in their direction of departure from the breeding pond which is correlated with the direction from which they arrived. Data already collected suggest that many animals utilize the same route of travel in subsequent years. The animals apparently do not use celestial cues in orientation, and the sensory basis for the orienting ability is unknown. The orienting phenomenon will be used to determine radiation effects. Radiation tolerance studies have been initiated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0604, RESPONSE OF PIGMENT CELLS TO X- AND UV-RADIATIONS
W.C. QUEVEDO, Brown University, Graduate School, *Providence, Rhode Island* 02912

The proposed project is directed at determining the extent to which the responses of mammalian pigment cells to UV- and X-radiations arise from direct modification of the irradiated cell or are dependent on events initiated within the particular cellular community of which it is a part. The problem of pigment cell 'niche' and radiosensitivity is examined and is subjected to experimental analysis. The significance of melanin pigment as a radioprotective agent is evaluated in the case of epidermal melanocytes. Particular emphasis is placed on determining the consequences of the proposal that the epidermal melanin unit, consisting of a melanocyte together with its constellation of associated epidermal cells (keratinocytes), is the fundamental integrated unit of pigmentary function in the epidermis of vertebrates. The functional and morphological properties of the epidermal melanin unit are examined in the skin of vertebrates representative of each of the major classes. Particular attention is given to the roles that genes and hormones play in modifying the responses of mammalian melanocytes to ionizing and ultraviolet radiations. The cellular basis for radiation-induced changes in melanocyte populations and the nature of cellular interactions during pigmentation of skin and hair are also examined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0605, IONIZING RADIATION, BEHAVIORAL DEVELOPMENT, AND AGING
E. FURCHTGOTT, Univ. of South Carolina, School of Arts, *Columbia, South Carolina* 29208

Pregnant albino rats are exposed between gestation days 14 and 18 to various doses of X-irradiation. After birth the behavior of the offspring is studied. During the next budget period an attemot will be made to determine the effects of very low doses 5 to 10 since Soviet investigators have claimed that even a one (1) R dose may produce deleterious effects. The animals will be tested on several operant conditioning schedules which resemble those used by the Soviet investigators.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0606, EFFECT OF WHOLE BODY X- AND GAMMA-IRRADIATION ON THE BIOSYNTHESIS OF CERTAIN SERUM PROTEINS
O.W. NEUHAUS, Univ. of South Dakota, School of Medicine, *Vermillion, South Dakota* 57069 (AT(11-1))

Changes in liver cell permeability occur when the animal organism is subjected to stress or exposed to X- and gamma-irradiation. We will study factors controlling the uptake of amino acids under these conditions. For most studies the unmetabolizable amino acid, alpha- aminoisobutyric acid will be used. Studies will include effects of adrenalectomy, hypophysectomy as well as therapy with hormones and analogues. We hope to establish a relationship with the cyclic AMP- adenyl cyclase system.

We will study effects of whole body irradiation on transcriptional and translational processes in protein biosynthesis. Spayed female rats treated with testosterone to stimulate a selective synthesis of male-sex dependent 'urinary' protein, will be exposed to whole-body irradiation. 14 C-orotic acid incorporation into RNA, polysomal stability, and effects on the endoplasmic reticulum will be determined.

Low dosages of irradiation appear to stimulate the synthesis of acute-phase plasma proteins. The identity of responsive proteins will be determined as well as changes in RNA synthesis, nuclear polymerase activity, polysomal profiles, polysomal stability and ribonuclease activity.

Results: 1. Whole body X-irradiation and inanition suppressed amino acid incorporation in liver microsomes. 2. Liver microsomes of irradiated rats are not defective since phenylalanine incorporation with poly U is normal. 3. Lethal X-irradiation but not inanition inhibits biosynthesis of polysomal and nuclear RNA. 4. X- and gamma-irradiation causes an increase in hepatic uptake of AIB.

SUPPORTED BY U.S. Atomic Energy Commission

5.0607, EFFECTS OF ULTRAVIOLET RADIATION ON ALGAE - MECHANISMS OF INACTIVATION AND REPAIR
G.D. SMALL, Univ. of South Dakota, School of Medicine, *Vermillion, South Dakota* 57069 (AT(11-1)1793)

The objective of this project is to study the mechanisms for the repair of UV-light induced damage in the DNA of model eukaryotic cells, the single-celled green algae. The most extensive information concerning the damaging effects of UV-light to DNA and repair systems for this damage are available for bacteria and their viruses. We are interested in (a) whether the mechanisms of inactivation and repair are the same in eukaryotic cells such as algae compared to bacteria, and (b) whether organelles such as chloroplasts and mitochondria have DNA repair systems independent of those in the nucleus. Photoreactivating enzyme is found in both the nucleus and the chloroplasts of Euglena gracilis. A systematic study of these enzymes is underway. A method to detect photoproducts in UV-irradiated algae is being developed. Finally, enzymes involved in the excision-repair mechanism in Chlamydomonas are being studied.

Results: 1. Photoreactivating enzyme has been detected in purified Euglena chloroplasts. 2. Photoreactivating enzyme from extracts of Euglena cells has been purified over 200-fold. 3. Crude extracts of Chlamydomonas have been found to degrade UV-irradiated DNA much faster than nonirradiated DNA, indicating the presence of enzymes specific for UV-irradiated DNA.

SUPPORTED BY U.S. Atomic Energy Commission

5.0608, RADIATION SENSITIVITY OF THE MICROBIAL FLORA OF FRESH WHITE (LEAN) FISH
D. DELASIERRASERR, Junta De Energia Nuclear, *Madrid, Spain*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0609, EXPERIMENTAL INVESTIGATIONS ON THE INTERPLAY BETWEEN NATURAL AND ARTIFICAL RADIATION PROTECTION

L. REVESZ, Karolinska Institutet, *Stockholm, Sweden*

The work will continue in the lines of the first year. One part will be directed to the further clarification of the effect of cysteamine on the natural repair of the cellular radiation damage, occurring in the intervals between the fractionated irradiation. The slope and the extrapolation number of the survival curves as well as the long term growth of the irradiated cells in tissue culture will be followed and the modification of these parameters by cysteamine will be studied. These results should show whether the cysteamine modifies the degree of radiation damage only or stimulates its repair as well.

The second part of experiments will concern the chemical exchange reactions between the internal, i.e. natural and the external radioprotectors. It is planned to use for this study both the cells internally labelled with radioactive cysteine and radioactive cysteamine in normal cells. The subsequent chemical and radiochromatographic analysis will bring data on the fate of the labelled cysteamine in cells, on the process of intracellular release of natural protectors (mainly glutathione) induced by cysteamine and eventually on the formation of so called mixed disulphides between proteins and protector.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0610, EFFECT OF X-IRRADIATION ON THE HORMONAL REGULATION OF THE THYMOLYMPHATIC TISSUE AND THE IMMUNE RESPONSE

W. PIERPAOLI, Schweizerisches Forschungsinst, *Davos, Switzerland*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0611, ANIMAL METABOLISM OF FISSION PRODUCTS AND RELATED NUCLIDES

M.C. BELL, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00063)

OBJECTIVE: Determine absorption, distribution and excretion of fission products in beef cattle, sheep, swine and animal products as affected by different factors; determine feasibility of predicting fission product metabolism from that of related nuclides.

APPROACH: Strontium will be substituted for a part of the dietary calcium to determine the effect on absorption, distribution and excretion of Sr-89, Ca-45 and stable Sr and Ca in beef cattle. In vivo and in vitro techniques will also be employed to study fission product metabolism by rumen microorganisms. The effect of monovalent cations on cesium retention will be determined. Basic information will be obtained on the deposition and lability of bone-seeking fission products by dosing newborn animals and following the deposition and erosion pattern at various intervals throughout the growing period. Auto-radiographic techniques combined with microscopic examinations will be used to study the dynamics of bone calcification and decalcification.

PROGRESS: Sheep fed insoluble Y-labeled fallout simulant at 2.5 mCi/kg to simulate 7% forage retention developed anorexia, diarrhea, and weight loss. Tissues most damaged were the rumen and abomasum where the Y sand collected. Feed intake of survivors usually returned to normal within 60 days. Beta irradiation of 57,000 rads to the dorsum of sheep, severely affected the skin and reduced body weight. Whole-body gamma irradiation of 240R at 1 R/min affected only the platelets and white blood cells. No mortality was observed from these three types of irradiation alone but when combined, 4 of 8 sheep died in 60 days. 4 of 4 steers given the 3 combined treatments died within 30 days. Plasma mineral changes were observed only on beta-irradiated sheep and cattle. Sheep fed Y sand and those beta irradiated to the skin showed increased Zn in vitro erythrocytic uptake and increased plasma Cu. Most changes in sheep fed Y sand were observed from 7 to 42 days and included depressed plasma Ca and Mg. Most of the changes in skin- irradiated sheep were seen after 60 days and included depressed plasma Fe. These plasma changes are probably associated with tissue repair.

SUPPORTED BY U.S. Dept. of Agriculture

5.0612, RADIOTOXICITY OF FISSION PRODUCT ELEMENTS

M.S. BELL, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN-UT-AEC-060102)

OBJECTIVE: The toxicity of radionuclides to the physiology of the animal with special reference to the Fission Product Elements.

APPROACH: Animals are subjected to various exposures to radionuclides and their effect on the physiology is noted. Special attention is given to the use of the Fission Product elements but not exclusive attention.

PROGRESS: In order to determine the vulnerability of livestock to fallout radiation, Y-labeled sand was fed to sheep at the rate of 2.5 mCi/kg of body weight to simulate fallout retention of 7 percent on forage. Severe radiation damage to the rumen and abomasum was accompanied by anorexia, diarrhea, and weight loss. Beta irradiation of 57,000 rads to 12% of the body surface severely damaged the skin and increased weight loss by 15% with no reduction in feed intake. Gamma irradiation of 240 R at 1 R/m affected only WBC and platelets. In 60 days, 4 of 8 sheep given all three treatments died and one of 8 fed Y sand died. Four of 4 calves given the 3 treatments died in 30 days with no deaths in calves on single treatments alone. Beta irradiation increased in vitro Zn erythrocytic uptake and altered plasma Cu, Fe, Mg, and Ca, while gamma irradiation had no effect on these elements. Two dairy cows surviving from a group of 6 fed 44 mu Ci Sr/kg of body weight in 1966 have been sacrificed at the termination of this phase of this project. They appeared healthy and it is estimated that their skeletal retention was less than 1% of the original Sr. The other 4 died from radiation injury 93 to 132 days after treatment with a bone retention of 8%. Due to the resignation of Dr. Cragle, this phase of the project is being terminated.

SUPPORTED BY Tennessee State Government

5.0613, EFFECTIVENESS AND EFFICIENCY OF PHYSICAL AND CHEMICAL MUTAGENS

B.V. CONGER, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00287)

OBJECTIVE: Study influence of modifying factors on radiosensitivity and mutability of plant seeds to fast neutrons. Compare mutagenic effectiveness and efficiency of gamma rays, fast neutrons and chemical mutagens alone and in combination treatments.

APPROACH: Seeds of various species of higher plants will be treated under various conditions of seed water content, atmosphere, temperature, etc. with fast neutrons, gamma rays and chemical mutagens separately and in combination. Various biological end points such as reduction in seedling growth, chromosome aberrations, mutation induction, lethality, and sterility will be measured. Particular emphasis will be placed on determining which combinations of mutagens and treatment conditions contribute to the highest rate of mutation induction relative to other kinds of damage produced. The basic mode of action of the mutagens (particularly fast neutrons) will also be studied.

PROGRESS: The influence of modifying factors, on response of barley seeds to unmoderated fission neutrons was studied. The post- irradiation oxygen effect observed in very dry barley seeds (2.2% water content) has not been previously reported for neutron irradiation of a 'dry' biological system. This effect disappears as the seed water is increased to 9.9 percent. Experiments on the post-irradiation oxygen sensitivity following gamma-irradiation of dry seeds from five species of higher plants differing widely in radiosensitivity and nuclear volume have been initiated. Results suggest a wide difference in the oxygen- enhancement ratio among the species studied. Seeds high in oil content appear to be less sensitive to post-irradiation oxygen treatment than seeds high in starch. The study of the mutagenic effectiveness and efficiency of gamma rays, fission neutrons and 14.7 MeV neutrons in barley is nearly completed. Both the fission neutrons

and the 14.7 MeV monoenergetic neutrons are much more effective in producing chlorophyll- deficient mutations than are gamma rays. Another experiment with barley to determine mutagenic effectiveness, efficiency and specificity of gamma rays, fission neutrons, ethylmethane sulfonate and 5-bromouracil alone and in combination treatments and after different periods of presoaking is currently being conducted.

SUPPORTED BY U.S. Dept. of Agriculture

5.0614, RESPONSE OF HORTICULTURAL PLANTS TO ACUTE GAMMA RADIATION

E.T. GRAHAM, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00230)

Objective: Determine the growth response of several horticultural species (vegetatively propagated plants) to acute gamma radiation. Locate the site of radiation injury in the apical meristems of irradiated plants, and to characterize the kind of injury necessary to cause the formation of abnormal stems, leaves, and flowers. Perpetuate by asexual reproduction any mutant or sport that may be of value to the nursery or florist industry.

Approach: The growth response study will consist of exposing actively growing plants to various dose levels of acute gamma radiation. Whole plant exposures of increasing increments will be used to determine the dose level required to bring about abnormal growth patterns and lethality to irradiated plants. Mutation rates and types of mutations in the irradiated plants will be compared to those of non-irradiated plants. Microscopic examinations will be made of apical meristems at various time intervals after exposure of the plant to acute gamma radiation. Abnormal growth patterns of the leaves, stems, and flowers will be related to radiation induced injury of the apical meristem. Material showing satisfactory horticultural characteristics will be propagated and maintained.

Progress: Fast Neutron Irradiation produced more changes than gamma. A buck mutant, from green to red, found in Coleus. Dwarf mutation of C. humus established. Few apparent mutations of woody materials have appeared.

SUPPORTED BY U.S. Dept. of Agriculture

5.0615, CELL SPECIALIZATION IN SHOOT APICAL MERISTEMS AS RELATED TO RADIOSENSITIVITY AND HISTOGENESIS

E.T. GRAHAM, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00273)

OBJECTIVE: Compare volumes of nuclei in meristematic cells in relation to radiosensitivity. Contrast DNA and RNA contents of irradiated and control apices. Trace origins of histogenic layers by means of normal and mutant plastids in cell lineages derived from apical meristems, using ionizing radiation to alter periclinal chimeras and to induce plastid mutation.

APPROACH: Irradiate periclinal chimeras of Dianthus, Euphorbia, and Coleus and prepare apical sections for microscopic examination by means of freeze substitution. Calculate volumes of nuclei from ocular micrometer measurements and relate these data statistically to degree of visible damage in tunica-corpus cells. Label irradiated apices with H- thymidine and H-uridine, fix in glutaraldehyde, embed in plastic, and section on the ultramicrotome. Analyze by histoautoradiographic and histochemical localization of DNA and RNA, using enzymatically extracted controls. Trace plastid lineages in natural and radiation-altered green/ivory variegated chimeras by means of a standard procedure for electron microscopy.

PROGRESS: A specific cytoplasmic injury was found in the shoot apex of young maize seedlings after an acute exposure to gamma radiation. The injury appeared as dense cytoplasmic condensates in interphase cells of the apical meristem and generative leaf tissue. Cytoplasmic condensation reached a maximum at about 12 hour postexposure and then disappeared during the next 24 to 36 hours, possibly due to autolysis. Severe shrinkage of cells occurred concomitantly with cytoplasmic condensation. Nuclear pyknosis in the shoot promeristem was another important injury induced by gamma radiation. Pyknosis was concentrated primarily in the corpus region of the promeristem, but was observed infrequently in the tunica. Pyknotic nuclei were prominent 24 to 36 hours postexposure, but were not observed after 48 hours. Cytoplasmic condensates accumulated during the first few hours postexposure and were clearly present prior to nuclear pyknosis. Both normal and pyknotic nuclei were colored pink in the Feulgen stain for DNA and blue in the aniline blue black stain for protein.

SUPPORTED BY U.S. Dept. of Agriculture

5.0616, EVALUATION OF MEAT FROM ANIMALS EXPOSED TO LETHAL RADIATION LEVELS

S.A. GRIFFIN, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00052-S)

OBJECTIVE: Evaluate the biological, physical and chemical properties of meat and evaluate methods of processing meat from animals exposed to lethal radiation levels.

APPROACH: Swine and cattle will be exposed to external gamma irradiation at a level to produce an LD 80-30. Animals will be slaughtered when they show signs of radiation sickness. Samples of blood, lymph, muscle, fat and organs will be studied for bacterial invasion. Physical and chemical properties of meat will be studied. Methods of processing under normal and possible post attack situation (no refrigeration) will be studied.

PROGRESS: Trials have been conducted with pigs irradiated at a level of 700 R at 1 R per minute. Bacterial examination of the blood has not indicated any bacteremia buildup. There has been no indication of bacterial buildup in the muscle. Some bacteria have been found in the lymph nodes. Trials were conducted with rats to evaluate reports that indicated bacteremia in irradiated animals. Bacteremia was produced in the rats.

SUPPORTED BY Tennessee State Government

5.0617, A STUDY OF EFFECTS OF RADIATION ON HOST-PARASITE RELATIONSHIPS

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Different stages in the larval development of Hymenolepis microstoma will be compared with similar stages in H. nana, H. diminuta, and H. citelli as to sensitivity to ionizing radiations. Infected flour beetles will be irradiated on days 1-6 after being fed tapeworm eggs, and the cysticeroids will be sampled periodically to observe delay in development and any specific effects.

Aging in Hymenolepis spp. in immunized and non-immunized hosts; the possible effect of host immunity upon senescence of potentially immortal cestodes will be tested by using X rays to suppress host immunity, then measuring the life span extension, if any, of the parasites.

Work will be continued on effects of radiation on fecundity of cestodes. Actual fertility will be measured by counting eggs ingested by the intermediate host, and comparing this number to 1) eggs hatched, 2) oncospheres reaching the hemocoele and 3) actual cysticercoids developing. The above measurements will be made on irradiated and non-irradiated cestodes.

Results: During FY 1968-9 observations were made of 1) retardation of Tribolium development by single and mixed infection with tapeworms, 2) changes in fecundity of Tribolium parasitized with Hymenolepis microstoma, 3) effects of radiation on H. microstoma developing in beetles and 4) continuation of a tapeworm 'selfing' study into the 15th generation. Publication of two papers and preparation of several others was accomplished.

SUPPORTED BY U.S. Atomic Energy Commission

5.0618, METABOLIC PROBLEM IN SECONDARY DISEASE

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Project aims are 1) correlate biochemical changes found in secondary disease of radiation chimeras with incidence of mortality and 2) determine the metabolic system or systems damaged critically by the disease. Changes in aspartic acid and serine metabolism are of particular interest. Observations made in mice with secondary disease uncovered changes subsequently found in animals with other forms of graft-vs-host disease. The radiation

chimera may thus be a model system for study of autoimmune disease, the cachexia of advanced malignancy, and, as most recently suggested, the natural phenomenon of aging. Mice will be lethally X-radiated and then given bone marrow from mice of different genetic background. Variation of dose of bone marrow cells, age of donor, sex of donor, and time of injection is controlled by systematic factorial design based on experimental design theory. The result is controlled variation of mortality rate which permits the biochemical changes found to be correlated with incidence of mortality in a formal way by use of mathematical statistical theory. Specific enzymatic activities in tissues, levels of tetrahydrofolic acid derivatives in liver, and the respiration pattern after injection of C14 labeled amino acids will be studied. This ongoing study of irradiation chimeras started in FY 67. Results: The level of aspartic acid is increased while serine is decreased in liver of radiation chimeras. The nitrogen balance is abnormal and there is unusual deposition of nitrogen in skin. Changes in respiration pattern after injection of labeled serine suggest that 'one carbon metabolism' may be altered.

SUPPORTED BY U.S. Atomic Energy Commission

5.0619, EFFECTS OF RADIATION ON REPRODUCTIVE PHYSIOLOGY IN FARM ANIMALS
R.L. MURPHREE, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00066)

OBJECTIVE: Evaluate effects of acute and chronic irradiation on reproductive physiology and growth in farm animals on: semen characteristics in the male, potential fertility in the male, estrual cycle phenomena in the female, potential fertility in the female, the endocrine system, growth of young animals.

APPROACH: Male and female cattle and swine will be exposed to varying levels of gamma radiation (Co 60). Observations will be made on the following: sperm production and fertility of males, lifetime fertility of females, viability, growth and fertility of offspring of females irradiated at different stages of gestation, histological and cytological changes in the ovary and testis following irradiation, and endocrine functions--pituitary, testis and ovary.

PROGRESS: The frequency of lambs with deformed legs born by ewes irradiated (200R, CO) on the 23rd day of gestation at rates of 0.3, 0.7, 1 and 47R/min. was 20, 33, 24 and 44%. No lambs with deformed legs were born by ewes irradiated on the 17th-22nd day of gestation. No deformed pigs were born by sows irradiated on the 15th-19th days of gestation (300R at 47R/min) or 20th-21st day at 1R/min. Dose-rates of 10 and 47R/min. on 20th-21st days resulted in near 100% of deformed pigs. Exposure of pregnant rats (dose 100R) at rates of 1, 2, 3, 4, 5, 10 and 47R/min. on 11th day of gestation resulted in 18, 37, 55, 65, 64, 51 and 56% frequency of young with abnormal eyes. Testis weights of males irradiated at 17 day of gestation at rates of 0, 3, 10 and 25R were 1.7, .4, 1.3 and 1.3 gm., respectively.

SUPPORTED BY U.S. Dept. of Agriculture

5.0620, EFFECTS OF RADIATION ON LARGE ANIMALS - SOMATIC
R.L. MURPHREE, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN-UT-AEC-060101)

OBJECTIVE: The somatic effects of ionizing radiation on large animals.

APPROACH: Large animals are exposed to ionizing radiation under various conditions. The interaction of dose and dose-rate on various physiological parameters are investigated.

PROGRESS: The frequency of lambs with deformed legs born by ewes irradiated (200 R, Co, on 23rd day of gestation at rates of 0.3, 0.7, 1 and 47 R/min was 20, 33, 24 and 44 percent. No lambs with deformed legs were born by ewes irradiated on the 17th-22nd day of gestation. No deformed pigs were born by sows irradiated 1) on 15th-19th days of gestation (300 R at 47 R/min) or 2) 20th-21st days at 1 R/min). Dose- rates of 10 and 47 R/min on 20th-21st days resulted in near 100 percent of deformed pigs. Exposure of pregnant rats (dose 100 R) at rates of 1, 2, 3, 4, 5, 10 and 47 R/min on 11th day of gestation resulted in 18, 37, 55, 65, 64, 51 and 56 percent frequency of young with abnormal eyes. Testis weights of males irradiated at 18 days of gestation at rates of 0, 10 and 25 R were 1.7, 1.3 and 1.3 gm, respectively.

SUPPORTED BY Tennessee State Government

5.0621, IRRADIATION OF MILK COWS
E.W. SWANSON, Univ. of Tennessee, Agricultural Experiment Sta., *Knoxville, Tennessee* 37916 (TEN00221)

OBJECTIVE: Determine the effects on dairy cows of high-level, sub- lethal doses of gamma irradiation given pre-partum and in lactation.

APPROACH: Cows will be paired on the basis of previous lactation, and one of each pair will be irradiated about two months prepartum. Irradiated cows will be compared with the non-irradiated controls for feed consumption, milk production, hematological effects and milk composition. The irradiated cows will also be re-irradiated at mid- lactation. In addition, several other cows will be irradiated for the first time in mid-lactation, and the effects on change of the lactation curve, or other effects determined.

PROGRESS: Eleven cows were given 3 doses of 200r each whole body irradiation in 1965-66. Four years after the initial treatments 5 of the cows are still in the milking herd. In their 3rd or 4th lactations after irradiation, they will average about 17,000 lbs. of milk in lactations averaging 340 days. A similar control group of cows in the same herd averaged only 14,446 lbs. in 286 days, due to a poor lactation of one of the controls. In the past year one of the irradiated cows died 2 wks after calving from gastritis, and 2 cows presently milking became non-breeders; so at the end of 4 years only 3 of the original 11 will be in normal production. A comparable depletion has occurred in the control group. There is no indication that the irradiation has adversely affected lactation ability or longevity. Lactation comparisons are continuing with identical twins comparing thyroid damaged and control twins. Feeding thyroxine to thyroid damaged cows, after lactation had started, increased their milk yield, but they did not attain normal yields. When thyroxine feeding was started before calving, nearly normal yields resulted. This result confirms the importance of thyroid activity for lactogenesis.

SUPPORTED BY U.S. Dept. of Agriculture

5.0622, BINDING OF RADIOACTIVITY TO RAT LIVER NUCLEIC ACIDS IN VIVO AFTER ADMINISTRATION OF AAF-9-C-14 OR N-HYDROXY-AAF-9-C-14
C.C. IRVING, U.S. Veterans Administration, Hospital, *Memphis, Tennessee* 38115

Previous reports that radioactivity was bound to rat liver in DNA in in vivo administration of 2-acetylaminofluorene-9-C-14 (AAF-9-C-14) were confirmed. In addition, administration of several other AAF derivitives, namely N-HO-AAF-9-C-14, N-acetoxy-AAF-9-C-14 and the glucuronide of N-HO-AAF-9-C-14, led to the binding of higher levels of radioactivity to rat liver rRNA and DNA. Maximum levels of bound radioactivity were found in rat liver RNA and DNA at 12-16 hr after a single injection of AAF-9-C-14. Bound radioactivity disappeared rapidly from liver RNA, with approximately 3 days being required for one-half of the bound radioactivity to disappear. By four weeks after a single injection of AAF-9-C-14, rat liver RNA no longer contained detectable radioactivity. On the other hand there was persistent binding of radioactivity to rat liver DNA followng a single injection of AAF-9-C- 14. Approximately 10% of the bound radioactivity found at 12-16 hr remained associated with the DNA at 4-8 weeks after injection of AAF-9- C-14. There appeared to be at least two different mechanisms involved in the binding of N-HO-AAF to rat liver rRNA and DNA in vivo, since approximately 75% of the fluorene residues bound to rRNA after injection of N-HO-AAF retained the N-acetyl group, while the N-acetyl group was retained in only 35% of the fluorene residue bound to DNA.

SUPPORTED BY U.S. Veterans Administration

5.0623, NEOPLASMS AFTER FISSION NEUTRON IRRADIATION
H.H. VOGEL, Univ. of Tennessee, School of Medicine, *Memphis, Tennessee* 38103

Single, whole-body exposure to fission neutrons, of 10 to 250 rads, were followed by the development of at least one mammary

neoplasm in 73- 87% of irradiated Sprague Dawley/ANL female rats. There was no evidence of a linear dose-effect relationship. Control, unirradiated rats showed 48% mammary tumor incidence during their lifetime, no neoplasms appeared within the first ten months. After a single, whole-body exposure to 5 rads of fission neutrons 63% of the rats developed mammary neoplasia to date. Histopathological analysis of 102 mammary neoplasims in 95 irradiated rats showed 70.6% cases of benign tumors, 10.8 % cases of sarcomas and 18.6% cases of carcinomas. Thus a ratio of benign to malignant neoplasm was 7:3. The fibroadenoma was the most common mammary neoplasm following neutron irradiation. Of 127 female rats irradiated with 5 to 35 rads of fission neutrons, 7 demonstrated palpable mammary neoplasms within 100 days of irradiation. It is apparent that the adenocarcinoma is the most common type of neoplasm directly after neutron exposure.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel - P.H.S.

5.0624, DOSE-TIME FACTORS INFLUENCING CELLULAR RADIOSENSITIVITY

J.S. BEDFORD, Vanderbilt University, School of Medicine, *Nashville, Tennessee* 37203

Three factors which markedly influence the dose-survival response of cells exposed to sparsely ionizing radiations are (1) the dose rate or manner in which the dose is fractionated in time, (2) the amount of dissolved oxygen present at the time of irradiation, and (3) the 'age distribution' of cells in various phases of their reproductive life cycle.

While each of these factors has received considerable attention in radiobiology, very little information is available on their interrelationships. It is not known for example, what changes in the 'age distribution' of cells in their reproductive life cycle may accompany prolonged low dose rate irradiation, prolonged anoxia, or both.

It is proposed that some light may be shed on these interrelationships by applying techniques of mammalian cell culture in combination with autorradiographic life cycle analysis. From such experiments, information of general interest in radiobiology will be obtained, and some insight may be gained toward providing a rational approach to cell life-cycle modulated tumor treatment regimes in radiotherapy.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0625, RENAL PHARMACOLOGY AND TOXICOLOGY OF FALLOUT NUCLIDES

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The renal excretion of various fallout radionuclides as well as their deposition in critical organs is probably achieved in part through their similarities and difference from the ions of common biologic occurrence. Therefore, the specific objective of this project is to study the relationships between the position of the various radionuclides (Cs 137, Sr90, Ba140 - La 140, Ca 47 - Sc 47, Zr 95 -Nb95, Ru 103 - Rh 103) in the periodic table and their retentive, excretory and toxicologic indicies in mammals. The selection of the radionuclides is based upon (1) their occurrence in the atomic fallout, (2) their potential as hazards to human populations, and (3) their scope as environmental pollutants. During 1970-71, the following were investigated: (1) Localization of the sites for the secretion of Cs 137, Rb 86 an K 42 in the nephrons of the same dog kidney by stop-flow and clearance techniques. According to these studies, all three radionuclides were reabsorbed in the proximal tubule and secreted in the distal tubule. Super 42 K and super 86 Rb were secreted at the same distal site. However, the distal secretory site for super 137 Cs was more proximal to that of K 42 or Rb 86. A distal tubular reabsorptive site could be demonstrated for K42 and Rb 86. Active reabsorption of Cs 137 was not observed. (2) Metabolic dissociation of the parent-daughter radionuclides Zr 95 - Nb 95. After intraperitonial administration of Zr 95 - Nb 95 in the transient equilibrium, the parent was preferentially absorbed and excreted in the urine during the first day. For 3 4 days, large amounts of the administered daughter was excreted. Between 7-42 days part of the mobilized Zr 95 decayed to daughter, which was probably translocated from bone and excreted in urine. After the 42nd day, the whole body loss of radioactivity was due to the physical decay of super Zr 95 - Nb95.

The following are the specific goals set for 1971-72: (1) Renal sites for reabsorption and secretion of radiostrontium in relation to radiobarium and radiocalcium; (2) Metabolic dissociation of the parent- daughter radionuclides, Ca 47 - Sc 47, Sr 90 - y 90.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0626, A STUDY OF INFECTIONS IN IRRADIATED PATIENTS

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It is well documented that humans and animals exposed to total-body irradiation are rendered more susceptible to infection. This increased susceptibility has been studied in some detail in experimental animals; however, little information is available on humans. The purpose of this study is to examine the underlying causes of altered resistance in irradiated human subjects. Our principal goals are to: (1) characterize the microflora of patients undergoing irradiation therapy in order to determine if microbial population shifts occur prior to infection; (2) identify the pathogen(s) in any infection, their portal of entry, and response to treatment; (3) assess the affects of irradiation on humoral and cellular defense mechanisms. The aerobic and anaerobic microflora of the respiratory tract, gastrointestinal tract, urine and skin are examined qualitatively, quantitatively, and biochemically at frequent intervals. Immunoglobulin levels (IgG, IgA, IgM), and complement (C'3) are measured at weekly intervals before and after irradiation. Bacterial agglutinins, bactericidins, and opsonins as well as the phagocytic index of blood or leukocyte enriched fractions are measured at frequent intervals before and after irradiation.

Results: The most consistent changes in the bacterial microflora after irradiation were in components of the anaerobic microflora. Alterations were also observed in the aerobic microflora, generally as an acquisition of microorganisms in the upper respiratory tract. More subtle changes were observed in the biochemistry and morphology of certain normal microflora components. Radiation appeared to have little effect on bacterial agglutinin and bactericidal titers. Decreased immunoglobulin levels, especially IgA and IgM were observed in some patients after irradiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0627, RADIOBIOLOGY AND NEOPLASIA - MORPHOLOGIC ASPECTS - HISTOPATHOLOGIC STUDIES

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OBJECTIVES: 1) To define mechanisms of radiation injury to man by correlating histopathologic features with biochemical, immunologic, and microbiologic changes. 2) To determine distribution of administered radionuclides in normal and cancerous tissues after in vivo whole-body assays and scans. 3) To advance understanding of the marrow organ in hematologic diseases and therapy. 4) To define the graft-versus-host reactions in man, including their evolution and response to therapy. 5) To collect tissues for projects in cytogenetics, biochemistry, and electron microscopy.

Irradiated human and animal tissues are studied employing special stains and histochemical reactions to define responses. Causes of death are established, with particular attention to deleterious effects of radiation, including kinds of infections that accompany immunosuppression and granulocytopenia. Our facilities for whole-body irradiation permit comparison of animal and human tissues systematically exposed to a wide range of exposure rates. Another unusual resource is the capacity for whole-body counts, radioassays, and distribution studies of radionuclides. Radiation dosimetry is important for determining exposure from procedures of nuclear medicine. Radioassays also are important for developing agents that localize in tumors. Currently radionuclides of gallium are of interest, because their concentration in neoplasms promises to aid tumor detection and possibly will provide insights into the biology of cancer.

Results: In 1969 autopsies of 28 patients confirmed the presence of advanced neoplastic disease. With few exceptions the cause of death was infection and most of the infections would be considered opportunistic. Hemorrhage was often present but in this series was not the cause of death. GI ulcerations, pancytopenia, and immunologic supression were common, antineoplastic drugs complicated the analysis of effects of radiotherapy. Most patients had been given radiopharmaceuticals. Five had gallium-67 sufficient for detailed assays, helpful in the interpretation of scans showing localization of Ga-67 in tumors and tissues after IV administration.

SUPPORTED BY U.S. Atomic Energy Commission

5.0628, BIOCHEMISTRY OF LIPIDS AND MEMBRANES IN IRRADIATED AND NEOPLASTIC CELLS

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The overall goal of this proposal is to determine the influence of irradiation, aging, and neoplasia on the molecular organization and function of membranes and on metabolic pathways for lipids in bone marrow, liver cells, cancer cells, and erythrocytes from mammals. The following projects are under investigation: (1) Effects of irradiation and aging on enzymic systems as related to the formation of fat cells in bone marrow tissue. (2) Effects of irradiation and aging on the structure and function of surface and intracellular biomembranes of liver cells and erythrocytes, (3) Lipid biochemistry of cancer cells, and (4) Radioprotective properties attributed to lipids and related compounds. The sources of tissues used in this research will be mice, rats, tissue culture cells (HeLa, Ehrlich ascites, and L-M fibroblasts) and humans.

Results: Forty publications on various aspects of the project have been published or accepted for publication. A complete listing is available from the Principal Investigator.

SUPPORTED BY U.S. Atomic Energy Commission

5.0629, RADIOECOLOGICAL EFFECTS OF FALLOUT

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Technical Objective: To determine the effects of chronic 137CS irradiation on a grass community and establish the rate of 137CS cycling runoff and leaching.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0630, RADIATION MUTAGENESIS IN MAMMALIAN CELLS IN VITRO

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The availability of genetic markers and the demonstration by us of chemical mutagenesis in mammalian somatic cells in culture indicate the feasibility and desirability of studies on radiation mutagenesis in the same cell system. Our purposes are three-fold: (1) to find the dose- effect relationship in the induction of gene mutations in mammalian somatic cells in culture; (2) to identify the nature of the genetic alterations at the mutational sites following exposure to X-rays or ultraviolet light; and (3) to compare the spontaneous and induced mutation rates, (a) between different loci in various types of somatic cells 'in vitro', and (b) between the comparable loci in somatic cells in vitro and in the somatic and germinal cells in intact mammals including man.

We have initiated experiments in which Chinese hamster cells and normal human diploid cells 'in vitro' were exposed to various doses of X rays. The mutational change assayed was the forward mutation from 8- azaguanine sensitivity to resistance. Resistance arises from a loss or reduction in activity of hypoxanthine guanine phosphoribosyl transferase. In Lesch-Nyhan syndrome in man, the gene controlling the same enzyme activity is X-linked.

Results: The X-ray survival of the hamster cells fits approximately a multi-target relation. With the X ray dose range used (0 to 1200 r) the frequency of induced forward mutation as a function of survivors increases significantly with dose. Forward mutation to a presumably X-linked recessive is a single event at doses below 200 R. At higher doses, however, the mutant frequencies increase in proportion greater than the first power of the dose. Moreover, there is a saturation effect at doses higher than 800 R. By reversion test, we have evidence that in mammalian cells X rays induce both nucleic acid base changes and gross deletions.

SUPPORTED BY U.S. Atomic Energy Commission

5.0631, MAINTENANCE OF MEMBRANE INTEGRITY IN MAMMALIAN CELLS

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Although in most cells DNA is the most sensitive target for many injurious chemicals or for radiation, there is evidence that surface membranes, which comprise a large and vital component of cellular structure, are also sensitive to noxious environmental factors. Surface-membrane damage is detectable physiologically by a decreased ability of cells to maintain their normal ionic relationships with their milieu; such lesions may be detected by changes in ionic composition of cells, changes in steady-state ionic fluxes, or concomitant changes in cell volume which may ultimately lead to lysis. In a number of cells, radiation-induced changes in such physiological parameters are reversible, a fact which implies that the membranes have been repaired. Techniques are now available for the isolation of surface membranes, and for the study of the turnover of chemical components of such membranes. We plan to correlate the physiological alterations observable in mouse ascites cells, which show rapid physiological repair, with turnover of membrane components. Non-nucleated mammalian erythrocytes, which carry out no protein synthesis, will be used as 'repair-deficient' controls.

Results: The ultraviolet action spectrum for erythrocyte lysis (known to be a membrane-damage phenomenon) has been determined. The distinct peak at 280 nm and trough near 255 nm implies absorption by aromatic residues in membrane proteins, and suggests further investigation of turnover of membrane proteins in the ascites cells. A correlation of the increased ionic fluxes after irradiation with cell- volume changes, and with the calculated safety factors representing the cells' ability to cope with these increased fluxes without lysis has led to an estimate of an LD50 for 'membrane death'. For human erythrocytes, this number is about 10 to the 3rd power ergs mm2 following irradiation at 280 nm.

SUPPORTED BY U.S. Atomic Energy Commission

5.0632, RADIOLOGICAL AND HEALTH PHYSICS HUMAN STUDIES

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Data needed for estimating absorbed dose from radionuclides entering the body are obtained by cooperating with staff of hospitals and universities where human data on stable element composition of tissues, diets, and anatomy are available. Specimens for analysis and data on weights and dimensions of organs are sought from grossly normal subjects coming to autopsy following sudden death. Currently, data are being gathered on blood content of lungs, weights of sections of the gastrointestinal tract, and composition of various types of bone- cortical, trabecular, cartilage. Cooperative studies are under way to estimate the position of the fetus in relation to other nearby organs (bladder, gastrointestinal tract) as preliminary to estimating dose to the developing fetus from photon emitters present in these organs.

Results: Data on trace element content of complete diets of a few adults have been obtained, the sampling extending over several years. Excreta of these same individuals have been analyzed as a basis for balance studies of individuals eating diets of their choice.

SUPPORTED BY U.S. Atomic Energy Commission

5.0633, THE EFFECT OF PREVIOUS PARITY ON THE INDUCTION OF OVARIAN TUMORS IN IRRADIATED MICE

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5. RADIATION

In a variety of radiation survival experiments previously performed on the RF mouse, it was repeatedly noted that exposure to sublethal whole-body radiation results in a marked increase in the incidence of ovarian tumors. The mice used in those experiments were always virgin females of differing ages. The effect of preradiation multiparity as an experimental modification of this system is unknown. The present experiment will compare ovarian tumor incidence (as well as life span and other disease incidence) in virgin females (either unirradiated or exposed to 150 R at approximately 6 months of age) or in females who have borne several litters of young, under the same treatment conditions. The procedures will be standard for those used in our survival experiments; maintenance in an open colony or a barrier colony, necropsy examination at time of death or terminal illness, and accumulation, storage, retrieval, and comparison of the life and disease data.

Results: The four groups of mice to be maintained in conventional colony conditions (virgin female-unirradiated or 150 R exposure, multiparous-unirradiated or 150 R exposure) have been set up and are some months post-treatment. Upon death, necropsies will be performed and data accumulation will progress. It is hoped to start the same types of groups in the barrier-maintained portion of the experiment.

SUPPORTED BY U.S. Atomic Energy Commission

5.0634, DISEASE OF WILD SMALL MAMMAL POPULATIONS ON RADIOECOLOGY STUDY AREAS

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The small mammals under study are those species involved in radioecology studies at ORNL, principally white-footed mice, cotton rats, rice rats, and shrews. These animals occupy various diverse habitats on the large AEC reservation area in Roane and Anderson counties in Tennessee. In order to tell if waste disposal, proximity to nuclear installations, etc. are having an effect on populations, it is necessary to know the usual activity patterns, diet, habits, reproductive performance, life span, diseases and other parameters in the populations involved. On the AEC area, control populations of the various species are available from uncontaminated sites for comparison with populations from sites with various degrees of contamination or disturbance. During the course of activities of the radioecology section, animals found dead or killed for test purposes are examined, and the necropsies are furnishing information on the disease parameters of the comparative populations. Where indicated, in-laboratory experiments are also performed on colony-maintained mammals of the same species. To a lesser degree, other species are monitored when available and other off-area sites are occasionally sampled for comparison.

Results: Information has beeen accumulated on well over 1000 mammals of several species and some case reports and extensive histologic reviews will be prepared. As new mammals become available, the information from their study will be integrated with that already available. Gross pathological and histological examinations are also being made on irradiated rodents living in field experiments and on wild species in laboratory experiments.

SUPPORTED BY U.S. Atomic Energy Commission

5.0635, CYTOLOGY AND TISSUE CULTURE IN GENETIC AND DEVELOPMENTAL STUDIES

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We will continue to use a number of recently developed techniques to study radiation produced genetic damage in the mouse and to compare this with genetic damage produced by other agents.

One area of study which raises problems of practical concern, as well as giving insight into basic mechanism, is the induction of enzymes in the test animals by chronic feeding of antioxidants in the food prior to irradiation or administration of the test mutagen. The concern is over the facts, repeated below, that agents which give protection against genetic and somatic damage by chemical agents actually increase the risk of radiation damage.

A correlated type of study which we will continue to emphasize is the separation of specific germ cell stages from the mouse testis to assay for enzyme activities involved in repair of radiation-induced and other genetic damage.

A project has been completed on the effects of prefeeding of BHT (butylated hydroxytoluene) on subsequent damage by X-rays and radiomimetic compounds. Both somatic damage and the induction of dominant lethal mutations by X-rays are increased by BHT prefeeding. This is in the opposite direction from results obtained for a number of alkylating agents, where BHT prefeeding protects dramatically against both genetic and somatic damage. The marked contrast in effect between radiation and alkylating agents applies even to cyclophosphamide which gives somatic effects very similar to those produced by X-rays.

SUPPORTED BY U.S. Atomic Energy Commission

5.0636, COMPARISON OF DOSE FRACTIONATION AND PROTRACTION AND RBE FOR LATE SOMATIC EFFECTS IN MICE IRRADIATED WITH FAST NEUTRONS

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The objective is to provide needed practical information as well as further insight into radiobiological mechanisms in regard to life shortening, tumor induction, opacification of the lens and other late somatic effects of ionizing radiation following whole body exposure of mice to acute, fractionated, and protracted whole body doses of fission spectrum neutrons and X-rays or gamma-rays. Mice are being or will be irradiated with single doses or fractionated doses at weekly intervals in the Health Physics Research Reactor with cumulative absorbed doses up to 200 rads. Protracted irradiation (1 rad/day) will be furnished by a small 252Cf source with a uranium housing to produce a simulated fission spectrum and substantially reduce the gamma/n ratio.

RESULTS: Preliminary results on induction of lens opacities (as observed with the slit lamp) with single doses of fast neutrons show that the RBE declines slowly or remains constant with increasing dose above about 100 rads. With decreasing dose, the reciprocal relation to dose becomes more pronounced and remains so at least to 1 or 2 rads. The completed results should allow RBE to be expressed as an analytical function of response parameters over a broad dose span down to threshold or near zero level for this particular mammalian tissue and aid in predicting dose-response behavior for other less radiosensitive effects.

SUPPORTED BY U.S. Atomic Energy Commission

5.0637, LETHAL EFFECTS OF NEUTRONS TO THE MOUSE ZYGOTE AND EARLY EMBRYO

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The human implications of and lack of definitive information on effects of high-LET irradiation on mammals in the early prenatal period have prompted a study of radiation effects of fast neutrons on the zygote and early embryo in the mouse. Mice are mated overnight and those females showing vaginal plugs are irradiated a few hours later with single doses of fission neutrons or are sham irradiated in the Health Physics Research Reactor. Seventeen days later dissections are performed and the incidence of live embryos, dead embryos, and uterine resorption sites is tabulated. Neutron doses of 2, 5, 10, 15, and 20 rads are being utilized and compared to results obtained with X ray doses of 20, 40, 80 and 100 rads. Some mice have been allowed to come to term and the litters have been set aside to study the incidence of lens opacities and tumors and longevity.

RESULTS: An increase in prenatal deaths has been found at all neutron doses. It appears that survival is a decreasing exponential function of dose of neutrons. Increased prenatal death has also been seen at the higher X ray doses but the precise shape of the dose- response curve is not yet established. The relative biological effectiveness (RBE) of neutrons will apparently vary markedly with radiation dose level.

SUPPORTED BY U.S. Atomic Energy Commission

5.0638, MODIFICATION OF LATE SOMATIC EFFECTS OF RADIATION BY HYPOXIA

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In an earlier study, irradiation of young adult RF mice with X rays (450-900 R) in a hypoxic gas mixture (5% oxygen in helium) as compared to air, gave a dose reduction factor of approximately 3 for life shortening. Also the dose-incidence relation normally found in this strain for radiation-induced leukemia (mostly thymic lymphoma) appeared to be displaced towards higher doses by hypoxic treatment but the data were not adequate to confirm this. We are now extending these observations to additional dose levels. Hypoxia had a definite but less pronounced effect on the induction or severity of radiation cataract. We have started experiments to see if this lack of protection for radiation injury to the lens cortex extends to lamellar or nuclear cataract, a subcapsular lesion induced before adulthood in high frequency by exposing newborn mice to moderate radiation levels.

Results: According to the initial findings in newborn mice. hypoxia reduces both the degree and severity of nuclear cataract produced by irradiation (150 R and 300 R) but the extent of the protection is yet to be determined.

SUPPORTED BY U.S. Atomic Energy Commission

5.0639, STRUCTURE OF THE SPORE-TYPE PHOTOPRODUCT

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Ultraviolet irradiation of bacterial spores produced thymine photoproducts which were chromatographically different from cyclobutane- type pyrimidine dimers produced in vegetative cells or in free DNA. These spore photoproducts were also produced along with pyrimidine dimers in dry DNA and dry films of nucleotides and nucleosides of thymine. Dry films of thymine monophosphate will be irradiated in order to produce enough of the major spore product to elucidate its structure by conventional chemical means.

Results: Ultraviolet, infrared and NMR spectra are consistent with the spore photoproduct being 5'-thyminyl-5-(5,6,Dihydrothymine).

SUPPORTED BY U.S. Atomic Energy Commission

5.0640, RESPONSES OF ANIMALS TO IONIZING RADIATION

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Major research objectives of these studies are to: (1) describe genetic constitutions of natural and laboratory populations and to determine effects on genetic structure by interacting influences of environmental stresses and ionizing radiation, (2) determine radiation effects on cells, tissue, life processes, and individuals of wild species, (3) measure effects of interactions between acute and/or chronic irradiation and environmental factors on populations, and (4) evolve models for prediction of radiation effects in animal components of ecosystems. These studies will provide data on the relative environmental hazard associated with the use of nuclear energy for peaceful purposes. Specific radiation-effected parameters being studied include mortality, reproduction, chromosomal aberrations, tissue damage, blood changes, metabolism, and age dependent effects. Organisms utilized for these studies include mammals, fish, amphibia, snails and insects. Comparative data on species differences, developmental stages, poikilothermy vs. homeothermy, competition, and environmental factors are providing essential input for predictive models of mixed population responses to radiation.

Results: 'Chironomus riparius' larvae reared in 250 and 500 micro curies H3/ml developed significant numbers of chromosomal aberrations but no aberrations were observed at the MPC level of 0.1 micro curies H3/ml. Blood changes are an important parameter for radiation effects and studies showed that Fe59 turnover reflects erythropoiesis, providing a useful non-destructive index for blood changes in free-ranging, irradiated mammals. The mean survival time of irradiated white-footed mice varies seasonally with a longest survival in June and the shortest in October.

SUPPORTED BY U.S. Atomic Energy Commission

5.0641, EFFECTS OF NUCLEAR ELECTROMAGNETIC PULSE (EMP) ON CIVIL SYSTEMS

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Objective is to determine whether EMP can seriously affect the performance of vital civil systems during a nuclear attack, and if so to find appropriate countermeasures.

EMP, an intense pulse of electromagnetic fields accompanying a nuclear detonation, can induce large currents and associated voltages in cables or other conductors. It is known that malfunction or damage in unprotected electrical or electronic equipment can sometimes result.

The research program is largely theoretical, although some experiments have been performed. Elements involved include: the determination of electromagnetic field characteristics, studies of the coupling of field energy into various conductor configurations, characteristics and effectiveness of various protective devices and methods, susceptibility to damage of equipment, and resultant system performance.

SUPPORTED BY U.S. Atomic Energy Commission

5.0642, RADIATION RESPONSE OF A SUB S SPERMATOGONIA

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Identification of the A sub s (A-stem) spermatogonium has changed our concept of stem cell renewal, and bears not only on our understanding of cell differentiation, but also on our understanding of the effect of agents which affect fertility and mutation frequency. The use of long-term 3H-thymidine labeling in conjuction with radiation revealed a possible relationship between differential cell survival and the effects of both high doses and dose fractionation on mutation frequency. This experiment should be repeated, and the investigation extended to other radiation doses and dose rates.

Results: A sub s spermatogonia have been shown to be radiation resistant, and to be the only spermatogonial type surviving doses of over 100R. The data suggest that qualitatively, the spermatogonial population surviving 100 and 500R is the same, and that the kinetics of these cells for the 8.5 - 17 day post-irradiation interval is the same as for the A sub s cells in controls. Thus one can be more confident that extrapolation of the straight line portion of the mutation rate curve should not result in underestimation of the effect of low doses.

SUPPORTED BY U.S. Atomic Energy Commission

5.0643, RADIOSENSITIVITY OF IMMUNOCOMPETENT CELLS IN STATES OF FLUX

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The objective of this project is to determine if the radiosensitivity of immunocompetent cells changes when steady-state equilibrium is destroyed by radiation or altered by continuing senescence. Recovery of immunocompetence in mice after sublethal irradiation as measured by generation of hemolysin plaque-forming cells occurs over a period of weeks. The recovery is characterized by a decrease to a minimal level of immunocompetence followed by exponential and abortive phases leading finally to an overshoot and gradual return to steady-state equilibrium. Assessment of radiosensitivity of immunocompetent cells in these phases and in senescent mice will be accomplished by obtaining the D37 values for those cells.

Results: D37 values for immunocompetent cells in abortive and exponential phases of recovery following irradiation are not significantly different from the D37 value for immunocompetent cells in steady-state equilibrium.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0644, X-RAY-INDUCED DAMAGE TO THE DNA OF HAEMOPHILUS INFLUENZAE AND CELLULAR RESPONSE TO THAT DAMAGE

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Our ultimate goal is to determine the molecular mechanisms of the genetic effects of radiations. Using biophysical and genetic techniques, we compare and contrast results of X-ray and ultraviolet (UV) irradiations. 'Haemophilus influenzae' cells are being used as a test system in studies of X-ray irradiation of whole cells and of transforming DNA irradiated 'in vitro'. On the molecular scale, initial absorption of energy from ionizing radiations is random rather than by specific molecules, as is typical for UV radiations. Hence doing genetic experiments using transforming DNA first irradiated 'in vitro' simplifies any mechanistic interpretation by reducing the irradiated molecular species to that transforming DNA.

Results: X-irradiation of 'Haemophilus' cells produces single- and double- strand breaks in their DNA, post-irradiation loss of acid insoluble DNA, reduced DNA synthesis, and reduced colony formation. Kinetic models of enzymatic degradation of DNA after X-rays have been developed which account for observed plateaus of remaining DNA being greater than cell survival or the Poisson expectation of unbroken strands. X-ray inactivation of transforming DNA, unlike its UV counterpart, is caused primarily by reduced integration into the host genome. Single strand breaks are correlated 1:1 with loss of transformation. Hence single strand breaks rather than nucleotide damage, seem to determine X-ray inactivation of transforming DNA.

SUPPORTED BY U.S. Atomic Energy Commission

5.0645, UV REPAIR IN NORMAL HUMAN CELLS AND CELLS FROM XERODERMA PIGMENTOSUM PATIENTS

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We are pursuing studies on the induction and repair of ultraviolet radiation damage to the genetic material of human and other vertebrate cells. A major current emphasis of the studies is to characterize and delineate the molecular basis of human UV-sensitive genetic diseases. This goal has been achieved in one such disease, 'Xeroderma pigmentosum'. Similar studies with other UV sensitive human genetic diseases are continuing.

Results: In collaboration with the Biophysics Group we have now thoroughly characterized the normal hyman cell pyrimidine dimer excision system. The first enzymatic step in the excision repair system has been clearly delineated by measurements of the molecular weight of human cell DNA after UV irradiation by means of alkaline sucrose gradients. Initial chain breaks are made by the UV endonuclease enzyme which is the first step in the repair system. This enzymatic function causes a decrease in the molecular weight of the DNA after UV. Utilizing this method and the method of direct measurement of dimer excision we have studied 7 patients with the hereditary disease Xeroderma pigmentosum. The results of these studies showed that in this disease essentially no dimers were excised and essentially no chain breaks were seen in sedimentation studies of the cell's DNA after UV irradiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0646, HEMOPOIESIS AND RADIOSENSITIVITY

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The state of activity of hemopoiesis at the time of exposure to ionizing radiation appears to be related to radiosensitivity of mammals. The broad objective of the project is to relate changes in hemopoiesis with radiosensitivity of the mouse. Of the methods we have used to evoke a marked change in hemopoiesis, injection of phenylhydrazine is most interesting becauue the chemical not only accelerates erythropoiesis but also alters the LD 50/30. The basis for this alteration in radiosensitivity may involve changes in numbers or in radiosensitivity of hemopoietic stem cells or a stimulation of the reticuloendothelial system. To test these possibilities, changes in stem cell number are assessed by quantitative transplantation of isogeneic hemopoietic cells into X-irradiated mice. Proliferative potential or surviving stem cells are measured by 30-day survival, by ferrokinetic, by spleen colony, or by hematologic methods.

Results: Phenylhydrazine given to mice 1 or 2 days before or after irradiation reduced the LD 50/30 considerably. The reason for this reduction is unclear. The LD 50/30 is increased about 100 R, however, when the drug is given about one week before exposure. Concomitant with protection, there is an increase in stem cell number in the spleen but not in the bone marrow, and there is not an increase in radioresistance of hemopoietic cells.

SUPPORTED BY U.S. Atomic Energy Commission

5.0647, LATE EFFECTS OF EXPOSURE TO LOW AND MEDIUM LEVELS OF WHOLE BODY IRRADIATON IN MICE

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The objective is to determine the relation of small doses of gamma radiation to shortening of life span and induction of neoplasms and other degenerative diseases, and to determine if the rate of irradiation (41 vs. 0.007 rad/min) changes the dose-response relation. At present it is difficult to estimate with confidence the shape of the dose- response curve for somatic effects at doses below about 100 rads. Yet, the chance of people being exposed to low doses appears to be increasing with the increased use of radioactive sources in power production, science, industry, and medicine. The experiment is presently divided into two phases: 1) Each week groups taken from a total of 120 ten-week-old mice were exposed to a single whole-body dose of 10 to 300 rad of gamma radiation at a rate of 40 rad/min. They are then maintained under rigorously controlled environmental conditions - to protect the mice from infectious disease and to reduce the influence of other variables since the difference in results for control and experimental mice are expected to be small. Most of the mice are allowed to live until death occurs naturally. Some of the mice are killed at weekly intervals from 12 to 120 weeks of age (Serial Sacrifice Group). All mice that die are examined by pathologists. The last of 15,000 mice in this phase were recently irradiated and the second phase was begun. 2) About 5000 mice, divided into two dose rate groups (40 and 0.007 r/min), will be handled essentially like those in phase one.

RESULTS: About 9,000 mice in phase one have died but it will take about two more years before the last mouse dies and the total data are available. Preliminary evaluation of the interim data, however, suggests that there may be a linear dose-effect down to the lowest dose tested - 10 rads. The problems in initiating phase two have been solved and it is well under way.

SUPPORTED BY U.S. Atomic Energy Commission

5.0648, THE CONTROL OF RESPIRATION IN UV-IRRADIATED BACTERIA AND ITS SIGNIFICANCE IN RECOVERY FROM RADIATION DAMAGE

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Ultraviolet irradiation (UV) of 'E. coli' B/r cells grown on glycerol causes almost complete inhibition of respiration and growth for several hours beginning about 1 hour after UV. The cessation of respiration is dependent upon RNA and protein synthesis and is associated with the disappearance of pyridine nucleotides from the irradiated cells. Immediately after a UV dose of 500 ergs, mm2 survival is about 1%; beginning about 2 hours after UV, the number of viable cells in the culture increases exponentially. We are using this system to study the role of DNA in the control of respiration in irradiated cells and to determine the biochemical and physiological steps leading to death or survival. We have isolated several niacin-requiring mutants of B/r and will trace the fate of isotopically labeled pyridine nucleotides after UV irradiation. Our approach to the death-survival problem is to use physical and chemical post-UV treatments that promote respiration and see how survival and other parameters for the treated cells differ from the untreated ones.

Results: Post-UV treatment with heat (45 C for 30 min) and 5- fluorouracil both prevent the cessation of respiration and promote cell survival. Immediately after UV, all irradiated cells support growth of T-4 bacteriophage but after 2 hours only viable cells support this growth. Heat treatment and 5-fluorouracil increase markedly the capacity of irradiated cells to support phage growth.

SUPPORTED BY U.S. Atomic Energy Commission

5.0649, VIRUS ACTIVATION IN RADIATION AND CHEMICAL CARCINOGENESIS

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It has been demonstrated that radiation-induced leukemia in C57BL and RFM mice is etiologically related to a specific class of viruses. It is uncertain, however, whether radiation acts to induce leukemia by: a) inducing proliferation of target cells susceptible to an indigenous leukemogenic virus or, b) that irradiation is capable of specifically activating the oncogenic potential of the virus or subcellular mechanism.

A means of distinguishing between these and some other alternatives is to determine if X-irradiation is able to activate viral synthesis in cultured cells, and then to determine whether the cells and/or the virus are leukemogenic. The same basic questions apply to neoplasms induced by chemical carcinogens. If the mechanisms of radiation and chemical carcinogens actually involve virus activation the most direct way in which this can be proven is with cloned cells in culture.

Results: The techniques necessary to assay murine leukemia virus synthesis and quantitate the number of cells in which the virus multiplies have been adopted. Experiments have been initiated to determine 'in vivo' the rate of viral 'activation' and the minimum dose of X-rays required. Other experiments have been initiated to test for activation of virus synthesis in cultured mouse cells. No results are yet available.

SUPPORTED BY U.S. Atomic Energy Commission

5.0650, PATHOGENESIS OF RADIATION INDUCED HEMOPOIETIC DEATH IN GNOTOBIOTIC MICE

H.E. WALBURG, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

Germfree (GF) mice exposed to radiation in the lethal range have only a slightly higher LD50/30 when compared to conventional (CONV) mice of the same strain. Since infection appears to play a major role in the death of irradiated animals, a sizeable increase in LD50/30 might have been expected. Since most of the GF mice die during the first two weeks following irradiation before the number of erythrocytes has been seriously reduced, anemia does not appear to contribute greatly to the death of the animals. Initial observations also suggest that hemorrhage is very much reduced in GF animals compared to their CONV counterparts. Although bone marrow replacement therapy is successful in preventing hemopoietic death in irradiated GF mice, it would appear that treated animals are not dying from absence of mature functional elements normally produced by the bone marrow. We have undertaken experiments to clarify the cause of death of lethally irradiated GF mice.

Results: Studies on the repopulation of the hemopoietic system in irradiated mice using organ uptake of 125IUDR suggested an effect of the microbial flora only as regards the rate of repopulation of the mesenteric lymph node. No evidence of defective repopulation of erythrocytic or granulocytic compartments was noted in GF mice. Studies on replacement therapy with mature cellular elements of the blood have been initiated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0651, INFLUENCE OF THE MICROBIAL ENVIRONMENT ON AGING AND LONG TERM EFFECTS OF RADIATION

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To determine the role of the microbial flora and fauna in aging and in the development of senescent lesions, germfree (GF) and conventional (CONV) irradiated and unirradiated mice are being examined with respect to their life span and incidence of disease. The data from these experiments should help define the influences of microbial environment on survival and help differentiate those pathological processes which are a response to the microbial flora from those caused by senescence of cellular and organ systems. These data will also permit the characterization of those specific diseases which are responsible for the life shortening effects of radiation in mammals. Mouse strains which have been or will be studied include those with short life span and specific cause of death and those with a long life span and nonspecific causes of death. Strains to be studied include non-inbred ICR and inbred RFM, AKR, C3H, DBA/2, and C57BL/6.

Results: In all strains studied to date, the mortality rate is lower in the germfree mice reflecting primarily a decreased mortality rate the first half of the life span. While most diseases that occur in CONV mice also occur in their GF counterparts, some neoplastic and non- neoplastic diseases occur with different incidences and different time of onset. Those diseases which are most affected by the microbial environment involve tissues of the host defense systems.

SUPPORTED BY U.S. Atomic Energy Commission

5.0652, RESPONSES OF PLANTS AND PLANT COMMUNITIES TO IONIZING RADIATION

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The major objective of this program is to provide an ecological assessment of the consequences of ionizing radiation on higher plants and plant communities. Experimentation with environmental and population variables that influence radiosensitivity is designed to provide both information on the detrimental effects of radiation and knowledge of how ecological systems function. At the species or population level growth chamber and green house facilities furnish means of controlling and testing ecological factors that interact with ionizing radiation to produce effects in natural assemblages of plants. An understanding of these interactions is prerequisite to interpretation and prediction of the consequences of radiation, or other man-made peturbations, in natural systems. The differential affects of several types of radiation are studied. Currently, information on radiosensitivity of native and agricultural plants to beta radiation is being compiled. In addition to providing new information on responses of plants to this particular radiation type, these studies should lead to the development of better radiological hazard assessments of nuclear weapons fallout. At the species level, studies on the effects of ionizing radiation on functional processes such as photosynthesis and nutrient transport continue to furnish parameters which can be used to assess ecological effects at a population or ecosystem level of organization.

Results: The interaction of sublethal ionizing radiation and light intensity on yellow poplar and silver maple tree seedlings adversely affected functional processes such as photosynthesis, root development and carbohydrate formation. Yellow poplar was more sensitive than silver maple but the survival capacity of both was reduced. The retention of particulate fallout simulants on plants depends more on species growth form and habits than the type and mode of fallout deposition. Chronic field exposure of fescue grass to 0.5 r/hr reduced seed production and germination significantly after a cumulative dose of 3000 rads.

SUPPORTED BY U.S. Atomic Energy Commission

5.0653, THE TIME COURSE OF RECOVERY FROM GAMMA RAYS AND FISSION NEUTRONS

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The objective of the present study is to provide a theoretical model and its experimental verification for radiation injury appearance and disappearance in the multiple physiological systems of the mammal. The model which has been developed requires only simple dose versus survival time data, and it is amenable to

experimental alterations such as pre- and post-exposure conditioning. In addition, the method of analysis is applicable to retrospective studies on data previously obtained for many large mammals. The experimental verification of this method is split into two phases, the acute and late effects. For the analysis of acute effects, approximately 2000 LAF sub 1 hybrid mice will be exposed to graded doses of gamma rays or fission neutrons, with the doses spaced equally in terms of their reciprocal. The late effects portion of the verification will be obtained from extensive gamma ray and neutron studies. In brief, these studies will provide estimates of the late effects of these two radiations if delivered early in life (t sub 1) or later in life (t sub 2), or thoughout the t sub 1, t sub 2 interval (chronic or fractionated). Each of these responses should be predictable by the model.

RESULTS: In comparing the present model with those in the literature, three major advantages have been uncovered: greater accuracy, greater experimental flexibility, and greater usefulness in large animal analyses. For example, the present model has been applied to such diverse problems as hematopoietic recovery and chemoprotection in mice and radiation injury in cold-blooded vertebrates. In each case, the calculated recovery kinetics corresponded closely to those determined by extensive analyses of single injury modes, and provided new information on a variety of injury modes.

SUPPORTED BY U.S. Atomic Energy Commission

5.0654, LATE EFFECTS OF RADIATION AS A FUNCTION OF DOSE RATES BETWEEN 1 R PER DAY AND 1 R PER SECOND

J.M. YUHAS, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405)

The objective of the present study is to define the relationship between dose and dose rate and a variety of late effects of ionizing radiation. The study is essentially a factorial design with 5 total doses given at 1 of 8 dose rates to adult CAF1 hybrid mice. Not all cells of the experiment will be included; i.e. some which are known to be ineffective or maximum response points will be deleted. Approximately 200 mice will be placed in each cell. With appropriate spacing of doses and dose rates it will be possible to analyze the effects of dose rate at a given total dose, the effects of total dose at a given dose rate, the effects of exposure time on a given dose, and the effects of variable dose over a constant time. Samples of mice will be given similar total doses later in life, in order to provide estimates of latent period for expression of injury.

RESULTS: The mathematical development of a model on which this experiment is based has been completed, and is covered in another abstract (Yuhas and Darden: The Time Course of Recovery from Gamma Rays and Fission Neutrons) and the complementary fission neutron study is also covered elsewhere (Darden and Yuhas: Late Effects of Single and Fractionated Doses of Fission Neutrons and Gamma Rays).

SUPPORTED BY U.S. Atomic Energy Commission

5.0655, LATE EFFECTS OF LOW DOSE RATE GAMMA RAYS DURING THE PRENATAL PERIOD

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The injury induced by radiation depends on the age or state of maturation of the host at the time of exposure. The foetal mammal is particularly sensitive to most forms of somatic injury which manifest themselves within a short period after irradiation, and the question immediately arises whether the extreme radiosensitivity of the foetus applies also to such late effects of radiation as life shortening and carcinogenesis. The experiments we are conducting will determine the late somatic effects of low dose rate gamma rays (approximately 1 R per 20 hour day) given during the preconception, foetal, post-natal, or young adult periods. These low radiation levels were selected in order to avoid 'artificial selection' of the experimental population through the induction of acute mortality and to provide exposure levels which would approximate those which might be received by the human foetus.

RESULTS: This is a new project that is just starting.

SUPPORTED BY U.S. Atomic Energy Commission

5.0656, EFFECT OF RADIATION ON TRACE ELEMENT METABOLISM IN CATTLE, SHEEP AND SWINE

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Effect of radiation on trace element metabolism in cattle, sheep and swine (part of a coordinated program of research on trace element metabolism and disease in animals of agricultural importance).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0657, EFFECTS OF FALLOUT RADIATION ON AGRICULTURE

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Technical Objective: To define the problems posed for civil defense by the effects of fallout radiation on important agricultural crops and food producing livestock.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0658, METABOLISM OF TRACE ELEMENTS

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The research in this phase is concerned primarily with effects of both external and internal beta and whole-body gamma irradiation on animal metabolism of minerals. This includes not only stable mineral elements but also the use of radioisotope tracer techniques. Emphasis is placed on the whole animal functioning as a coordinated unit to supply necessary data and guidelines for organ systems and detailed biological research. Species comparisons are made among those which are economically important to man as food and also among those similar to man in size and metabolic functions. Imbalance of food nutrients and interaction of radiation damage and metabolism of both nutrients and toxic ions are being investigated. Results from these data are of dual value to supply not only radiation biology data, but also essential information on animals which supply about 40 percent of the food energy and about 68 percent of the food protein in the human diet.

RESULTS: Feeding cattle and sheep 2 to 2.4 mCi Y90 labeled sand/kg of body weight increased in vitro Zn^{65} RBC uptake, increased plasma Cu and reduced plasma Mg and Ca. Irradiation of 8 to 12 percent of the skin from Sr90-Y90 sealed sources increased in vitro Zn65 RBC uptake, increased plasma Cu and decreased plasma Fe. Stable plasma Zn was only slightly altered and the Zn65 RBE uptake appeared to be associated with the development and recovery from the beta irradiation lesions. Whole body gamma irradiation had no measurable effects on these parameters.

SUPPORTED BY U.S. Atomic Energy Commission

5.0659, RADIATION STUDIES ON LIVESTOCK UNDER SIMULATED FALLOUT CONDITIONS

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The research in this phase is designed to obtain information that is not available from the literature on the assessment of vulnerability of livestock production to fallout radiation. This will include research primarily on food-producing ruminant (cattle and sheep) livestock to determine the effects of gastrointestinal (GI) and skin beta exposures and the interaction of these with whole-body gamma irradiation. Limited studies are also proposed for swine. Over 80 percent of our ruminant livestock are continuously on grazing land throughout the year and could be exposed to ingested fallout, skin burns, and whole-body gamma irradiation. Data are needed on ruminants because they are important not only as a food reserve valued at over 18 billion dollars, but they also presently supply about one-fourth of the energy, one-half of the protein and three-fourths of the calcium to the U.S. diet. It is expected that radiation effects on livestock lethality, productivity, radiation insult interactions, gross and microscopic pathological changes and metabolic alterations will be studied in these irradiated animals.

Supported in part by funds from OCD through DBM.

RESULTS: Most of the sheep and cattle exposed to multiple modes of radiation died within 60 days. These simulated fallout radiation sources were: gastrointestinal tract radiation from feeding Y90 labeled sand; radiation of 8 to 12% of the skin using sealed Sr90-Y90 sources; and 240 R at 1 R/min whole-body gamma from 60Co. Deaths within 60 days from single sources was restricted to only a small percentage of those fed Y90 labeled sand. Anorexia, diarrhea and severe weight loss were the principal results from feeding Y90 labeled sand which caused severe damage in the rumen and abomasum. Skin irradiation reduced productivity while whole body gamma had no measurable effect on livestock productivity.

SUPPORTED BY U.S. Atomic Energy Commission

5.0660, EARLY EFFECTS OF 14 MEV NEUTRON IRRADIATION IN SWINE

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The purpose of this study was to obtain as much information as possible from a small number of swine on the effects of 14 Mev neutrons which would permit comparison of data of lower energy neutron and gamma radiations. The areas of study were the general clinical changes, hematology (complete blood counts), mortality and gross and microscopic pathology.

There was no information available on the effects of high energy neutrons on large animals of size comparable to man and the need for this information from the standpoint of human radiobiology stimulated the thoughts leading to this study. We were not aware of the possibility or feasibility of exposing swine to 14 Mev neutrons until we were invited by the Health Physics Division of the Oak Ridge National Laboratory, in the latter part of September 1968, to consider using the HENREE-II accelerator at the Nevada Test Site (NTS). The accelerator was scheduled to cease operation in December 1968, thus time was one of several factors which limited the scope and size (number of animals used) of the experiment.

RESULTS: The LD50(30), tissue dose-in-air, was calculated to be 498 rads (95% confidence limits equals 347-649 rads). Dose distribution was very uniform across the animals; thus, the LD50(30) midline absorbed dose was higher than the LD50(30) midline absorbed doses for fission neutrons and Co60 gamma radiation. The higher midline dose, perhaps, contributed to the more severe signs of gastrointestinal damage in the swine exposed to 14 Mev neutrons. The primary cause of death, however, appeared to be due to damage to the hematopoietic system.

SUPPORTED BY U.S. Atomic Energy Commission

5.0661, LATE EFFECTS OF WHOLE-BODY GAMMA AND MIXED NEUTRON-GAMMA IRRADIATION ON LARGE ANIMALS

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Late effects of gamma and neutron-gamma irradiation of burros are being studied. Emphasis is principally on longevity and detection of physio-pathological changes which can be attributed to or associated with irradiation damage. Each animal is subjected to thorough physical and laboratory examination twice yearly. The major portions of these studies have been in progress for more than twelve years.

Data pertaining to late effects of irradiation on long-lived animals are relatively sparse compared to that of short-lived small laboratory animals; thus, data from studies such as these are necessary to bridge the gap between short-lived animals and man. In addition to the need for information on large animals from a human radiobiology standpoint, there is need for knowledge of irradiation effects on food- producing animals which is essential not only in dealing with emergencies, but also with animal management in the event a large percent of our livestock population is affected.

RESULTS: The rate of mortality among the irradiated burros has been much higher than in the controls. Blood dyscrasias, particularly thrombocytopenia have been observed frequently in the irradiated prior to death. The clinical and pathological findings have been similar in the gamma and neutron-gamma irradiated survivors and decedents. The lesion of greatest significance was the decreased number of megakaryocytes in the bone marrow which corresponded in severity to the clinical thrombocytopenia. Life shortening, based on current data, was estimated to be less than 4%/100 R in the gamma-irradiated and less than 7%/100 rads in the bomb-irradiated burros.

SUPPORTED BY U.S. Atomic Energy Commission

5.0662, LATE EFFECTS OF WHOLE-BODY GAMMA IRRADIATION ON THE WORK PERFORMANCE AND RELATED PHYSIOLOGY OF SHETLAND PONIES

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The objective of this study is to evaluate the physical fitness of Shetland ponies which recovered from early effects of whole-body gamma irradiation by subjecting the ponies to work assignments and measuring various physiological changes which occur during exercise.

Studies dealing with effects of exercise on animals surviving irradiation have been limited mostly to small laboratory animals and to the period immediately after irradiation. Little is known about the physical capabilities of large, long-lived animals surviving radiation exposures. The data from this study will contribute to an estimate of the physical capabilities of man following exposure to ionizing radiation.

RESULTS: This experiment has been in progress for more than three years. During the interim the irradiated ponies have performed their work assignments with equal efficiency to that of the nonirradiated controls. Significant differences (P less than 0.05) between irradiated and nonirradiated ponies have been observed in heart rate, respiratory rate and rectal temperatures. Change in ambient temperature appears to affect the irradiated more than the controls.

SUPPORTED BY U.S. Atomic Energy Commission

5.0663, THE EFFECT OF INTENSITY OF 60CO GAMMA RADIATION ON THE EARLY MORTALITY OF SWINE

D.G. BROWN, Univ. of Tennessee, U.T. A.E.C. Agric. Res. Lab., *Oak Ridge, Tennessee* 37830 (AT-40-1-GEN-242)

Irradiation studies with large animals have been limited and little is known about the effect of dose rate. A range of LD50/30 values has been reported for burros and swine exposed to several sources of ionizing radiation and under various field and laboratory conditions. Several variables inherent in each of the experiments from which the lethal values were derived (type of radiation, quality of radiation, minute intensity, and age and size of animals) presumably influenced the mortality response. The contribution of each variable to the mortality response cannot be quantitated from the data available. Dose rate was one of the factors which varied considerably among the experiments reported on swine and appeared to affect the mortality. The highest LD50/30 value was observed at the lowest dose rate and the lowest LD50/30 value was observed at the highest dose rate.

In view of the need in human radiobiology for useful data on animals of sizes similar to man and the increasing use of swine in experimental radiobiology, it has become more imperative that a quantitative analysis of certain variables such as dose rate be undertaken. The purpose of this experiment was to determine the LD50/30 for swine at various intensities while minimizing other variables as much as was feasible.

RESULTS: The LD50/30 values calculated from the data were 717, 433, and 355 R, respectively, for 1, 10 and 50 R/min. The LD50/30 midline exposure doses measured in a 114 kg swine cadaver were approximately 455, 275, and 225 R, respectively. The relative effectiveness of 10 and 50 R/min were 1.65 and 2, respectively, where 1 R/min was assigned the value of 1.

SUPPORTED BY U.S. Atomic Energy Commission

5.0664, CONTROL AND MODIFICATION OF SEED RADIOSENSITIVITY

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5. RADIATION

The major objectives of this program will be to study (1) the influence of various modifying factors, such as oxygen, water content, temperature, etc., on the radiosensitivity of seeds from a wide range of plant species to both sparsely and densely ionizing radiation and (2) the relationship between radiosensitivity of seeds of different species and nuclear factors, such as nuclear volume, interphase chromosome volume, DNA content per nucleus, and DNA content per chromosome in the cells of the embryonic shoot apical meristem. From results of these studies we hope to extend our knowledge of basic mechanisms by which sparsely and densely ionizing radiation induce biological damage in the resting seed.

Seeds are the most frequently used plant part of mutagenic treatment. The advantages of using seeds are that large numbers of relatively uniform individuals can be treated and transported conveniently under conditions which can be precisely controlled and reproduced.

RESULTS: A post-irradiation oxygen effect (OER the difference between 1.3-1.4) has been demonstrated for neutron irradiation of very dry barley and rice seeds. This effect disappears in barley seeds as the water content is increased to a difference of 10 percent. Seeds of different species appear to differ greatly in their response to oxygen treatment following gamma irradiation. For example, OER values range from 1.2 for onion to 13 for rice.

SUPPORTED BY U.S. Atomic Energy Commission

5.0665, THE EFFECTS OF FAST NEUTRONS ON PLANT GROWTH AND MUTATIONS

M.J. CONSTANTIN, Univ. of Tennessee, U.T. A.E.C. Agric. Res. Lab., *Oak Ridge, Tennessee* 37830

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0666, EFFECTS OF RADIATION ON THE REPRODUCTIVE SYSTEM

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Quantitative and qualitative aspects of the evolutionary pattern of the germ cell and associated gonadal structures are being determined within the bovine and porcine species. As specific areas of change are delimited, radiation is administered and its effects are determined both through quantitative and qualitative microscopic analyses of gonads excised at varying times after irradiation and through semen and steroid anayses, where applicable. Since our studies have demonstrated that individuals within the large-animal species vary widely in their basic germ-cell endowment, increased emphasis is being placed on determinations of the ultimate effects a given dose of irradiation has upon lifetime reproductive capacity. In these studies, the technic of unilateral castration (ovariectomy and orchidectomy) is being employed. Not only does this reduce the amount of time necessary to complete an experiment, but in addition, each animal can serve as its own control.

RESULTS: Following doses (50 R/minute) of 82 plus or minus 5, 140 plus or minus 5 and 220 plus or minus 5 rads absorbed by bovine testes aged 20 to 30 days (N equals 10) germ-cell numbers were reduced to 21 plus or minus 2% of control, but level of cellular survival did not differ between doses (P less than 0.01). Also, level of germ-cell survival (21 plus or minus 1% of control) did not differ (P less than 0.05) in testes irradiated (82 to 220 rads) at ages varying from one to 60 days of age, but the number of germ cells per 600 tubular cross- sections increased (P less than 0.01) from 204 plus or minus 36 in day- 60 testes (220 rads) to 468 plus or minus 36 in testes irradiated when 90 plus or minus 5 days of age (210 rads).

SUPPORTED BY U.S. Atomic Energy Commission

5.0667, EFFECTS OF RADIATION ON LIFETIME REPRODUCTION

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The objectives of this study are to determine the effects of varying levels of acute total-body irradiation on 1) fertility and longevity of cows, 2) viability and growth performance of their calves, and 3) long-term pathological response of the survivors.

Sexually mature females were exposed at varying doses up to 400 R single exposure and 600 R in a fractionated double exposure. Two hundred and nineteen of those animals surviving beyond the first 30 days after irradiation are being maintained for their reproductive life.

RESULTS: Neither birth weights nor weaning weights (7 months of age) of calves from irradiated dams has been affected. Also, number of live-births per cow, through seven gestations, has been unaltered by irradiation, even though only 68 percent of the cows (controls and irradiated combined) gave birth to a calf during the past year. Percent of cows surviving to date is as follows: Control - 90; 200 R - 85, 300 R - 68, 400 R - 75 and 300 R plus 300 R - 82.

SUPPORTED BY U.S. Atomic Energy Commission

5.0668, PATHOLOGY

D.F. JOHNSON, Univ. of Tennessee, U.T. A.E.C. Agric. Res. Lab., *Oak Ridge, Tennessee* 37830 (AT-40-1-GEN-242)

The program of radiation pathology is primarily devoted to interpretation of pathological alterations in organs and tissues of animals subjected to various forms, doses, and sources of ionizing radiation. Cadavers are subjected to gross examination, and the samples of tissues taken from them are subsequently reviewed microscopically.

Necropsies and histopathological perusals are not, however, performed solely on cadavers and tissues from animals utilized exclusively for radiological experimental purposes. A variety of conditions and etiological factors are found in relation to deaths in unallocated animals. The observations made concerning many of these cadavers are as important as those rendered in regard to the individuals used for experimental purposes.

Such activities are conducted with the aid of the usual tools employed by the pathologist. These consist of the post-mortem laboratory and instruments, the histotechniques laboratory, histochemistry and conventional microscopy.

RESULTS: In recent years, attention has been directed principally toward detailed studies of long-term survivors of ionizing radiation. Gross studies have been completed on some cattle, sheep, and swine; histopathological evaluation of many of the tissues from these animals is now being conducted. Macroscopic and microscopic perusal of tissues from surviving burros and cattle is still in progress.

SUPPORTED BY U.S. Atomic Energy Commission

5.0669, EFFECTS OF PRENATAL IRRADIATION ON GROWTH

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Growth retardation in rats as a result of prenatal irradiation has been well documented. A gross picture of weight differences may be obtained by considering body and organ weights, but if cell numbers and cellular materials are determined, the reason(s) for smaller animals along with the pattern of growth may be investigated. The rat progresses through three phases of growth which gradually merge from one to the other. Growth due to hyperplasia, hyperplasia plus hypertrophy, and hypertrophy may be followed by determining total DNA (cell numbers) and cellular materials in the organs that are of interest.

Whether growth depression due to irradiation during gestation is a combination of initial cell death, reproductive death or to damage to growth regulating organs that are involved in hormonal secretion or regulation of protein synthesis are areas to be investigated. Several workers have reported impaired enzyme function in the liver of prenatally irradiated animals as a result of radiation insult to the hypothalamus-hypophysis area. Others have shown impaired protein synthesis in the total fetus irradiated between the 14th-16th days of gestation. The impairment of these systems at suboptimal levels would prevent cell division 'from proceeding at a normal level and growth retardation would be the outcome.'

RESULTS: The smaller organs from the irradiated animals are due to fewer cells per organ rather than difference in RNA and protein per cell. The response of liver and kidney from the irradiated animals during the postnatal period, 1-160 days of age, indicates fluctuations in cell numbers in relation to controls ranging from 56 to 84%. The recovery of the thymus and spleen from the irradiated males was similar to adult response to irradiation of these organs and reflects the predominant haemopoietic cells found in that organ. Growth hormone injections in young irradiated males resulted in weight increase ranging from 8-20% over irradiated controls.

SUPPORTED BY U.S. Atomic Energy Commission

5.0670, TISSUE CULTURE STUDIES IN LARGE ANIMALS

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Irradiation damage to chromosome structure and induced changes in cell behavior are being evaluated through the in vitro culture of peripheral blood leukocytes from domestic animals. The favorable number and morphology of the pig's chromosomes and the ease with which their cells grow in culture make this the most desirable of our species. Other species and other cell systems are employed when needed for special purposes or for verification or species comparison. Several parameters of leukocyte behavior in culture are being examined in order to determine whether changes may occur which are well correlated with radiation dose and more eadily measured than the chromosome abrerration rate. Emphasis is placed on the relationship between in vivo and in vitro exposures of cells in an attempt to avoid the necessity of exposing the entire animal in order to evaluate his response to irradiation. We are also exploring the relationship between chromosome damage in somatic cells and that induced in the male germ cells.

RESULTS: Chromosome damage after exposure to 14 MeV neutrons was significantly higher following 'in vitro' irradiation than that found in cells taken from the same animals immediately after a similar exposure. Correlations between dose and aberration rates were sufficiently high with both 'in vivo' and 'in vitro' exposures to permit the development of a formula for predicting 'in vivo' chromosome aberrations from the rate obtained for an 'in vitro' irradiated blood sample. The lower 'efficiency' of neutrons for producing 'in vivo' breaks suggests some protective mechanisms in the 'in vivo' system.

SUPPORTED BY U.S. Atomic Energy Commission

5.0671, RADIOIODINE AND LARGE ANIMALS

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Iodine is of interest both as a necessary dietary trace element and as a potential irradiation hazard. A knowledge of iodine metabolism and effects of I131 thyroid damage is important in the dairy cow, the domestic milk producing animal of greatest economic importance, because of the intimate relationship function lactation. Results obtained with other species do not always apply to cattle because of large quantitative species differences. Current objectives include study of: 1) forms in which iodine exists in the digestive tract and circulatory system and factors influencing absorption and excretion of iodine; 2) interrelationships among various iodine concentrating systems including the thyroid, mammary gland, salivary glands, gastric stomach, placenta, and kidney; and 3) effects of partial thyroid destruction by acute I131 doses on iodine and calcium metabolism and performance, including growth, reproduction, and lactation. Partial thyroid destruction has been produced in one member of each of nine pairs of identical twin heifers by single doses of 100 to 180 muCi I131 per Kg body weight. Calcium-thyroid interactions have been investigated in a total of 33 calves and 12 mature cattle. All cows except one thyroid damaged cow which failed to breed have completed the second lactation, ten cows have completed the third, and one pair has begun the fourth lactation.

RESULTS: Thyroxine replacement therapy was begun for thyroid damaged cows during the second month of the second lactation and continued through the third. Milk yield, body weight, and heart rate of thyroid damaged cows, expressed as percentages of their control twins, averaged 52, 103 and 86, respectively, during the first lactation; 58, 89 and 89 thyroxine therapy in the second; 62, 85 and 111 after thyroxine therapy in the second; and 91, 88 and 103 during the third lactation. Animals with I131 thyroid damage or normal animals fed thiocyanate show decreased ability to clear intravenously administered stable or radio calcium. Thyroxine therapy appears to correct this condition.

SUPPORTED BY U.S. Atomic Energy Commission

5.0672, EFFECT OF DOSE RATE AND TOTAL DOSE OF GAMMA IRRADIATION UPON METABOLIC PARAMETERS IN BIRDS

F.R. MRAZ, Univ. of Tennessee, U.T. A.E.C. Agric. Res. Lab., *Oak Ridge, Tennessee* 37830 (AT(40-1))

Developmental stages of animals are usually more sensitive to irradiation than the adult. The chick embryo being divorced from its mother, permits a closer examination of radiation injury to developing tissues. Therefore, White Leghorn eggs will be irradiated by gamma rays at each of the following dose rates: 1/4, 1/2, 1, 2 and 4 R/hr during the entire incubation period except for 1/2 hour/day. The effect on mortality, growth rate, length of time to sexual maturity of females, egg production, fertility and hatchability of their eggs and growth and reproductive performance of their progeny will be ascertained by a comparison with controls.

The effect of dose rate at maturity upon the progeny of the irradiated hens will be determined using the same parameters. A minimum of 30 White Leghorn hens will be exposed to a total gamma ray dosage of 800 R at each of the following dose rates: 1, 5, 25 and 45 R/min and compared to controls.

White Leghorn chickens at varying ages will be exposed to 800 R from gamma rays at a dose rate of 1 R/min. At intervals after irradiation Ca45, Sr85 and P32 will be orally administered or perfused into the small intestine to assess the effect of radiation upon intestinal absorption, blood levels and tibia deposition of these nuclides.

RESULTS: Mature White Leghorn, Coturnix and Bobwhite Quail females were exposed to various combinations of rate of exposure and total dose levels of whole body gamma irradiation. The irradiated birds laid significantly fewer eggs than the control groups during the first ten- day period following exposure. Total dose seemed more important than rate of exposure. Coturnix and Bobwhite females were less sensitive to the lethal effect of whole body gamma irradiation than White Leghorn females.

SUPPORTED BY U.S. Atomic Energy Commission

5.0673, THE METABOLISM OF STRONTIUM AND RELATED NUCLIDES IN POULTRY

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The fate of strontium in poultry with special reference to its role in the metabolic pathways and their interaction with similar nuclides is our major concern. The mechanisms of discrimination at interfaces of organs, cells and cellular particulates during vital life processes will be investigated. The information obtained in these studies is useful in understanding the relationship of fission products to essential minerals and thereby developing countermeasures to fission product contamination and in understanding aberrations in mineral metabolism.

Strontium and its relationship to calcium and phosphorus in the small intestine of White Leghorn hens are now being studied. Perfusions of the small intestines with varying levels of Ca, Sr and P and their radionuclides coupled with differential centrifugation of the mucosal cells of the small intestines and uteri are being applied. The effects of low dose rate (1 R/min) of externally emitted gamma irradiation (800 R) on the absorption of these elements by White Leghorn chickens utilizing both oral dosing and perfusion are also being studied at different periods after irradiation.

RESULTS: The perfusion of the small intestines of White Leghorn hens (with an egg 'in utero') with varying levels of Ca and Sr revealed a decrease in the Sr85 Ca45 ratios from 0.8 at absorption to 0.5 at the egg shells. The radionuclide contents and

Sr85: Ca45 ratios in the cellular particulates of the small intestine and uterus decreased as particulate size decreased. The presence of Sr without Ca tended to increase Sr85; Ca45 ratios and increase their content in the jejunal and ileal mitochondria. Ca alone brought the ratios closer to unity and reduced the effect of Sr in combination.

SUPPORTED BY U.S. Atomic Energy Commission

5.0674, THE EFFECT OF RADIATION ON PRENATAL DEVELOPMENT

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This phase of our studies is concerned with the effects of dose- rate (gamma radiation from Co60 on the teratogenic response in prenatally irradiated lambs, pigs and rats. Major emphasis is being placed on exposure at developmental stages previously demonstrated to be quite sensitive to radiation. Previous findings have shown that irradiation of lambs on the 23rd-25th days and of pigs on the 20th-21st days of gestation resulted in malformed limbs. No other organ systems have consistently been effected in either species. In rats, the frequency of malformed eyes following exposure on the 11th day and testicular damage following exposure on the 18th day of gestation are the endpoints being used for dose-rate studies in this species.

It now appears that there is a definite dose-rate response in the pig and rat, whereas, the situation in the lamb is equivocal. Future efforts will be directed toward a better characterization of the dose and dose-rate response within and between species.

RESULTS: The effect of a 100 R dose delivered on the 11th day of gestation at rates of 1, 2, 3, 4, 5, 10, 25 and 47 R/min. on eye anomalies in rats has been studied. Frequency of abnormal eyes increased with rates of 1 to 3 R/M reached a maximum at 3 to 10 R/M and appeared to decrease slightly after 47 R per minute.

SUPPORTED BY U.S. Atomic Energy Commission

5.0675, METABOLIC EFFECTS OF GASTROINTESTINAL AND SKIN RADIATION INJURY

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The gastrointestinal syndrome has long been recognized as the result of large doses of X- or gamma-irradiation and the histological changes which occur, particularly in the small intestine, are well documented. Less is known about the metabolic changes produced by radiation injury to the gastrointestinal tract, particularly in large mammals. Although skin erythema was one of the first types of radiation injury to be studied, research related to radiation damage to this organ, like that of the GI tract, has been focused primarily on histological changes. Radiation damage to either of these areas may produce serious alterations of the metabolic processes, which though not fatal themselves, may be contributing factors in hematopoietic radiation death or have a deleterious effect on the long term health of the animal. Development of methods to measure damage to the skin and gastrointestinal tract would be useful in determining the relative biological effectiveness of neutrons for damage to these organs.

Results: Concentrations of iron, copper and zinc in the plasma and erythrocytes, uptake of Zn65 by erythrocytes, plasma protein concentration, and routine hematology are being measured on 8 control sheep and 8 sheep given 25,000 rad beta radiation to the skin. The irradiated areas are routinely photographed in order to follow the sequential development of irradiation lesions. Changes in the platelets, plasma iron, plasma copper, are the most consistent indicators of radiation damage to the skin.

SUPPORTED BY U.S. Atomic Energy Commission

5.0676, SPECIES COMPARISON OF THE ACUTE IRRADIATION SYNDROME

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Detailed studies of the acute radiation syndrome have been carried out primarily in small laboratory animals because of ready availability, low cost, and ease of maintenance. Although interpretation of experimental data obtained from one species to predict response to another species is always difficult, there is increasing evidence to indicate that the response of larger mammals to radiation may differ from that of smaller mammals. Direct experimentation in humans is impossible, but a comparison of the acute radiation symdrome in several large mammalian species offers hope for obtaining an understanding of the basic mechanism involved. This type of understanding is difficult to achieve, however, when the distribution pattern of radiation dose is such that several organs are affected at the same time, and lethality is the primary end-point measured. This project will be designed to develop methods other than lethality for studying the acute radiation syndrome, and to compare the effects of acute radiation injury in different species.

Results: Preliminary experiments on iron kinetics have been initiated in sheep and swine.

SUPPORTED BY U.S. Atomic Energy Commission

5.0677, PHYSICO-CHEMICAL STUDIES OF RADIATION EFFECTS IN CELLS

E.L. POWERS, Univ. of Texas, School of Arts, *Austin, Texas* 78712 (AT(40-1)-3408)

The aim generally is recognition of physical states and chemical species intermediate between the absorption of radiant energy and the exression of biological damage in cellular systems. The modification of water content, water structure, and the presence and absence of chemical and physical modifiers allow separation of damage into a number of independently acting components. The work in the next few years will involve UV effects of several kinds. The changes in sensitivity to 254 nm have been observed as water content of spores changes, and as oxygen is removed. The chemical consequences of these wild be studied. Also, dose rate of the UV in some spore stocks is an important physical determiner of sensitivity. In these stocks it is now Bnown that continuous vs. interrupted beams of UV give different results, and a formal study of this phenomenon is under way. In all these regular analyses of photo products will be attempted. High pressures of inert gases modify radiation sensitivity in the spore in a manner depending upon water content. This study will be extended to mammalian cells.

SUPPORTED BY U.S. Atomic Energy Commission

5.0678, PHYSICO-CHEMICAL STUDIES ON IRRADIATED CELLS

E.L. POWERS, Univ. of Texas, School of Arts, *Austin, Texas* 78712

Objective: The overall objective is to recognize the early events that are important in the induction of damage in cells exposed to high- energy radiation. The end-point for many years has been the death of the cell; now, the mutation process has been added. We attempt to accomplish the aim by using cells that can be exposed to varied and extreme environments without harm so that physical and chemical experiments that have known consequences in in vitro experiments can be done with the cell with a biological end-point as the measure.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0679, EFFECTS OF LASER EXPOSURE IN FUNCTIONAL VISION

A.J. WELCH, Univ. of Texas, Graduate School, *Austin, Texas* 78712 (F41609-71-C-0001)

Technical Objective: The objective of this study is to investigate the electrical activity of the optic pathway associated with exposure to ruby laser radiation at threshold and suprathreshold energy levels. Studies of this nature may serve to establish Air Force levels for laser exposure below the current allowable levels.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0680, RADIATION EFFECTS ON MATURE CHICKENS
W.C. BANKS, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01338)

OBJECTIVE: Compare results from 2 different types of radiation, that is a neutron-gamma mixture as opposed to just gamma.

APPROACH: At the completion of studies of gamma ray radiation on chickens it was noted that the expected decrease in fertility and egg production did not occur. On the contrary, survivors showed an increase in production over the non-irradiated controls. This is at variance with mammalian studies. It is proposed to procure 200 young chickens and at maturity, and following usual blood studies, to irradiate them with sub-lethal doses of radiation using the nuclear reactor for the source of ionizing radiation. The chickens will be maintained and matings allowed for production and fertility studies. In addition, we would like very much to know if a different kind of radiation will continue to show the marked difference in sex susceptibility between male and female chickens.

PROGRESS: The original research was completed and accepted by the U.S.A.E.C. and the T.A.E.S. An adjunct was suggested and approved. The purpose was to compare radiation effects of chickens exposed to the nuclear reactor compared to chickens that had been exposed to cobalt 60 radiation. The lethality studies were not conclusive and showed variation in death losses at different levels instead of an increasing percentage at higher levels. However, interesting results were produced in hatchability and egg production in chickens exposed to different levels of radiation. Following are results after 82 days post radiation exposure for egg production and hatchability, respectively: Control (non irradiated, 67.9% and 80.3%; House 01 - 200r, 300r, 400r survivals, 70.8% and 87.4%; House 02 - 500r, 600r, 700r survivals, 67.3% and 77.6%; House 03 - 800r, 900r, 1000r survivals, 68.9% and 89.3%.

SUPPORTED BY Texas State Government - Austin

5.0681, DELAYED SENSORY EFFECTS OF PRENATAL IRRADIATION
S.O. BROWN, Texas A & M University System, School of Science, *College Station, Texas* 77843

The purpose of this investigation is to supply knowledge concerning the delayed effects of continuous, low level and acute prenatal irradiation on delayed sensory capacity. Five groups of Spanish goats are given irradiation during gestation: Group I 521.5R; Group II 1043R at the continuous low dose rate of 0.17R hour 0.35R hours respectively, and Group III 521.R and Group IV 1043R acutely (200R minute).

Upon reaching maturity all subjects will be given conditioned avoidance training in order to establish a conditioned foreleg flexion response to a broad range of conditioned stimuli. It has been established that such conditioned responses provide reliable indices of sensory capacity when used in conjunction with the method of limits. The sensory modalities to be tested are: (1) Audition (loudness and pitch thresholds), (2) Vision (brightness and critical-flicker-fusion thresholds), and (3) cutaneous (Vibratory and temperature thresholds).

Group I and II are being trained and tested and Group II receiving 1043R at 7R daily show important sensory losses. The animals of Group III receiving 521R in acute doses are approaching maturity while Group IV receiving 1043R did not survive the radiation treatment.

The program is proceeding with all testing systems functional.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0682, THE ROLE OF LIGHT AND TEMPERATURE IN THE GROWTH AND DEVELOPMENT OF PLANTS
R.D. POWELL, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01127)

Objective: Obtain further information about the quanlitative and quantitative effects of light and the possible interrelationship of radiation and temperature in controlling vegetative and reproductive responses of selected plants. Determine the effect of temperature and light on: vegetative growth: flower formation; fruit set; study the interaction of red and far-red light with gamma-radiation and plant growth regulators on the photomorphogenetic response of plant tissue.

Progress: 1. Boll set in cotton is impaired by high night temperature. This result is brought about by a failure in pollen development. 2. Chilling injury can be demonstrated in leaf tissue from cotton plants. This effect is not related to moisture stress. There appears to be little effect on cell membranes. 3. Okra plants are severely damaged by chilling at 50 F. This response occurs at both low and high humidity.

SUPPORTED BY Texas State Government - Austin

5.0683, INFLUENCE OF PHYSICAL STATE OF CHROMATIN ON NUCLEIC ACID & PROTEIN SYNTHESIS & ON RADIATION SENSITIVITY OF CELL DIVISION
M.E. GAULDEN, Univ. of Texas, School of Medicine, *Dallas, Texas* 75230 (AT(40-1))

This study is concerned with cell division and the effects of radiation on it. Attention is focused on the relation of chromosome condensation and extension during the cell cycle to nucleic acid and protein synthesis and to radiosensitivity. Data are collected by direct observations on dividing neuroblasts in cultures of the grasshopper embryo and by autoradiographs of the observed cells. Two agents known to affect the physical state and progression of chromosomes have been chosen for study, namely, colchicine and culture medium of increased or decreased ionic strength. The amount of unscheduled DNA synthesis (radiation-induced thymidine uptake in non-S phases) in individual cells will be compared to the extent of a radiation effect, i.e., inhibition of prophase progression.

Results: Colchicine over a 10,000-fold range of concentration affects the rate at which neuroblasts reach metaphase; both inhibition and stimulation of rate occur. These are accompanied by morphological changes in the changes in the chromosomes of telophase, interphase and prophase. The extent of colchicine effects are a function of concentration and exposure time. Radiation-induced tritiated thymidine uptake has been shown to occur only in those prophase cells (non-S) that revert to interphase. Uptake is enhanced by growing the cells in hypotonic culture medium.

SUPPORTED BY U.S. Atomic Energy Commission

5.0684, EFFECTS OF UV ON GENETIC MATERIAL
W.F. HARM, Univ. of Texas, School of Medicine, *Dallas, Texas* 75230

We are investigating the effects of ultraviolet radiation (mainly 254 nm) in bacteria and bacteriophage. Special emphasis is given to various repair mechanisms by which the original UV photoproducts are altered or by-passed. Studies are currently made in the following areas: (1) Analysis of photoenzymatic repair by light flashes; (2) Effects of Streptomycin on dark repair; (3) Relationship between liquid- holding recovery and early steps of excision-resynthesis dark repair occurring in buffer; (4) Reasons for the very high efficiency of excision resynthesis repair after irradiation at very low dose rate.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0685, PHOTOREPAIR OF UV DAMAGE TO DNA - PURIFICATION & PROPERTIES OF THE DNA-PYRIMIDINE DIMER PHOTOMONOMERASE (ABBREV)
H. WERBIN, Univ. of Texas, School of Medicine, *Dallas, Texas* 75230 (AT(40-1))

Man's ecological environment is influenced by the interaction of sunlight on biomolecules, for example, in the induction of smog, vitamin D in the skin, photosynthesis and diurnal rhythms in plants and animals. We have purified 70,000-fold from cell-free extracts of yeast, one of these molecules, the DNA-pyrimidine dimer photomonomerase, heretofore called, the DNA-photoreactivating enzyme, that requires light to carry out its function, repair

of UV-damaged DNA. The ultraviolet absorption and fluorescent spectra indicate association with the enzyme of a chromophore involved in photoreactivation. We propose to continue the purification until the enzyme is obtained homogeneous. Then we will attempt to dissociate the enzyme into the apoprotein portion and the chromophore. The physical and chemical parameters of the latter will be examined, such as molecular weight, sedimentation constant, amino acid analysis and amino acid composition of binding sites. The chromophore will be concentrated, separated, isolated and its structure determined. By understanding the interaction of sunlight on the biosphere, we can more intelligently counter those of its interactions that are harmful to man.

Results: The DNA-photoreactivating enzyme has been purified 70,000-fold by affinity chromatography on irradiated DNA-cellulose. Only one major protein impurity remains to be eliminated in order to obtain a homogeneous enzyme preparation for further studied. Like the algal enzyme, the yeast enzyme was found to be reversibly inactivated by ferricyanide. The enzyme preparation showed a peak in its UV absorption spectrum at 380 nm and the same maximum in its excitation spectrum. A maximum in its fluorescence spectrum was at 470 nm. These data indicate that the chromophore involved in photoreactivation has been uncovered.

SUPPORTED BY U.S. Atomic Energy Commission

5.0686, RESPONSE OF SKIN TO MONOCHROMATIC LIGHT

J.M. KNOX, Baylor University, School of Medicine, *Houston, Texas*

This project is designed to study the effects of monochromatic light on skin. Several approaches are being used to study the effects of ultraviolet, visible and infra-red on various biological systems, including microorganisms, tissue culture cells, laboratory animals and human volunteers. The response of normal skin and cells to threshold and larger injury doses of ultraviolet are being studied. The action spectrum for cutaneous carcinogenesis is being determined. The effects of photosensitizing drugs on various biological systems are utilized to attempt to elucidate site of action and mechanisms of photosensitization with different agents and in naturally-occurring photosensitivity reactions. Other studies include the effects of environmental conditions on ultraviolet injury and a series of studies designed to measure the effects of atmospheric and environmental conditions on the solar spectrum.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0687, BIOCHEMICAL CHANGES IN SKIN INDUCED BY IRRADIATION

E.W. RAUSCHKOLB, Baylor University, School of Medicine, *Houston, Texas*

Previous studies have shown that ultraviolet (UV) light markedly reduces the levels of cholesterol in human skin. Explanations for this phenomenon have centered upon either direct effects of light, per se, on the sterol moeity or a light-induced imbalance between sterol anabolism and catabolism. We have demonstrated that short-term, broad spectrum radiation induces structural changes in the sterol nucleus in both buffered biological systems as well as in aqueous emulsion under the same experimental conditions to which skin had been exposed in previous experiments. Using a monochromatic light source, wave lengths of 265 nm were found most effective in altering the sterol molecule. Because large reductions in the cholesterol levels of skin briefly exposed to UV radiation should not be expected to result from effects on the rate of synthesis, the possibility remains that the previously observed reduction in cholesterol levels of UV exposed skin was due to direct alteration of the molecule by light.

An investigation of the effects on skin of broad spectrum light, in which wavelengths below 290 nm were excluded, revealed that the incorporation rates of C14-acetate into the total lipid, free sterol, neutral fat, and phospholipid fractions were lowered. Parallel studies on skin obtained from swine indicated that reduced levels of incorporation of acetate into the various classes of lipids were the result of altered synthesis and not due to reduced precursor uptake, increased lipid breakdown, or direct effects of light, per se, on the lipid moeities.

Further studies with human skin demonstrated that the light susceptible site of sterol synthesis lies along the biosynthetic pathway between acetate and mevalonate. Our data suggest that light interferes with sterol synthesis prior to acetyl Coenzyme A (acetyl CoA) and probably involves the activation of acetate or the availability of acetyl CoA pools of size sufficient to sustain sterol synthesis.

SUPPORTED BY Robert A. Welch Foundation

5.0688, BIOCHEMICAL CHANGES IN SKIN INDUCED BY IRRADIATION

E.W. RAUSCHKOLB, Baylor University, School of Medicine, *Houston, Texas*

A systematic investigation into the biochemical alterations produced by sunlight and ultraviolet light irradiation on human, intact skin presents a challenging research problem in the basic sciences and in dermatology. There are numerous studies describing morphologic, gross and microscopic, changes as well as histochemical alterations subsequent to the skin's exposure to ultraviolet light. However, biochemical analyses of the major epidermal components remain limited.

The following research problem is designed to permit a more comprehensive, better controlled investigation of alterations in skin constituents as related to irradiation exposure. In particular, careful attention will be given to biochemical modifications which may give some clue to the mechanisms in re 1) the capacity of irradiation and environmental factors to injure skin with the ensuing production of erythema, inflammatory response, promotion of pigment formation, acceleration of degenerative changes and of premature aging, 2) the relationship of ultraviolet light to photosensitivity and its role in precipitating or aggravating systemic diseases such as lupus erythematosus, pellagra, porphyria and photosensitization phenomenon associated with certain drugs, 3) the influence of sunlight and ultraviolet light on enzyme activity and the formation of substances with potent biochemical and physiological actions both beneficial (e.g. formation of Vitamin D) and deleterious (e.g. formation of premalignant and malignant skin morphology).

Hopefully the research project will contribute to a better understanding of the complex subject of photobiology.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0689, IRRADIATION PROTECTION AND HISTOCOMPATIBILITY

J.J. TRENTIN, Baylor University, School of Medicine, *Houston, Texas*

A) Study of control mechanisms for hemopoietic repopulation and differentiation in the irradiated animal. B) Study of the growth and differentiation potential of hemopoietic stem cells from bone marrow and lymphoid organs using the spleen colony method and other methods.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0690, FACTORS INFLUENCING LD50, LD100 AND PRENATAL RADIATION INJURY

H.L. BARTON, U.S. Veterans Administration, Hospital, *Houston, Texas* 77031

The preparation of facilities to accommodate the breeding and maintenance of specific Pathogen Free (SPF) mice has been completed at the Animal Research Facility. A working laboratory, an SPF mouse room and an X-ray room are set up and have been prepared to maintain an active level of investigation in the area of mammalian radiobiology.

Calibration of the 220 kVp x-ray machine has been completed and data is available on the variation in output with changes in field size, filtration, target distance and operating parameters. An X-ray beam shutter has been fabricated to allow precise determination of exposure. Uniform mouse irradiation will be insured by the use of a variable speed turntable that can accommodate up to 15 mice per irradiation.

The fogging and decontamination procedure to prepare Room 7 in the Animal Research Facility for habitation by SPF mice has been completed. A representative of Center Chemical

Co. supervised the use of the disinfectant chlorocide which was used for the fogging and the subsequent decontamination procedures. The area has been routinely cultured and any area showing possibility of contamination is again scrubbed down with the disinfectant and re-cultured until clean.

All sterile supply items such as masks, gowns, boots, gloves, (for investigators), and animals supplies such as bedding and food are placed into the room for use as needed.

There are ten male and ten female Balb/c mice in the Laboratory. These animals represent the nucleus of the breeding group that will be maintained under rigid control to insure the quality of the inbred strain. Under continuing development are breeding procedures, cytogenetic techniques and irradiation methods.

SUPPORTED BY U.S. Veterans Administration

5.0691, CYTOGENETIC INJURY IN X-RAY IRRADIATED MICE

H.L. BARTON, U.S. Veterans Administration, Hospital, *Houston, Texas* 77031

Project No. 39-68 has completed two major experiments during the past year and has several additional studies in progress. The completed studies dealt with methodology associated with the analysis of chromosome aberration in mouse bone-marrow cells. Variations in the time of application and the concentration of the mitotic arresting drug colchicine were evaluated in order to determine the optimum time/concentration for obtaining the maximum number of clear and well- spread chromosome plates in both unirradiated and irradiated mice. Another study has been completed that was designed to show the variation in the intensity of cytogenetic damage as a function of post-irradiation time. The data, however, have not been completely evaluated.

Several studies are in progress. One is a collaborative effort with Dr. Donald Wilhoit of the University of North Carolina. He is irradiating mice with a prescribed protracted or fractionated radiated scheme and is evaluating the mean survival time for these mice. We are determining the cytogenetic damage in hopes of correlating this information with mean survival time. Exposures in our mouse colony are in progress to determine the relationship between cytogenetic damage and acute lethality in X-irradiated mice. Another study is in progress to evaluate the relative biological effectiveness of californium-252 compared to radium-226. Mice are irradiated with one or the other of these radiation sources in a specially-fabricated irradiation jig, and the cytogenetic damage is evaluated. A study to determine the extent of cytogenetic damage, if any, in newborns following prenatal pelvimetry examination is in progress. This work is in collaboration with Dr. Angel Werch of the Department of Obstetrics and Gynecology.

SUPPORTED BY U.S. Veterans Administration

5.0692, BIOCHEMICAL EFFECTS OF RADIATION ON INTACT HUMAN SKIN INCUBATED IN VITRO

E W. RAUSCHKOLB, U.S. Veterans Administration, Hospital, *Houston, Texas* 77031

Previously we reported from this laboratory ultraviolet light induces reduction in the level of cholesterol in human skin. It was observed that short-term, intense broad spectrum radiation induced structural changes in the sterol nucleus both in serum and aqueous emulsions. Approximately 50% of cholesterol-4-14C in the aqueous emulsion was converted to more polar photoproducts in 10 minutes and some of the radioactivity appeared as a gas. Although the identity of the volatile products in the experiments remains to be determined, involvement of the fourth carbon of the A ring on the parent molecule is requisite. The results of these experiments do not eliminate the possibility that a light catalyzed degradation of cholesterol occurs in vivo. However, the rapid effect of light on aqueous emulsions of the labelled sterol suggested direct action on the cholesterol moiety.

In an effort to further characterize the conditions under which the sterol was destroyed, the wavelengths involved were determined by use of ultraviolet grating filters and monochromatic light. When filters, which transmit only visible wavelengths longer than 330 nm, were employed no alteration of the sterol occurred. A spectrograph of the light source used in the experiments indicated the wavelengths responsible for the photoaction on cholesterol. Following exposure to the respective energy levels, about 37% of the cholesterol was altered at 254 nm. At 6000 mj/au squared about 22% of the cholesterol was altered at 254 nm.

The next step was to investigate the effect of ultraviolet light upon lipid synthesis de novo. Skin biopsy specimens from volunteers were subjected to radiation using a Xenon light source yielding radiation comparable to sunlight; non-irradiated specimens served as controls. The incorporation of the label into lipid fractions was determined by chromatographic techniques. The results indicate 1) that non-irradiated skin specimens synthesize lipid, including cholesterol, at a rate equal to that of liver parencyma and 2) that exposure to ultraviolet light inhibits total lipid synthesis which includes phospholipids, sterols, (cholesterol) neutral fats and triglycerides. In recently conducted experiments it appears that ultraviolet light interferes early in the synthetic pathway of sterol synthesis from acetate to cholesterol. (Text abridged).

SUPPORTED BY U.S. Veterans Administration

5.0693, RADIATION RESPONSE OF IN VITRO MAMMALIAN CELLS

R.M. HUMPHREY, Univ. of Texas, Graduate School of Medicine, *Houston, Texas* 77025

Alkaline sucrose density gradients will continue to be used for molecular weight determinations as a measure of repair capability. Experiments are planned to ascertain the molecular events following exposure of mammalian cells to ultraviolet light and ionizing radiations. The purpose of these experiments will be to correlate these molecular events with cell survival in order to better understand the mechanism of radiation action and the cells response to injury.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0694, RADIATION AND BIOPHYSICAL STUDIES ON VIRUSES AND CELLS

A. COLE, Univ. of Texas, Graduate School of Medicine, *Houston, Texas* 77025 (AT(40-1))

The objective is to determine the structure of mammalian chromatin and chromosomes and the mechanisms of radiation action in this organelle. Such studies are central in understanding radiation effects in cells. Isolated mammalian deoxyribosenucleic acid (DNA), histones, nucleoproteins, chromosomes, and whole cells are utilized to investigate chromosome damage, single and double strand DNA scission and repair, helix denaturation and other radiation effects. The observations utilize analytical and preparative ultracentrifugation, stereo electron microscopy and optical detection of thermal denaturation. Effects of gamma rays and californium-252 neutrons will be compared. The location of radiosensitive sites within the cell is studied using partly penetrating electron and heavy particle beam irradiations.

Results: Deproteinized mitotic chromosomes extend to hundreds of micrometers and appear to contain about 64 parallel DNA molecules. Irradiation of cells or isolated chromosomes produces single and double strand DNA breaks. For moderate doses (several breaks per molecule), the average energy expended within the DNA molecule per break is about 50 eV for single strand breaks, 600 eV for double strand breaks in mitotic cells or chromosomes, and 2,000 eV for double strand breaks in interphase cells. Single strand breaks can be repaired by the cell; double strand break repair remains questionable. Strand breakage of naked DNA in solution appears to be indirect. At concentrations of 0.3 mg/ml and dose levels that produce about five breaks per molecule less than 0.03 eV is expended directly within the DNA per single strand break and less than 0.4 eV per double strand break. A 12 to 70 fold protection against breakage is observed if the DNA is first complexed with various histone fractions. The particle beam studies implicate a thin radiosensitive region near the nuclear membrane in interphase cells and a more diffuse region near the chromosomes in mitotic cells.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0695, LONG-TERM EFFECTS OF INTENSE SPECTRAL LIGHT EXPOSURE ON PRIMATES
H.G. SPERLING, Univ. of Texas, School of Medical Sciences, *Houston, Texas* 77025

It has been shown that prolonged exposure to intense spectral light produces very long-term, perhaps permanent changes in the spectral sensitivity of primate eyes. The effects coincide in the spectrum with prominent features of the photopic foveal spectral sensitivity function which has been related to the absorption spectra of the cones. The effects of blue light amount to a 90% reduction in sensitivity over the blue region, and have lasted over one year with no effect outside the blue or in the unexposed eye.

This program will continue to study this phenomena in two directions. First, psychophysiological studies will be conducted with increasingly intense spectral lights from argon and krypton ion lasers in order to ascertain the nature of the effect in the green and red regions of the spectrum, to explore the intensity-time relationships for producing the effect, and the recovery time to different durations, intensities, and wavelengths.

Second, histological studies will be conducted in an effort to ascertain the nature of the effect, and if successful, efforts will be made to make statistical estimates of the population of the three classes of cones as a function of degree of functional loss.

SUPPORTED BY U.S. National Science Foundation

5.0696, THE RADIOBIOLOGY OF NORMAL TISSUES
H.R. WITHERS, Univ. of Texas, Graduate School of Medicine, *Houston, Texas* 77025

A microcolony 'assay' system has been used to measure survival of intestinal mucosal cells from irradiation. Intestinal crypt stem cells are capable of accumulating and repairing large amounts of sublethal X- or gamma-radiation injury. Even after doses of 850 rads the capacity for sublethal damage is not saturated. This capacity is less when irradiation is with 14MeV monoenergetic neutrons and very small or absent when exposure is to 252 californium fission neutrons.

The response of crypt cells to irradiation depends on their position in the division cycle at the time of irradiation. The results of experiments in which hydroxyurea was used to induce synchrony within crypt stem cells suggest that late S-phase is the most resistant.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0697, EFFECTS OF X-IRRADIATION ON THE HUMAN TESTIS - AN ELECTRON MICROSCOPE CYTOCHEMICAL STUDY
J.D. BERLIN, Texas Technological University, School of Arts, *Lubbock, Texas* 79409 (AT(40-1))

Normal human testes which have received X-irradiation doses of 20, 75, 200, and 600 r will be subjected to an electron microscopic cytochemical examination to determine the effects of irradiation on the subcellular structure and function of the testis. The testis is an extremely radiosensitive tissue. An early irradiation effect is the breakdown of spermatogonial cells which leads to azoo-spermia. The reappearance of the spermatogenic cell series marks the beginning of the recovery process, however, the timing of complete repopulation of the seminiferous tubules is dose dependent and may require several years for high doses. In addition to these morphological events, it has been suggested that irradiation may alter the localization of various enzymes. We will examine biopsies obtained from a few minutes to several months after irradiation to define changes that occur in the subcellular structure and in enzymic localizations during spermatogonial degeneration and the recovery process. Our results with the irradiated material will be compared with that we have found to occur in normal, non-irradiated human testes. The enzymes to be examined include acid phosphatase, thiamine pyrophosphatase, glucose-6-phosphatase, inosine diphosphatase, and various other nucleoside di- and triphosphatases.

Results: In normal human testis Sertoli and spermatogenic cells we found glucose-6-phosphatase in the endoplasmic reticulum (ER), thiamine pyrophosphatase in the Golgi complex (GC), inosine diphosphatase in the ER and GC, and adenosine mono- and tri-phosphatases on the plasma membrane. Acid phosphatase was present in the lysosomes of the Sertoli cells. After irradiation, we observed an increased activity for acid phosphatase and thiamine pyrophosphatase, a decreased activity for glucose-6-phosphatase, and no change in the activities of adenosine mono- and triphosphatases.

SUPPORTED BY U.S. Atomic Energy Commission

5.0698, EFFECTS OF IRRADIATION UPON AIRCREW EQUILIBRIUM
D.J. BARNES, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Early transient incapacitation (ETI) has been observed in trained primates exposed to acute, high doses of weapons radiation. The mechanisms concerned are unknown, however the decrement is sufficient to cause mission failure where continuous performance is required. The objective is to evaluate the effects of pulsed fission-spectrum radiation upon crewman's ability to perform complex flight functions dependent upon visual and proprioceptive integrity. Stimulus and response characteristics are designed to be complementary to man's behavior in an operational environment.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0699, RADIATION EFFECTS ON CREW-TYPE MULTIPLE TASKS
D.J. BARNES, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: Trained primate performance decrement has been observed following weapons radiation exposure. The injury mechanisms are unknown and the effects on the visual, auditory and motor systems have not been adequately determined. The objective is to evaluate these systems post exposure by using a standardized multiple avoidance program (MAP) which simulates pilot visual, auditory and motor performance. This task can also be used to evaluate special radiation stresses such as nanosecond, flash X-ray exposures which may be encountered in the operational environment.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0700, RADIATION ALTERED AIRCREW TRACKING ABILITY
D.J. BARNES, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: Radar operators, offensive and defensive weapons systems personnel, navigators, and other aircrew members will engage in the continuous performance of monitoring and tracking signals on a cathode ray tube (CRT). The disruption of this behavior by radiation injury will have serious effects upon mission completion probabilities. Knowledge of the cardiovascular changes associated with such disruption is vital to both the treatment and prevention of performance decrement due to radiation. The objective of this work unit is to ascertain the relationship between the cardiovascular parameters of brain blood flow, blood pressure, and heart rate and the ability to perform a continuous operationally-relevant task in a radiation environment.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0701, COMPUTER DATA REDUCTION FOR AIRCREW FLASHBLINDNESS PREDICTION
R.V. BARTHOLOMEW, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: The Air Force requires absolute spectroradiometric data on nuclear flashes to predict safe separation distances for flashblindness and retinal burns and to define protective devices criteria for these hazards. The objective of this ef-

fort is to develop, put into operation, and maintain the equipment and computer procedures for the recovery, processing, and final presentation of spectroradiometric data obtained from nuclear flashes, experiments on flashblindness protection equipment and other intense light sources which can cause flashblindness or retinal burns.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0702, EFFECTS OF IRRADIATION ON COMBAT CREW TASK COMPLEXITY
G.C. BROWN, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

It is operationally important to differentiate between simple motor behavior and the more cognitive (reasoning) elements of decision making in evaluating man's relationship in weapons systems S/V analysis. The objective of this effort is to delineate radiation response as a function of task complexity. The radiosensitivity-task relationship in primates can then be used to predict man's capabilities in a comparable environment.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0703, PATHOLOGICAL RESPONSES TO SELECTED AEROSPACE ENVIRONMENTS
C.G. HUIZENGA, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: In selected aerospace operations, personnel are required to perform in or near environments that present potential medical hazards. Laser energy, ionizing radiation, extremely high altitudes, mixed gas atmospheres, toxic substances, and infectious agents, all common to various Air Force operations, may produce detrimental effects in man. This defines the pathologic effects of these environments, thus providing suitable data for safe exposure limits and/or the development of therapeutic treatments.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0704, BIOLOGICAL EFFECTS OF RADIATION EXPOSURES FROM LONG DURATION FLIGHTS AND REPEATED MISSIONS IN LOW DOSE LEVEL ENVIRONMENTS
J.H. KIRK, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Aircrews will be exposed to prolonged, low levels of radiation from fallout in nuclear warfare and in future operations involving very high altitudes, nuclear propulsion and isotope power sources. Little is known about the effects of low dose continuous radiation on man's performance and decision making abilities. In order to evaluate sub- clinical injury, new sensitive endpoints must be developed and special technics applied to define the low dose rate injury mechanisms. Neutrons, X-rays, electrons and protons will be studied using realistic dose rates ranging from rads per hour to rads per day. Long research and development lead time is needed for this type of biological study to provide essential mission planning data when new systems become operational.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0705, RADIATION PRODUCED BRAIN INJURY - AIRCREW PERFORMANCE DECREMENT
M.A. NATHAN, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: January 1970-March 1971. performance decrement has been consistently observed in trained primates exposed to weapons radiation. Since performance is dependent on the central nervous system (CNS) a temporary loss of consciousness and/or alteration of brain function can result in mission failure. This effort will investigate radiation injury to the brain and to systems supporting the brain.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0706, LASER DAMAGE THRESHOLDS IN LIVING CELLS FOR OPERATIONAL SAFETY CRITERIA
J.E. PRINCE, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: Permissible exposure levels for Air Force use have been extrapolated from animal data and are based on minimum visible ophthalmoscopic and histological changes. Uncertainties in extrapolation of animal data to humans and possible damage at the cellular level have necessitated the use of possibly excessive safety factors. The objective of this effort is to evaluate human cell response to laser radiation. Data collected from these studies will aid in establishing permissible exposure levels. Additionally, data from these studies will aid in understanding the mechanism of laser biological damage.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0707, THE EFFECTS OF RADIATIONS ON THE GENETIC SYSTEMS OF ORGANISMS IN RELATION TO THEIR PHYSICAL AND BIOCHEMICAL SYSTEMS
M.L. ALEXANDER, Southwest Texas State Univ., School of Science, *San Marcos, Texas* 78666 (AT(40-1))

The investigations are designed to study the mutagenic process for induction of genetic mutations. The induction of delayed mutations with chemical and X-radiation and the effect of dose fractionation on the mutagenic process are the primary objectives of the research program.

The genetic system of Drosophila will be utilized for measuring sex-linked recessive lethals, delayed sex-linked recessive lethals, autosomal recessive lethals and visible mutation at specific loci. The specific projects include: 1) Mutagenic effect of DNA feeding, 2) The induction of delayed mutations in spermatogonial cells with X-radiation, and 3) Mutation rates at specific gene loci with continuous and fractionated doses of X-radiation.

Results: 1) Degraded DNA (tetra-nucleotides) will not be mutagenic if the highly polymerized form is not mutagenic; 2) The contribution of delayed mutations to the overall mutation recessive lethal rate is under investigation; 3) The data for continuous and fractionated doses of X- radiation are not extensive enough to compare the dose rate effects at present.

SUPPORTED BY U.S. Atomic Energy Commission

5.0708, ELECTROPHYSIOLOGIC AND HISTOCHEMICAL STUDIES ON EFFECTS OF IONIZING RADIATION ON THE CENTRAL NERVOUS SYSTEM
N. HARIRI, Ege Universitesi, *Bornova, Izmir, Turkey*

The programme of work shall be to continue studies on the effects of radiation protectants on the brain of rabbits subjected to irradiation. The following studies shall be carried out: Determination of the extent of the radiation protectant action of reserpine on - (1) the monoamines of the central nervous system (a sensitive fluorescence method is supposed to be used); (2) the electrophysiological changes in the brain; (3) the changes in DNA and RNA content of brain neural cells; (iv) the histopathology of the glial and neuronal cells by use of electron- and light-microscopy.

Preliminary study of the effects of serotonin on the brain physiology and cytology following irradiation of the heads of rabbits.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0709, SOME INTERNAL AND EXTERNAL FACTORS WHICH DECREASE OR INCREASE THE SENSITIVITY AGAINST RADIATION
A. SENGUN, Cekmece Nucl. Res. & Tr. Ctr., *Istanbul, Turkey*

1. The toxic effect of the radioprotector, AET on the rat embryonic cells grown at tissue culture by plating technic will be determined. For experimental purposes, the highest non-toxic dose of AET will be used. 2. The effect of AET on DNA, RNA, and protein synthesis of embryonic cells will be determined by the

use of tissue culture technics and tritiated thymidine, tritiated uridine and tritiated glycine or leucine. 3. The effect of AET, added prior irradiation to the cells, on the viability of the irradiated cells (by Co-60) will be determined. 4. The effect of AET on DNA, RNA, and protein synthesis of irradiated cells will be investigated.

For (1) and (3) Dose Effect curves will be prepared.

For (2) and (4) the autoradiograms of the cells will be prepared. The per cent labelling and the amount of grains in the labelled cells will be determined.

If time permits, the same experiments will be repeated with another radioprotector, cysteamine.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0710, THE RADIOSENSITIVITY OF MAMMALIAN GERM CELLS

H.M. BEAUMONT, Univ. of Birminghan., *Birmingham, England, United Kingdom* (AT(30-1)3846)

Our experiments are designed to examine the effects of irradiation on oocytes as judged by (a) changes in populations of ovarian oocytes and (b) the ability of oocytes to develop after fertilization; and to define and investigate factors influencing the radiosensitivity of oocytes.

It has been established that the radiosensitivity of oocytes differs within and between species: quantitative studies of the ferret, guinea pig and neonatal rat are in progress. Changes in the fine structure of oocytes after irradiation are being examined in the monkey and rat, two species whose oocytes differ markedly in their response, those in the monkey being much more resistant to the lethal effects of irradiation.

We have recently demonstrated that changes in the hormonal environment affect the radiosensitivity of oocytes in the rat. This study is continuing in order to define which of the gonadotrophic and/or gonadal hormones is effective.

The processes of spontaneous and induced atresia amongst oocytes are being investigated to see whether there is any evidence that atresia represents a 'selection' process, only those oocytes which are genetically fit and capable of giving rise to normal zygotes usually surviving to ovulation.

Factors underlying the onset of infertility in senile mice will also be investigated.

Results: We have demonstrated that hormonal factors influence the radiosensitivity of oocytes: those in hypophysectomized rats are much more resistant and/or take longer to be eliminated after exposure than oocytes in the unoperated animal. Administration of exogenous gonadotrophin reverses the effect of hypophysectomy.

SUPPORTED BY U.S. Atomic Energy Commission

5.0711, DEOXYCYTIDINE LEVELS IN URINE AND PLASMA AS AN INDEX OF IONIZING RADIATION DOSE

I.V. CHAPMAN, Univ. of Dundee, *Dundee, Scotland, United Kingdom*

Initially an attempt will be made to develop a method for determining microgram quantities of deoxycytidine in urine and plasma samples from human patients.

Investigations will be initiated into the influence of X-ray therapy of CdR levels in the samples indicated above. It is proposed that loading studies will be carried out with selected patients in an attempt to highlight metabolic changes resulting from exposure to X-rays.

Loading studies will also be carried out with mice. It is suggested that theresults from this species are more easily related to man than those from rat because of the levels of deoxycytidine aminohydrolase in the liver.

Radiotracer studies, involving H3 and C14 labelled deoxycytidine will be carried out to investigate pool size changes, biological half-life and turnover time in rats and mice.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0712, RADIOSENSITIVITY OF GENETIC STRUCTURES AND MOLECULAR BASIS OF RELATIVE BIOLOGICAL EFFECTIVENESS OF RADIATIONS OF DIFFERENT QUALITIES

G. NEARY, Medical Res. Council, *Harwell, England, United Kingdom*

In order to attack the general problems indicated in the Title of the Project, attempts are being made to obtain information on the quantitative and qualitative nature of the damage to radiosensitive structures in cells at three levels, namely, the instantaneous lesions first produced by the radiation, the fixed lesions which result from metionic reactions of the instantaneous lesions, and the permanent lesions which are not repaired or by-passed by the biochemical machinery of the cell. The influence of radiation quality (including interactions between radiations of different qualities) and of modifying treatments, at all three levels of lesion production in cells of various degrees of inherent radiosensitivity are being examined.

The radiobiological systems used continue as before: strand breakage in DNA in vitro and in vivo, chromosome aberration production in plants and in animal cells in culture, mutation and cell-killing in yeast and bacterial cells.

The radiations include charged particles of defined energy and LET and monochromatic X rays of low quantum energy.

Attention is being given to the perturbing effects of radiation on the kinetics of a population of dividing cells, using relatively simple populations in 'Tradescantia' and 'Campelia' anthers; such disturbances are particularly important in potential distortion of dose-response curves for chromosome aberrations. These studies will help in the interpretation of data for more complex cell systems.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0713, THE AGE FACTOR IN RADIATION SENSITIVITY OF MAMMALS

J. ROTBLAT, Saint Barthol. Hosp. Med. Col., *London, England, United Kingdom*

The mechanism of tumour induction following radiation will be continued with reference to the effect of age on the proliferative and adaptive characteristics of the cell populations of the normal tissue, compared with cell kinetics and possible feedback mechanisms in pre- neoplastic and gross neoplastic lesions of the same tissues.

The mechanisms of leukaemia induction at different ages and the effect of the development or regression of leukaemia on the normal bone marrow and spleen stem cell population will be studied.

In the lung parenchyma, where normal cells kinetics are presently being measured at different ages, under resting, compensatory or stimulated conditions, the cell kinetics, preferential site of growth, and population characteristics of lung tumours will be studied in the normal and radiation-injured lung, with or without urethane.

In the ovary the work on the interaction of oocyte number and total hormonal interplay on the yield and type of tumours following radiation or urethane will be continued.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0714, PULSE RADIOLYSIS OF NUCLEIC ACID DERIVATIVES

C.L. GREENSTOCK, Mount Vernon Hospital, *Northwood, England, United Kingdom*

Pulse radiolysis is being used as a tool to investigate fast chemical reactions occurring in dilute aqueous solutions of nucleic acid derivatives irradiated by microsecond pulses of ionizing radiation from a linear accelerator.

Any transient species having an optical absorption different from the parent solute molecule is detected and followed kinetically by means of a photomultiplier detector and oscilloscope.

Earlier studies by the author showed that the three primary species formed in the radiolysis of water (aqueous electrons, protons, and hydroxyl ions) attach nucleic acid bases, particularly pyrimidines, to form transient species or adducts. These very reactive adducts undergo a series of reactions to form stable changed or damaged molecules. The yields of these changed molecules are a measure of the radiosensitivity of the irradiated molecules.

One of many methods in radiation chemistry of modifying this radiosensitivity is by 'electron transfer', in which the electron is transferred from a potentially damaging site on the solute molecule to an added electron acceptor molecule, thus effecting a rapid 'repair' process.

Electron transfer will be studied initially between nucleic acid derivatives and later extended to other important biochemicals.

SUPPORTED BY Canadian Government - Ottawa

5.0715, REPAIR MECHANISMS AND VARIATIONS IN RADIOSENSITIVITY WITHIN THE GENERATION CYCLE OF YEAST CELLS

E. LANGGUTH, Univ. De La Republica, *Montevideo, Uruguay*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0716, THE EFFECTS OF X-IRRADIATION ON STEROID BIOTRANSFORMATIONS BY TESTICULAR TISSUE

L.C. ELLIS, Utah State University, Graduate School, *Logan, Utah* 84321 (AT(11-1))

Studies are being undertaken to ascertain what specific enzymatic steps and how sensitive these steps in the synthesis of androgens are to in vitro and in vivo X-irradiation. The changes in androgen synthesis will be correlated with specific aspects of the radiation syndrome to determine whether they reflect changes in naturally occurring radioprotective mechanisms of the organism or whether androgen synthesis is a factor that contributes to radiation sickness. Pineal function is being evaluated after irradiation to determine what relationship this gland has to testicular function as it relates to changes in the testis after irradiation. Naturally occurring radioprotective compounds are being evaluated to determine their relationship to radioprotection of the testis and to the effects these compounds have on testicular function. Radioprotective systems within the testis are being evaluated to ascertain how they relate to the changes in radiosensitivity of the testis that are known to occur with age. Histological data are being correlated with the biochemical data to determine what relationship exists between androgen synthesis, its metabolism, and the destructive and regenerative changes that occur after irradiation.

RESULTS: Androgen synthesis and its metabolism by rat testicular has been observed to correlate with histological changes in the germinal epithelium. Melatonin synthesis by the pineal gland has been observed to be altered after irradiation and these changes correlate with histological and endocrine changes in the testis. Lipid peroxidation and prostaglandins have been implicated in normal testicular function and alterations in testicular function after irradiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0717, THE RESPONSE OF HIGHER PLANTS TO ULTRAVIOLET LIGHT AND OTHER STRESS FACTORS

F.B. SALISBURY, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00729)

OBJECTIVE: Study ultraviolet light as a stress factor including a continuing search for resistant species, studies of the mechanisms of damage and of resistance to ultraviolet light with emphasis on biochemical features of resistance. Study low temperature as a stress factor.

APPROACH: Ultraviolet light as a stress factor. Plant species will be screened to determine their resistance to UV light using a germicidal UV lamp and a xenon arc lamp. The mechanisms of damage by and resistance to UV light will be studied by kinetic approaches to the photochemistry and biochemistry of response to such light. UV effects on enzymatic reactions will be investigated. Low temperature as a stress factor. Winter cereals as well as native alpine species will be studied in the mountains, at the Blue Creek farm, and in the laboratory. Enzyme activity as a function of temperature will be emphasized.

PROGRESS: Studies on UV light were continued but deemphasized. Previous work was submitted for publication. A new postdoctoral fellow (Manfred Weidner) and a new graduate student began on the project. One year of observation of plants growing under snow was completed, and another field project was initiated, this one including some experimental approaches (shading, heating, insulating plots under snow) and accurate measurement of light penetration of the snow, using a trench dug before snowfall. Laboratory studies on plant growth at low temperatures were initiated, including enzyme and electronmicrograph research. Studies on heat transfer between the leaf and its environment were continued and accelerated somewhat.

SUPPORTED BY Utah State Government

5.0718, THE EFFECT OF INTERNAL EMITTERS ON THE HEMATOPOIETIC SYSTEM

J.H. DOUGHERTY, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)119)

The hematological changes following a single intravenous injection of a wide range of doses of several internal emitters Ra226, Pu239, Ra228 (MsTh), Th228 (RdTh), Sr90 Ra 224 and Am241 into adult beagles have been followed for 18 years. The general aim of this study was to evaluate the relative toxicity of these radionuclides to the hematopoietic system. The blood picture is followed at closely spaced intervals for the life span of each animal in order to determine when hematological changes occur. The greatest effect is on leukocytes and platelets with depression of red cells only at highest dose levels.

SUPPORTED BY U.S. Atomic Energy Commission

5.0719, ASSESSMENT, EVALUATION AND CONTROL OF RADIATION EXPOSURE TO MAN AND HIS ENVIRONMENT - EXPOSURE TO EXTERNAL AND INTERNAL RADIATION

T.F. DOUGHERTY, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

Studies of internal irradiation constitute the research efforts of this project. Biological effects of Ra226, Pu239, Ra228 (mesothorium), Th228 (radiothorium), Am241 and Sr90 are compared. The basic study was initiated in 1950. A large amount of data has been amassed and it is currently being analyzed. The skeleton is the principal site of deposition for the above-mentioned radionuclides which are administered as a single intravenous injection into young adult beagles at approximately 16 months of age. A wide range of dose levels varying from permissible body burdens to cancerogenic levels are studied with comparable controls.

The objective is to relate the onset and/or development of the various biological effects as a function of radiation dose and time. Whole body counting, radiochemical analyses and autoradiography are used extensively to obtain radiation dose rate information. Biological studies include clinical observations, radiological studies to document the changes in the skeleton, histo-pathology of bones, teeth and various soft tissues. Extensive hematological and blood chemistry studies are made. Principal cause of death is osteogenic sarcoma, a finding in general agreement with the observations made on humans exposed to Ra226. Liver and skeletal damage are the principal result of exposure to radionuclides which are deposited primarily in the skeleton. Current data are available in our annual progress reports.

SUPPORTED BY U.S. Atomic Energy Commission

5.0720, 239-PU RETENTION IN THE CHINCHILLA

R.D. LLOYD, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

The metabolism and biological effects of internally-deposited plutonium have been studied in mice, rats, dogs, and other animals because of the importance of estimating the hazards of 239 Pu for man. Chinchillas are long-lived mammals that metabolize radium in a similar fashion to the human. Six of these animals were injected with 239 Pu in citrate buffer as a comparison with our previous extensive studies in beagles. During the first 21 months after injection, plutonium retention in these animals could be characterized by a sum of 2 exponentials, such

that 63 percent was retained as if it had a biological half-time of about 11 days and 37 percent had a half-time of 1475 days. In 2 animals dying 142 and 168 days after injection, about 85 percent of the retained plutonium was in the skeleton, 9 percent in the liver, and 6 percent in other soft tissues. Plutonium retention in the chinchilla appears to be lower than that in the dog, and the proportion of retained activity in the liver is less than either the dog or the human.

SUPPORTED BY U.S. Atomic Energy Commission

5.0721, PB-210 STUDIES IN BEAGLES

R.D. LLOYD, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

The metabolism and effects of internally-deposited Pb and Pb-210 are becoming more important. Environmental Pb contamination is being given deserved attention, elevated Pb-210 levels in the Arctic are being studied in relation to the entry of radioactive Pb into human food supplies, and residual pb-210 burdens in uranium miners are being investigated as an indication of past exposure to radon and radon daughters in mine atmospheres.

To obtain metabolic data in large mammals, a few young adult beagles were injected with Pb-210 in citrate buffer. Retention was determined by total-body counting. In a typical beagle, injected Pb-210 was retained as if 36 percent had a biological half-time of 4 days, 43 percent had a half-time of 33 days and 21 percent had a half-time of 990 days for the first 1000 days after injection. The excretion was mainly fecal with about 3/4 of the total excreated Pb-210 appearing in the feces during the first 3 weeks. Pb-210 levels in the blood remained relatively high: the fraction of injected activity still circulating was 0.40 at 1 days, 0.14 at 1 week, and 0.03 at 1 month. One dog sacrificed 28 days after injection had about 63 percent of the retained Pb in the skeleton, 20 percent in the liver, 8 percent in the blood and 9 percent in other soft tissues. Liver had the highest Pb-210 concentration of any tissue measured, 1.6 times that in the skeleton.

SUPPORTED BY U.S. Atomic Energy Commission

5.0722, 241-AM METABOLISM AND EFFECTS IN BEAGLES

R.D. LLOYD, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

Americium-241 is associated with 239Pu in reactor fuels and is becoming an increasingly important hazard in the nuclear industry. The retention, distribution, excretion, and effects of injected 241Am is being studied in beagles. A number of animals have been injected and their retained activity is being followed by total-body and partial-body counting. Soon after injection, about 50 percent and 40 percent, respectively, of the administered 241Am was deposited in the liver and in non-liver tissue (mainly skeleton). In the animals injected with 0.00179-0.305 mu Ci/kg, the liver and non-liver burdens decreased slowly each with a biological half-time of about 10 yr during the first 850 days. Two dogs injected with about 2.80 mu Ci/kg exhibited a sharp 'decrease' in liver retention beginning about 100 days after injection accompanied by an 'increase' in non-liver 241Am. Both showed extreme degenerative liver changes at death 401 and 448 days after injection. Excretion of injected 241Am was mainly urinary with about 7/8 of the total for the first 3 weeks appearing in the urine. Distribution studies of retained 241Am confirmed that liver and skeleton were the principal deposition sites, but showed activity in many soft tissues. Americium concentration in the thyroid gland was higher than any soft tissue except the liver. Autoradiography indicated that 241Am was deposited close to the functioning thyroid cells. The kidney also had a relatively high concentration of activity, selectively deposited in the glomeruli. Some surviving dogs injected with about 0.904 mu Ci/kg presently have functional damage to the kidney as well as the liver.

SUPPORTED BY U.S. Atomic Energy Commission

5.0723, RELATIVE BIOLOGICAL EFFECTIVENESS OF RADIONUCLIDES IN THE BEAGLE SKELETON

C.W. MAYS, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

Osteosarcomas have been the chief cause of death in our adult beagles injected intravenously with bone-seeking radionuclides in citrate solution. The effectiveness of these nuclides depends on the type of radiation emitted and where this radiation is absorbed. Alpha radiation is more effective than beta radiation and the alpha emitters which deposit on bone surfaces are more effective than those which deposit throughout bone volume. For death with osteosarcoma 8 years after injection, values for relative biological effectiveness based on the average skeletal doses in rads one year before death and relative to 226Ra equals 1 are: 239Pu equals 6; 228Th equals 8; 228Ra equals 2.5; and 90Sr equals 0.07 to 0.24. Efforts are continuing to determine the relative effects of various radionuclides in producing other endpoints within a variety of induction times.

SUPPORTED BY U.S. Atomic Energy Commission

5.0724, DISTRIBUTION OF PB-210 IN CANINE BLOOD AFTER INTRAVENOUS INJECTION & ASSOCIATION OF NUCLIDE WITH BLOOD CONSTITUENTS IN DOGS & HUMANS (ABBRE

W. STEVENS, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

After intravenous injection of Pb210 into beagles, the nuclide reached its maximum concentration in blood several hours after administration. Most of the Pb210 was associated with blood cells. The concentration in blood was measured for 287 days after injection at which time 0.058 percent of the injection dose was still circulating. 'In vitro' experiments with canine and human blood showed that about 90 percent of the nuclide combined with red cells was associated with the red cell cytoplasm and less than 10 percent was bound to the stroma. Transfer across the red cell membrane was possible without prior binding of the nuclide to plasma proteins. After gel chromatography and disc electrophoresis, most of the lead was found in hemoglobin containing fractions. In the dog varying amounts were also found in fractions of high electrophoretic mobility. In humans the largest fraction of Pb210 was found with a minor hemoglobin band. Only after saturation of this fraction greater quantities were found in the main hemoglobin band.

SUPPORTED BY U.S. Atomic Energy Commission

5.0725, DEATH FROM AGING, CANCER, IRRADIATION, AND OTHER STRESSES

B.J. STOVER, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

Evidence is accruing that somatic mutations are important in aging and in the induction of the degenerative diseases as well as in oncogenesis and radiation damage (H.J. Curtis, Radiation and Aging, Symp. Soc. Exp. Biol., '21': 51-64, 1967). The occurrence of a mutation reflects a change in the environment of a cell which may be an alteration in the concentration of a critical precursor to the gene. Since biological processes proceed near equilibrium, the occurrence of such a change results in counter changes. Thus the mutation rate is a steady-state phenomenon. Application of the theory of absolute reaction rates makes it possible to analyze the life-shortening and oncogenic action of irradiation. Death curves for nonirradiated beagles that die from aging and cancer and those for beagles that receive skeletal alpha irradiation leading to osteogenic sarcomata are similar in shape. They differ in that death occurs earlier in the case of the irradiated dogs, and the hastening of death is a function of the radiation dose.

SUPPORTED BY U.S. Atomic Energy Commission

5.0726, MICROSCOPIC DISTRIBUTION OF 241-AM IN THE BEAGLE

G.N. TAYLOR, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

Americium-241 retention in the soft tissues of the beagle following a single intravenous injection of a citrate buffered solution was significantly elevated in the following sites: In the hepatic cells of the liver, in macrophages containing engulfed hemosiderin, in calcified foci, such as those occasionally found in the renal medulla and in certain PAS positive connective tissue structures. The latter accounted for relatively high concentrations in the interfollicular areas of the thyroid, the renal corpuscles, the media of the smaller arterioles, and the cartilaginous structures of the lungs. Death resultant to kidney and liver failure occurred at approximately 400 days following injection of 2.8 mu Ci 241Am/kg.

SUPPORTED BY U.S. Atomic Energy Commission

5.0727, RADIUM INDUCED EYE TUMORS
G.N. TAYLOR, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

Prolonged retention of 226Ra, 228Ra or 228Th has resulted in a significant number of intra-ocular melanomas in beagles. Thus far, such tumors have occurred below the lowest presently observed osteosarcoma dose by factors of 3 and 6 for 226Ra and 228Ra, respectively. They have developed at the lowest osteosarcoma dose in 228Th dogs, but not below this level. Intraocular melanosn was induced by 90Sr and 239Pu, but thus far, intraocular neoplasms have not been produced by these radionuclides.

SUPPORTED BY U.S. Atomic Energy Commission

5.0728, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION OF SEEDS
P. RODRIGUEZ, Univ. Cen. De Venezuela, *Caracas, Venezuela*

Studies on the effect of neutron irradiation of seeds (part of a coordinated programme of research on the use of neutrons in seed irradiation).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0729, FACTORS UNDERLYING IMPAIRMENT OF AMPHIBIAN LIMB REGENERATION & ALTERATION OF ENDOCRINE FUNCTION BY IONIZING RADIATION (ABBREV)
J. DENT, Univ. of Virginia, School of Arts, *Charlottesville, Virginia* 22903 (AT(40-1))

Various endocrine and other factors known to stimulate regeneration in non- regenerating systems will be tested and their effects observed in irradiated amphibian limbs. Ultrastructural and cytochemical comparisons between irradiated and non-irradiated cells and tissues will be made and correlated with features of function and reproduction.

SUPPORTED BY U.S. Atomic Energy Commission

5.0730, HUMAN BODY INTERACTION TO RF ENVIRONMENTS
W.E. INNIS, U.S. Navy, Weapons Laboratory, *Dahlgren, Virginia*

Technical Objective: Explore and describe the effects of the interaction of the human body with rf fields, suggest possible application of the results to areas of safety and reliability of Navy equipment which must be used in rf environments, and suggest possible military applications of observed physiological effects.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0731, STUDIES ON THE EFFECT OF NEUTRON IRRADIATION ON SEEDS
C.F. KONZAK, Washington State University, School of Agriculture, *Pullman, Washington* 99163

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0732, THE NATURE, INDUCTION AND REPAIR OF RADIATION-INDUCED C :NETIC DAMAGE IN PLANTS
R.A. NILAN, Washington State University, School of Agriculture, *Pullman, Washington* 99163 (AT(45-1)-2221)

This investigation is designed to obtain new knowledge about the nature of radiation-induced genetic damage, especially at the DNA level, and about the mechanisms by which ionizing radiations induce genetic changes in flowering plants. The specific objectives of the research are: 1) To determine the interrelationship among DNA lesion, mutations and chromosome aberrations in irradiated plant cells. 2) To determine how peroxides, catalase, peroxidase and gibberellic acid (which appear to be implicated in the radiation-induced damage in plant cells) affect the changes on DNA and, hence, chromosome aberrations and mutations. Seeds of Himalaya barley (CI 620) will be used in this investigation. DNA from treated and control embryos will be analyzed for breaks. These breaks will be compared to frequencies of chromosome aberrations and chlorophyll-deficient mutations within the same treated populations. The respiration inhibitor sodium azide will be utilized extensively in experiments under Obj. 1 since it differentially influences the ratio of chromosome aberrations and mutations in irradiated cells and since it induces mutations but no chromosome aberrations in non-irradiated cells. The manner by which sodium azide and gibberellic acid influence catalase and peroxidase levels in the cell and presumably the production of peroxides and genetic damage in irradiated cells will be determined by experiments for Obj. 2.

Results: Techniques for isolating, purifying and analyzing DNA from irradiated and control embryos of barley have been developed. The respiration inhibitor, sodium azide, in conjunction with radiation and at low pH increases chromosome aberrations but has no effect on mutation frequencies. On the other hand, when sodium azide is applied alone it induces a relatively high frequency of mutations but no chromosome aberrations. Sine the work on this projct has been recently initiated, results from experiments with gibberellic acid are too premature to report at this time.

SUPPORTED BY U.S. Atomic Energy Commission

5.0733, A STUDY OF FACTORS GOVERNING PLANT RADIOSENSITIVITY
R.A. NILAN, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01068)

OBJECTIVE: Detect and understand mechanisms through which ionizing radiation induced biological effects in cells of higher plants. Identify and determine the nature of the after-effects and indirect effects of ionizing radiation in seeds. Determine the action of agents and factors, such as oxygen and certain chemical mutagens, which modify the biological effects of ionizing radiation.

APPROACH: The actions of two mutagenic agents, namely oxygen and diethyl sulfate, which interact with radiation in the induction of biological effects in cells of irradiated barley seeds are being studied. These studies include experiments designed to help understand how factors such as water content and temperature of a seed and radiation energy influence the oxygen-radiation interaction and learn more about the nature of the factors which affect the mutagenicity of oxygen. Other experiments are probing the radiation-diethyl sulfate interaction with particular attention to the roles of hydrolysis products and pH and the induction of cytogenetic changes induced by the combined treatments and by X or gamma rays alone.

PROGRESS: Two of the components of damage in irradiated dry barley seed were analyzed. The oxygen-dependent, radical-dependent component can be modified by radiation energy between 300 kv and 50 kv and can occur at oxygen concentration as low as 3% O(2) in the hydration gas. This component is initiated by oxygen-radical interactions. The oxygen- independent, radical-independent component occurs in seeds not only at 10% and 12% water content but also at 6% water content. This component is not intimately involved with metabolism. More has been learned about the induction, prevention and repair of radiation-induced damage in plant cells. Gibberellic acid is a factor in these mechanisms and its breakdown and protection in irradiated cells have been determined. The respiration inhibitor sodium azide in conjunction with pH differentially modifies the ratio of mutations and chromosome aberrations in irradiated and non-irradiated cells. Studies of the induction and repair of genetic damage in terms of DNA lesions were conducted. DNA from barley embryos can be readily isolated and analyzed for radiation damage and repair.

5. RADIATION

SUPPORTED BY Washington State Government - Olympia

5.0734, TERRESTRIAL AND FRESHWATER ECOLOGY:
V. SCHULTZ, Washington State University, School of Science, *Pullman, Washington* 99163 (AT(45-1))

Preparation of 'Terrestrial and Freshwater Radioecology TID-3910 (Supplement No. 6)'.

SUPPORTED BY U.S. Atomic Energy Commission

5.0735, SPACE NUCLEAR SYSTEMS STUDIES
J.E. BALLOU, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

Space vehicles containing nuclear reactors or radionuclide power sources could present special hazards in case of early abort or upon return from orbit; the problems are principally those of small, intensely radioactive, insoluble particles. Studies are made of the deposition and retention kinetics of inhaled particles, determination of dose-effect relationships for individual or crushed particles passing through or retained in various regions of the gastrointestinal tract and lung, and with similar dose-effect conditions on the skin. Dogs and miniature swine have been the principal experimental animals.

Results: Some 30 dogs with various forms of 238 PuO2 deposited in thair lungs are being held for observation of late effects. One animal has developed an alveolar cell carcinoma, about 2 years postexposure, with a terminal body burden of 0.8 mu Ci. Three beagle dogs were exposed to aerosols of 238PuO2 - ZrO2 solid solution, and three to 238PuO2-ThO2 solid solution aerosols, and were euthanized 3 months postexposure to compare plutonium retention and translocation. No unusual effects were noted.

SUPPORTED BY U.S. Atomic Energy Commission

5.0736, FATE AND EFFECTS OF RADIONUCLIDES IN ALASKA
L.L. EBERHARDT, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The objectives of this study are to determine the fate and effects of fallout radionuclides in Northern Alaskan environments. In the past, emphasis was placed on investigating the routes, rates, and amounts of SR90 and Cs137 in the lichen-herbivore-Eskimo (carnivore) food web. A study of the possible effects of chronic ingestion of radionuclides by man is implicit. An important aspect of this project is to quantify any potential radiation-induced effects, utilizing the most sophisticated techniques available; examination of chromosomal aberrations appears to be the most significant method.

Redults: The two-year study of seasonal cycles of Cs137 in three Alaskan population groups having different caribou utilization patterns was completed. Whole-body counting was continued at Anaktuvuk Pass on a semi-annual schedule to document summer maxima and winter minima. Extensive samples of caribou and carnivores were obtained as an aid in interpreting measurement of Cs137 in humans. A definite seasonal cycling of Cs137 in lichens became apparent, the 1969 spring caribou migration at Anaktuvuk Pass yielded animals that contained consistently greater Cs137 concentrations than had been expected - and ring and dicentric chromosomal aberrations were found in circulating leukocytes. No major differences were found in Cs137 concentrations in lichen samples obtained at Anaktuvuk Pass and at three sampling locations in the major caribou wintering ranges on the south side of the Brooks Range some 200 to 300 Km southwest of Anaktuvuk Pass. The unusually high Cs137 concentrations in caribou muscle resulted in higher maxima in Eskimo residents of Anaktuvuk Pass than had been expected; average values in adults were about twice those observed in July 1968. Two series of blood samples from male Anaktuvuk Pass Eskimos were analyzed for chromosomal aberrations as part of a cooperative study with Oak Ridge National Laboratory.

SUPPORTED BY U.S. Atomic Energy Commission

5.0737, URANIUM MINERS EXFOLIATIVE PATHOLOGY
M.E. FRAZIER, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The purpose of this project is to compare the histopathology and pulmonary exfoliative cytology of experimental beagle dogs following inhalation of potential/pulmonary carcinogens to the cytology and pathology of uranium miners that have detectable pulmonary epithelial metaplasia or neoplasia. The experimental dogs have been exposed to low levels of inhaled 239PuO2, or to radon gas, cigarette smoke, uranium ore dust, diesel fumes, or combinations of these agents. Histopathology of lung tumors from uranium miners will be compared to those from hard rock miners which may give an indication of different pathogenic mechanisms. The work will establish culture systems for pulmonary neoplasms from uranium miners and experimental dogs.

Results: The cooperative review program has strengthened our capability to evaluate lung lesions in dogs, and has helped to standardize the nomenclature with accepted terminology of human lung lesions. Adaptation of special techniques, incuding special histochemistry and exfoliative cytology, has allowed a much better comparison of lung tumor pathogenesis and histology of induced tumors in dogs with those occurring in uranium miners.

SUPPORTED BY U.S. Atomic Energy Commission

5.0738, RADIATION EFFECTS ON CHYLOMICRON SYNTHESIS AND CAPILLARY PERMEABILITY IN MICE
J.C. HAMPTON, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

Ingested fatty acids cross the intestinal epithelium to enter the lymph and blood stream, even after X-ray doses which are known to strip epithelial cells of ribosomes and to appreciably alter other cell organelles responsible for protein synthesis. This must be reconciled with the fact that protein synthesis is required in the production of chylomicrons, the normal transport form of lipids. Are fatty acids present in plasma after irradiation incorporated into chylomicrons, or do they cross the damaged epithelium, unchanged, by diffusion? Radiation has been shown to affect capillary permeability in the small bowel of the mouse. Experiments will be performed to determine whether similar effects can be detected in other major vascular beds, primarily those of heart, lungs, kidney, pancreas and skeletal muscle.

Results: Copious amounts of labeled lipid were absorbed by jejunal epithelial cells, and a lesser amount by ileal cells, in controls, and at 1 and 2 days following 3 kR to total body X-rays. The amount of lipid in epithelial cells diminished rapidly at 3 and 4 days postirradiation. These cells seem capable of absorbing lipid but transport across the cells is greatly impaired. The fenestrated type of capillary normally present in intestinal villi promptly disappears as epithelial damage becomes more severe at the 3 and 4 day postirradiation interval.

SUPPORTED BY U.S. Atomic Energy Commission

5.0739, RADIATION PHYSICS
A.J. HAVERFIELD, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1))

This study is primarily concerned with how radiation produces effects in matter, particularly biological effects. This is done by studying the initial interactions by which ionizing radiations transfer energy to matter and the subsequent transport and degradation of that energy. The study includes determination of the partition and distribution of the energy in the radiation field and in the irradiated medium and the determination of rates and mechanisms of energy transferred and transported. Measurements were made of the differential cross section for ejection of electrons by fast proton impact on gas targets. Cross sections, differential in electron emission angle and energy, were obtained for N2 at nine angles between 20 degrees and 130 degrees, and for five proton energies between 300 keV and 1.7 MeV. The cross sections, integrated over the emission angles, were compared to those calculated from binary encounter theory. Good agreement is found except for electrons ejected with velocities approximately equal to the incident proton velocity. For such electrons, the calculated cross sections are about 1/2 the measured values. Similar results were obtained for electrons ejected from neon by 1.4 MeV protons and also for 1.0 MeV protons on molecular hydrogen. Study was made of the luminescence from benzene at room temperature upon excitation by electrons and protons. In

addition to the singlet monomer fluorescence previously unobserved under electron and proton bombardment in liquid benzene, several fluorescing radiolysis products were observed. By using a flowing liquid target, most of the radiolysis-product emission was eliminated and spectra consistent with those reported for u.v. excitation were obtained. The results suggest that the primary emission from benzene is the same for the various modes of excitation (electron and photon and proton irradiation).

SUPPORTED BY U.S. Atomic Energy Commission

5.0740, NAVY ENVIRONMENT--PHYSIOLOGICAL, PATHOLOGICAL AND BEHAVIORAL EFFECTS OF MICROWAVE RADIATION

E.L. HUNT, Battelle Memorial Institute, *Richland, Washington* 99352 (N00014-70-C-0197)

Technical Objective: This investigation is part of a Navy program to evaluate the potential hazards of microwave radiation to Navy radar operators and other Navy personnel.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0741, RADIATION AND HUMAN SPERMATOGENESIS

C.C. JANNKE, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This program of cooperative research with Dr. C.A. Paulsen of the University of Washington, School of Medicine, was initiated in 1966. It has included counts, motility, vital staining, fluorescent antibody, and morphology studies of sperm in samples of seminal fluid collected from control and testicular irradiated subjects. These studies were designed to complement and augment the prime research program of Dr. Paulsen. Our participation in this program is limited to performance of tests on samples submitted by other participants. Results to date: The program included four volunteers receiving 100R of testicular X-irradiation, four receiving unilateral testicular biopsy, and two controls. Anti-human sperm antisera was produced in rabbits for positive controls. Sperm from controls was incubated with serum samples from irradiated and biopsied subjects and stained, by an anti-human gamma globulin fluorescent conjugate, for detection of human anti-sperm antibodies in test subject sera. Other monitoring tests included total sperm count, sperm motility rating, and percentage of live sperm. The group receiving 100 R X-irradiation showed an initial decrease in total sperm count within one week post irradiation. Sperm counts reached less than 10% of preexposure level by nine weeks postexposure and had not exceeded 10% by 59 weeks postexposure. Positive fluorescent antibody staining of sperm was demonstrable between 3 and 39 weeks postexposure. The total sperm count of the biopsied individuals decreased to less than 40% of the preexperimental values within 9 weeks posttreatment and had increased by 19 weeks posttreatment to greater than 50%. Postive fluorescent antibody staining was demonstrable between 5 and 27 weeks posttreatment.

SUPPORTED BY U.S. Atomic Energy Commission

5.0742, RATES OF DEPOSITION OF AIRBORNE RADIONUCLIDES IN THE ALASKAN ENVIRONMENT

C.E. JENKINS, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The atmospheric deposition rates, routes, biological uptake rates, and concentrations of fallout radionuclides and their stable element counterparts in the terrestrial and marine environments of Alaska are being investigated. Emphasis is placed on food chains that consistently lead to higher radionuclide concentrations than found in temperate regions of the world and on the routes taken by radionuclides in their relationships to man and his environment. Included are stable elements, Be-7, Na-22, Pb-210, Po-210, and Ra-226, and the artificial radionuclides, including the major fission products and the neutron activation products. From knowledge gained, it is possible to relate air concentrations to concentrations in biota of terrestrial and marine environments, define the biological pathways and buildup of 15 to 30 radionuclides deposited from the earth's atmosphere, and establish the behavior and relationship of radionuclides to their stable element counterparts. It has been clearly demonstrated that radionuclides and their stable element counterparts do not necessarily behave alike in their initial uptake and retention by biological organisms. The study employs mainly neutron activation analysis for stable element measurements, while the radionuclide measurements are made primarily by direct instrumental techniques.

Results: Some 16 radionucides are being traced through a simple food web on three successive trophic levels, lichen-caribou-wolf or man. Each successive trophic food level discriminates against Mn-54, Co-60, Y-88, (Zr-Nb-95), Ru-103, Ru-106, Sb-125, Ce-144, Eu-155, Pb-210, and Bi-214, whereas Na-22, Zn-65, Ag-110m, and Cs-137 are concentrated on each level. Radium-226 is highly concentrated by caribou but not by wolf in the bone tissue. Radionuclide accumulations in lichen vary by species and the location; caribou and wolf accumulations are age, sex, and season dependent.

SUPPORTED BY U.S. Atomic Energy Commission

5.0743, EFFECTS OF IRRADIATING SKIN

D.D. MAHLUM, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This project has three major objectives: (1) determination of the response of skin to ionizing radiation as influenced by size of exposure site and radiation dose administered, (2) determination of the effect of age at time of exposure, and (3) determination of the effect of combined treatment of the skin with radiation and known pharmacologic compounds with carcinogenic properties. Rats and miniature swine are used as test subjects.

Results: Observation continued on miniature swine exposed as young adults to Tl204 plaques of various areas. After 18 months, only the skin areas of 0.5 sq cm or larger, which were irradiated at the 6.25 krad or higher doses are grossly visible as thin, whitened circles. No signs of tumor development are apparent. Some tumors are beginning to appear in rats similarly exposed. At 15 months postexposure, tumors had developed at two of 192 sites exposed on adult rats, at 9 of 162 sites on rats exposed as weanlings, and at 28 of 165 sites on rats exposed shortly after birth.

SUPPORTED BY U.S. Atomic Energy Commission

5.0744, METABOLISM AND EFFECTS OF RADIONUCLIDES IN FETUS AND YOUNG

D.D. MAHLUM, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

Many of the biological parameters used to calculate permissible levels of exposure of adults to radioactive materials are inappropriate for the rapidly growing infant or child. These differences, together with the greater intrinsic radiosensitivity of the immature organism, emphasize the need for more detailed information on the metabolism and toxicity of radionuclides in the juvenile animal. This project has been principally concerned with the effects of age on the metabolism and toxicity in rats of I131, Cs137, Ce144, P32, Zn65, and the monomeric and polymeric forms of Pu238 and Pu239.

Results: The distribution of monomeric Pu239 was determined in the fetus and placenta of the rat, and the effects of such deposition noted at various intervals after injection of various times during gestation. From preliminary observation it appears that the incidence of mammary tumors in rats exposed to I131 while immature is elevated in comparison to unexposed controls of the same age or to animals exposed to the same radiation dose as adults. A variety of studies suggest that I131 beta irradiation of newborn rats is more effective than X-irradiation in decreasing thyroid function. Rats exposed to Ce144 as newborns, weanlings, or adults showed different patterns of carcinogenic response.

SUPPORTED BY U.S. Atomic Energy Commission

5.0745, TERRESTRIAL ANIMAL ECOLOGY

T.P. O'FARRELL, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

5. RADIATION

The terrestrial animal ecology project is to characterize the functional roles of the animal species of the Hanford ALE Reserve desert ecosystem. Special emphasis is placed on the relationships between population dynamics, physiological adaptations, and radiation sensitivity to environmental parameters, especially vegetative productivity, microclimatology, and the availability of water, minerals, and nutrients. Research efforts are also directed toward defining the fate and effects of elements in the desert-steppe and their transfer through the trophic levels.

Results: A population of free-ranging pocket mice, 'Perognathus parvus,' exposed to acute ionizing radiation in 1967 was sampled periodically to test whether there are synergistic effects between radiation insult and environmental stress; we have been unable to reject the null hypothesis of no interaction. Information on the long-term effects on the longevity and reproductive potential was summarized for three years. Longevity was inversely proportional to the amount of radiation administered. Trapping stations were established on the Reserve, with the objectives to determine distribution of species and relative abundance as a function of altitude and vegetation types, and to collect samples for a preliminary disease survey. Ectoparasites, including fleas, ticks, and lice, were preserved for each host, and tissue samples were preserved for histopathological diagnoses, serological testing, and examination for endoparasites. The higher elevations had the greatest species diversity, but the lower elevations had the greatest population sizes. Trapping also yielded information on the population dynamics of unirradiated small mammals. Apparently, the absence of seeds during years of poor germination of annual plants acts as part of a complex feed-back mechanism which effectively reduces reproductivity in the dominant mammals. Special emphasis was placed on describing the breeding biology of the grasshopper mouse, 'Onychomys leucogaster.'

SUPPORTED BY U.S. Atomic Energy Commission

5.0746, EFFECTS OF RADIOIODINE IN SHEEP AND SWINE

R.F. PALMER, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

Long-term radioiodine studies in sheep to define the lowest daily feeding level that will cause detectable damage during the lifespan of these animals have been in progress since 1949. The long-term feeding studies are completed, and only a few offspring animals, exposed in utero and by suckling, remain on observation.

Results: There were no unusual findings during the past year.

SUPPORTED BY U.S. Atomic Energy Commission

5.0747, INHALATION STUDIES - AEROSOL TECHNOLOGY STUDIES

J.F. PARK, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The objective of this project is to develop techniques of aerosol generation, sampling and characterization applicable to animal inhalation exposure studies, emphasizing those aspects which enable more definitive analyses to be made of the extent to which the physical and physico-chemical properties of aerosols affect the deposition, retention, translocation, excretion and biological effects in animal as well as in a human exposure situation.

RESULTS: An examination of the characteristics of an aerosol as determined by several types of sampling instruments or combinations of instruments was initiated. A survey of techniques used for the generation of monodispersed aerosols led to the conclusion that the most promising methods for plutonium would be a spinning disk generator, for the size range 0.5 micro millimeters to 10 micromillmeters, using a plutonium dioxide or a plutonium nitrate colloid as feed material, and a vaporization-condensation technique for the size range 0.01 micromillometers to 0.5 micromillimeters using plutonium metal as the source material in an atmosphere of helium. The generation of constant concentrations of aerosols of various materials from dry powders was investigated in detail.

SUPPORTED BY U.S. Atomic Energy Commission

5.0748, INHALATION STUDIES - BIOLOGICAL EFFECT STUDIES

J.F. PARK, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This project is concerned with the acute and chronic biological effects of inhaled radioactive particles to aid in defining critical tissues for permissible limit considerations. Pulmonary carcinogenesis is a major end point, investigated in dogs that have inhaled plutonium oxide particles. Effects in the lymphatic system are of particular interest, as are studies of the mechanisms of retention, clearance, and pathogenesis at the cellular level.

RESULTS: In a long-term study of the effects of inhaled 239PuO2, all 15 dogs that died after surviving as long as 54 months postexposure had lung tumors. The lowest plutonium lung burden associated with a tumor was 0.05 micromillimeters Ci at death, 9 years after exposure. Five animals survived in this study. Pathology data were obtained in continuing studies of the effects of inhaled 147Pm203, 239Pu and 238Pu, particularly in regard to the lymphatic system. Light and electron microscopic techniques were used to study the effects of inhaled 239Pu2 at the cellular level.

SUPPORTED BY U.S. Atomic Energy Commission

5.0749, INHALATION STUDIES - BIOCHEMICAL STUDIES

J.F. PARK, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This project is concerned with the biochemistry of normal and irradiated pulmonary tissue. The objective is to aid in understanding the effects of inhaled radioactive particles. Most of the studies employ rats as the experimental animal.

RESULTS TO DATE: Lung lipid content increases 24 hours after exposure to X-irradiation. Lung mitochondria derived from thoracic X- irradiated rats incorporated more 14C from palmitate into lecithin, triglycerides, monoglycerides and diglycerides, between 14 and 24 hours postexposure, than did mitochondria derived from control animals. The microsomal fraction did not show this stimulation. In experiments designed to elucidate the pathway of lung lecithin synthesis, lung mitochondria, lung microsomes and slices of lung tissue were incubated with (Me - 14C) choline, 1, 2 - 14C choline, (Me - 14C) methionine, and (U - 14C) ethanolamine. The optimal conditions for incorporation by the subcellular fraction were determined. Palmitate is incorporated into lecithin almost exclusively as a whole molecule without prior elongation or modification.

SUPPORTED BY U.S. Atomic Energy Commission

5.0750, LOW LEVEL PLUTONIUM INHALATION STUDIES IN BEAGLES

J.F. PARK, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This project is concerned with a specific experiment to determine the long-term effects in beagle dogs of low-level inhalation exposure to plutonium dioxide. The experiment will extend previous and continuing studies at higher exposure levels. It will test 238PuO2 as well as 239PuO2. Exposure levels will extend to as low as 0.002 muCi deposited in the lung, which corresponds to present permissible occupational deposition levels.

RESULTS: Breeding of dogs for this experiment is underway. Exposure chambers were designed and are being fabricated. A computerized data storage and retrieval system was developed for particular application to this experiment.

SUPPORTED BY U.S. Atomic Energy Commission

5.0751, COMPARATIVE DISPOSITION OF PLUTONIUM AND AMERICIUM AFTER INHALATION

J.F. PARK, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

Plutonium levels in exposed persons are often estimated by whole- body counting of Am241, which is present as a contaminant of all plutonium, and is more easily counted than is plutonium. This procedure is valid only if americium and plutonium are handled in a similar manner in the body. This project is testing that assumption by careful analysis of Am/Pu ratios in a variety of samples from dogs exposed to various types of plutonium at a variety of intervals prior to the taking of the sample.

Results: There is little indication that 241 Am and 239 Pu are significantly separated in the body after inhalation of 239PuF4 or 239PuO2 containing 241 Am.

SUPPORTED BY U.S. Atomic Energy Commission

5.0752, TERRESTRIAL PLANT ECOLOGY
W.H. RICKARD, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The terrestrial plant ecology project deals with the intra- and inter-specific relationships of plants and the impact of physical and biological environment on plant distribution, growth, reproduction, and yield. It is also concerned with the movement and accumulation of mineral elements and radionuclides by plants and the relationship to the soil substrate. Detailed information on the functional roles of the flora are a requisite for interpreting and predicting the fate and effects of radionuclides in the environment. The area used in this project is the Arid Lands Ecology Reserve (ALE), a 120 square mile piece of the USAEC Hanford Reservation, located in the most arid part of Southeastern Washington State.

Results: Descriptive field studies range from community structure, phytosociology, and mapping to phenology and observations on the recolonization of cultivated fields. Quantitative studies measure the harvest yield, moisture use, and mineral and radionuclide uptake by the various kinds of plant communities. Laboratory studies measure the influence of moisture and temperature regimes and competition on the uptake of minerals and radionuclides by desert-steppe plants.

SUPPORTED BY U.S. Atomic Energy Commission

5.0753, REMOVAL OF INTERNAL EMITTERS
V.H. SMITH, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The objective of this project is to develop methods that will hasten the removal, prevent the deposition, or otherwise decrease the damage potential from ingested or absorbed radionuclides. Necessarily associated with this effort is the development of information on the absorption, translocation, mobilization, and tissue distribution of radionuclides, to help in understanding and predicting their behavior and to serve as a basis for recommendations for the treatment of exposed persons. Rats or miniature swine are the usual test subjects and most agents are chelons or materials thought capable of mobilizing metals.

RESULTS: The deposition, total-body retention, excretion and blood disappearance of promethium were studied in miniature swine to complement earlier therapy experiments and to correlate with experiments in man. An effort to increase the efficacy or oral chelation therapy using aspirin as an irritant to increase the absorption of DTPA from the stomach was relatively ineffective. It was shown that Zn-DTPA was less toxic and a desirable alternate to therapy with the currently used Ca salt. As much as 140 mmol/kg of Zn-DTPA given subcutaneously at the rate of 2 or 4 mmol/kg per day had little effect on growth or rats when injections were started on day 4 or 10 after birth. The calcium and manganese salts were less well-tolerated. In weanling and newborn rats DTPA was more effective in preventing deposition when given 1 hour after plutonium citrate than similar treatment in adult rats; however, more plutonium was retained in the livers of the neonatal animals.

SUPPORTED BY U.S. Atomic Energy Commission

5.0754, INHALATION HAZARDS TO URANIUM MINERS, BIOLOGICAL STUDIES
B.O. STUART, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The relatively high incidence of lung cancer and other pulmonary diseases in uranium miners is clearly associated with exposure to mine atmospheres. In addition to the hazard of inhaled radon daughters, ore dust concentrations, diesel engine exhaust fumes and cigarette smoking are possibly synergistic factors which must be considered. This project involves daily exposure of both hamsters and dogs to controlled levels of radon daughters and uranium ore dust for the lifespan of the animals. Four groups of 100 hamsters each receive daily exposures at 30, 600, and 600 WL plus ore dust, and controls. Eighteen dogs are being exposed daily to 600 WL plus ore dust; nine dogs are being maintained as controls. In parallel studies supported by the National Institute for Environmental Health Sciences, HEW, additional hamsters are being exposed to combinations of atmospheric contaminants including diesel exhaust fumes, and dogs are inhaling cigarette smoke in addition to the radon and daughters and ore dust.

Results: At nearly 1-1/2 years of age, the exposed hamsters are approaching their mean lifespan; 40-50% of the animals remain alive in each of the study groups. None of the animals examined to date showed pulmonary neoplasia. Final interpretations will be based upon detailed histopathological examination of all animals at the conclusion of the studies. No significant changes in respiratory rate, minute volume, tidal volume, thoracic radiographs, hematology or clinical chemistry have been observed in the dogs after six months exposure.

SUPPORTED BY U.S. Atomic Energy Commission

5.0755, GASTROINTESTINAL IRRADIATION STUDIES
B.W. WACHHOLZ, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This project includes studies of morphologic damage, functional disturbances, permeability changes, and the influence of secretions as results of irradiation of the alimentary tract. The principal experimental animal has been the rat but more recently studies have been extended to miniature swine, rabbits, mice, and guinea pigs.

RESULTS: Additional data were obtained on the bilateral exposure of mature miniature swine to gamma radiation from a cobalt-60 source. The ratio of the median radiation dose for lower-body deaths to that which caused death after whole-body exposure was about 8 to 1, in contrast to the usual ratio of 2 or 3 to 1 seen for small laboratory animals. From the standpoint of both morphologic and histologic observations, vascular injury appeared to be more prominent in the irradiated intestine of swine than in that of rodents.

SUPPORTED BY U.S. Atomic Energy Commission

5.0756, U.S. TRANSURANIUM REGISTRY OF AEC, AEC CONTRACTOR AND LICENSEE EMPLOYEES
P.A. FUQUA, Hanford Environ. Health Found., *Richland, Washington* 99352 (AT(45-1)-1837)

To serve as a national focal point for the acquisition and provision of information about the effects of transuranic elements on man.

Investigations with laboratory animals have demonstrated that minute quantities of plutonium, americium, and other transuranium elements can cause malignant growth in the tissue in which it is deposited. The Registry will establish the applicability to man of these investigations through a program of data accumulation from details of exposures and autopsy findings of workers who have had exposures to the radionuclides of interest.

There is no accurate method for estimating low level depositions of commonly encountered compounds except by measurement of autopsy material. Development of standardized methodology for identification, selection and analysis of organ tissues represents a basic need and goal.

These objectives will be accomplished by establishing (a) a population of those workers past, present, and future who work with transuranium elements, (b) accumulating on a continuing basis, estimates of the amount and location of internal depositions of plutonium in these workers, and improving these determinations by reconciling with actual burdens found at autopsy or alternate means, and, (c) following such workers by clinical and epidemiological methods to determine adverse effects on health and longevity.

Results: Arrangements have been made at Hanford for inclusion in the Registry of all new workers who have become potentially exposed to the transuranium elements. Over 500 current employees at Hanford have been interviewed and have signed documents of cooperation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0757, CHRONIC RADIATION EXPOSURE - CORRELATION OF RADIATION EXPOSURE WITH BIOLOGICAL EFFECTS ON MAN
P.A. FUQUA, Hanford Environ. Health Found., *Richland, Washington* 99352 (AT(45-1)-1837)

To determine the long range effects of low level chronic radiation exposure to man, including the incidence of leukemia or cancer, and the effect of the mortality rate and differential causes of death between those with occupational exposure to ionizing radiation and those not exposed.

Although certain biological effects of radiation have been noted in man, radiation induced shortening of life span comparable to that observed in animals has not been documented in human populations.

The research design utilizes multiple control groups of atomic industry workers. The mortality experience of each control group will be compared with the mortality experience of the exposed groups according to their ionizing radiation received in the course of their employment.

Results: Efforts to date have been directed to the accumulation of basic data on approximately 75,000 workers and siblings. Accumulation of radiation exposure data for twenty years has been completed for certain groupings of employees.

SUPPORTED BY U.S. Atomic Energy Commission

5.0758, REAL-TIME SPACE-NUCLEAR EFFECTS ON SOLAR CELLS FOR SPACECRAFT PRIMARY POWER
R.R. BROWN, Boeing Company, *Seattle, Washington* (F33615-71-C-1583)

Technical Objective: Develop meaningful, accelerated laboratory test procedures to determine the survivability of solar cells in both the natural space and nuclear weapon environments.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0759, LOW LEVEL CHRONIC IRRADIATION OF SALMON
L.R. DONALDSON, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105 (AT(45-1)-2225-T2)

Chinook salmon (Oncorhynchus tshawytscha) eggs and alevins were exposed continuously to low levels of gamma radiation from a 60Co source, from the instant of fertilization until the yolk sac was completely absorbed. The irradiated fish were compared with a similar stock that was not exposed to irradiation. The level of irradiation exposure was gradually increased from 0.5 roetgen/day for the 1960 brood year, to 1.3 roetgens/day in 1965, 2.8 roentgens/day in 1966, 5.0 roentgens/day in 1967 and to 10.0 roentgens/day, a total of 820 roentgens, for the 1968 brood year. In 1969 the level was increased to 20.0 roentgens/day.

RESULTS: At a level of 0.5 roentgen/day no damaging effects were found. The data for the higher levels of exposure will be evaluated as the adults return from the sea. Studies are carried on during the entire life span of the fish.

SUPPORTED BY U.S. Atomic Energy Commission

5.0760, EFFECT OF IONIZING RADIATION ON ISOLATED CELL NUCLEI
K.L. JACKSON, Univ. of Washington, School of Medicine, *Seattle, Washington* 98105

The objectives of this study are to define the mechanism of the damage caused by ionizing radiation to certain metabolic processes in lymphoid cells. It has been established that very shortly after exposure to X-radiation, lymphoid cells display an altered ability to take up nucleic acid and protein precursors and lose some types of materials to the surrounding medium. The present study is concerned with radiation-induced alterations in those processes which are responsible for transport of materials into and through the nucleotide pool.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0761, THE STUDY OF IRRADIATION EFFECTS ON THE HUMAN TESTIS - INCLUDING HISTOLOGIC, CHROMOSOMAL, AND HORMONAL ASPECTS
C.A. PAULSEN, Univ. of Washington, School of Medicine, *Seattle, Washington* 98105 (AT(45-1))

Our principal aims are: (1) to relate X-ray radiation dosage to changes in gonadal function, (2) to utilize the radiation gonadal changes as the means for studying anterior pituitary interrelationships, (3) to explore our current concepts concerning radiation dosage expressed in physical terms and their relation to biologic effects. Program aspects include quantitation of spermatogenesis, study of serum FSH, LH and testosterone levels following irradiation, studies of chromosomal changes and electron microscopy studies of testicular histology.

Results: The data accumulated so far indicate that the human testis is quite sensitive to X-ray irradiation. Thirty r delivered acutely produces brief azoospermia and 15 r produces severe oligospermia of a transient nature. Doses of 50, 100, and 400 r produce more rapid and extended periods of azoospermia. With increasing doses, recovery still occurs but is correspondingly prolonged.

SUPPORTED BY U.S. Atomic Energy Commission

5.0762, COLUMBIA RIVER STUDIES, 1970-1971
A.H. SEYMOUR, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105 (AT(45-1)2225,TA)

Two of the six proposed projects are temperature and ionizing radiation effect studies. For one project, larvae of the Pacific oyster will be exposed at various life stages to H3 and Zn65 and incubated at water temperatures ranging from 20 C to 28 C; for the other, phytoplankton will be exposed to temperature stresses up to 30 C above ambient in a manner that simulates the nuclear reactor. Radiation stress also will be applied. Another project is a long-term experiment to determine the biological half-life for zinc in oysters living in a natural environment. The relationship of the output of Zn65 by the Hanford reactors to Zn65 in marine organisms will be determined by monitoring Zn65 in mussels from the Washington Coast. The radiation dose to Willapa Bay oysters, in situ, and in sediments from a bay near the mouth of the Columbia River by means of thermo-luminescent dosimeters is the objective of another project. Lastly, the concentration factors and specific activity values for Cr51 in beach diatoms and Zn65 in Willapa Bay oysters will be determined from values for large water samples, hundreds of liters.

RESULTS: For oyster larvae, temperature effects occurred between 24 C and 28 C and at H3 and Zn65 concentrations of 10 to the minus 3rd power Ci/liter. For the alga, Chlamydomonas reinhardi, temperature effect on 14C uptake was observed at 45 C, 23 C above ambient. The biological half-life values for zinc in oysters varied with season and ranged from 100 to 1350 days, average 538 days. The decrease of Zn65 in Washington mussels taking into account lag time, is closely related to the shutdown of Hanford reactors. For a 1969 beach sample 62 miles north of the Columbia River the values for 51C and Cr were 271 pCi and 15.8 microgram per gram of dry sample.

SUPPORTED BY U.S. Atomic Energy Commission

5.0763, EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS
A.D. WELANDER, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105 (AT(45-1))

The purpose of the research is to study the effects of ionizing radiation on the embryological stages of salmonids reared at different temperatures. Irradiation dose, which ranged from 12 to 1800 r (approx. 100 r/min.), in geometric progression, was delivered to seven different embryological stages. The fish were

irradiated and reared at temperatures ranging from 8.5 degrees C to 17.2 degrees C, and the effects on survival, growth, morphology and fecundity noted. These experiments indicate accelerated growth, not only by higher temperatures, but also by certain doses of ionizing radiation administered at critical developmental stages. Doses greater than 300 r appear to lower the tolerance to high temperatures and temperatures above 130 degrees C prove lethal for young chinook salmon independent of irradiation. Rainbow trout survive in water over 18 degrees C. More than 24,000 chinook salmon eggs have been used in this study, many of which were reared well beyond the feeding stages. In the spring of 1968, 469 rainbow trout eggs, irradiated with 21, 83, and 207 r at eyed stage were raised at comparatively high temperatures. These fish were spawned during the spring of 1970 with 65 females producing 176,000 eggs; 101,000 eggs have survived to the eyed stage. A limited number of these eggs, representing 8 experimental groups, will be held through the feeding stage for further observation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0764, GENETIC EFFECTS OF CUMULATIVE IRRADIATION IN RATS
A.B. CHAPMAN, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin* (AT)

The objectives of this research are to estimate the induced mutation rate in a mammal (albino rat) by sampling the genome broadly and, in conjunction with other data to provide a more realistic picture of the genetic effects of radiation in other animals and man. The traits used to reflect the effects on the genome are: sex ratio, size of litter, regularity of litter production, mortality rate of individuals at different stages of development, growth, age at sexual maturity, behavior, physical abnormalities, and kind and color of hair. Modifications of the lethal equivalent theory, and classical genetic techniques are being used as the means for estimating the genetic effects of irradiation.

Results: Estimates of X-ray induced dominant lethal mutants per gamete, per roentgen based on numbers per litter born alive, on those alive at 21 and at 69 days, 1.4 plus or minus 0.6 (10 to minus the 4th power), 1.4 plus or minus 0.8 (10 to minus the 4th power) and 0.9 plus or minus 0.9 (10 to minus the 4th power), respectively. Comparable estimates for autosomal recessive lethals are 1.0 plus or minus 0.8 (10 to minus the 4th power), 1.2 plus or minus 1.1 (10 to minus the 4th power) and 1.6 plus or minus 1.3 (10 to minus the 4th power). For sex- linked recessive lethals based on these same traits the estimates are 1.6 plus or minus 1.4 (10 to minus the 4th power), 0.8 plus or minus 1.9 (10 to minus the 4th power) and 2.0 plus or minus 2.2 (10 to minus the 4th power) per X-chromosome per roentgen. Genetic effects of cumulative irradiation on age at sexual maturity in the female and on body weights of males and females are also indicated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0765, STUDIES ON THE EFFECT OF X-RAYS ON DNA SYNTHESIS IN POLYTENE CHROMOSOMES
W. PLAUT, Univ. of Wisconsin, School of Letters, *Madison, Wisconsin* 53706 (AT(11-1))

The results of our studies up to the present time have shown that unscheduled synthesis of DNA can be stimulated by both X-rays and ultraviolet light in the polytene chromosomes of Drosophila melanogaster, that this synthesis can be distinguished from normal DNA synthesis by its spatial distribution, its occurrence when normal DNA synthesis does not take place, its insensitivity to DNA and RNA inhibitors and its susceptibility to certain protein inhibitors when normal synthesis is not affected. Ultraviolet light, besides duplicating X-ray effects, does not induce incorporation in the presence of caffeine, but does in BU-DNA, although the rate of DNA synthesis as well as that of RNA is reduced.

Future plans include a more detailed study of protein involvement in induced synthesis using additional inhibitors, an attempt to obtain more detailed information at the molecular level through molecular autoradiography of DNA extracted from salivary glands, and an investigation of the possible relationship between repair synthesis and recombination, using mutations affecting the latter. We will also continue observations of the temporal replication pattern in genetically modified material and with analogues.

SUPPORTED BY U.S. Atomic Energy Commission

5.0766, THE EFFECTS OF IRRADIATION ON ERYTHROCYTE CHIMERISM & IMMUNOLOGIC TOLERANCE IN CATTLE TWINS
W.H. STONE, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin* (AT(11-1)-1210)

To study the effects of irradiation and other treatments on the state of chimerism and immunologic tolerance in cattle twins. Being a unique in vivo system of interaction between genetically distinct tissues, it is possible to investigate the mechanisms that control and influence the relative proportions of the mixed tissues. In addition, chimeric animals exhibit immunologic tolerance allowing for reciprocal transplantation without immunosuppressive drugs. The possibility that the genetically unique tissues in a chimeric twin exchange chromosomes and genes is being investigated. Two cases of somatic cell mating have already been found and viruses are being used to enhance the occurrence of somatic cell mating. Immunologic studies on bovine embryos and fetuses are being performed, with regard to formation of chimerism. Some of this work is done at the Virginia Polytechnic Institute. Project began in 1961 and will be continuing.

RESULTS: Fractionated doses of whole body irradiation markedly shifts the equilibrium proportions between the two hematopoietic tissues in chimeric twins. The mechanism of this effect is not understood. Furthermore, a chimeric twin may exhibit partial tolerance for skin grafts and complete tolerance for kidney grafts. A comparison of the chimeric condition based on erythrocyte antigens and on lymphocyte types (karyotypes) revealed marked differences as might be expected of a state of split tolerance. Attempts to artifically produce chimeras have thus far failed using transplantation of hematopoietic tissues. New immunogenetic parameters such as allotypes have been discovered.

SUPPORTED BY U.S. Atomic Energy Commission

5.0767, RADIATION EFFECT ON PROTEIN & NUCLEIC ACID METABOLISM
M.B. YATVIN, Univ. of Wisconsin, School of Medicine, *Madison, Wisconsin* 53706

The continuing aim of this project is to obtain information about the nature of radiation-caused injury and recovery mechanisms of tissues in varying physiological states. As proposed in the original grant request, nucleic acid studies will be emphasized because of their unique role in controlling cell function through the regulation of protein synthesis. It is hoped that the proposed researches will enable us to determine why ionizing radiation apparently affects gene transcription and/or translation differently, depending on the mode of gene activation (i.e. hormonal, dietary, regenerating liver). We intend to extend our current program to investigate the nature of the action of ionizing radiation on gene expression in systems under hormonal control. Furthermore, in an effort to elucidate the mechanism of radiation injury and recovery, experiments utilizing radiomimetic drugs either alone or in combination with radiation are planned. Ideally, information obtained by such studies could be applied in both ameliorating the undesirable effects of radiation injury and conversely in enhancing the damaging effect of ionizing radiation on malignant cells. It is envisioned that these studies will be of value in the clinical radiotherapy of malignant disease.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0768, PHOTOBIOLOGICAL STUDIES ON EARLY DEVELOPMENT
A.F. RIECK, Marquette University, School of Medicine, *Milwaukee, Wisconsin* 53233

Studies will be made to hopefully identify specific photoproducts produced with ultraviolet irradiation in the developing system of Echinarachnius parma. Since it has been shown that UV can transiently delay the protein synthesis necessary for the subsequent DNA synthesis and karyokinesis and

cytokinesis of a given cell cycle, specific attempts will be made to learn the degree of differential production of photoproducts relative to this. Attempts will be made to learn if the photolesion is in the DNA or some of the DNA-like RNA which could possibly also be photoreactivatable. In addition studies will be made to learn if the same phenomenon can be observed if sperm are exposed to UV before fertilization as well as when eggs are exposed post- fertilization.

Investigations will continue regarding the separation, if possible, of photoproducts involved in cell division delay as compared to photoproducts which would be lethal or cause substantial changes in the developmental sequence.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0769, RADIOBIOLOGY OF NORTHERN FOREST COMMUNITIES

T.D. RUDOLPH, U.S. Dept. of Agriculture, North Central Forest Exp. Sta., *Rhinelander, Wisconsin* 54501 (AT(49-7))

This research is to provide information required to predict and to define the impact of ionizing radiation on natural forest ecosystems and on individual components of these ecosystems. Seasonal as well as long- term exposures to gamma radiation will be included to increase knowledge of the radiobiology of organisms comprising northern forest communities. A 1440 acre forest containing typical but diversified northern forest communities near Rhinelander in northern Wisconsin is the study area. The first phase of the research involves simultaneous gamma irradiation from a 10,000 curies 137Cs source of three forest types (aspen, paper birch, and northern hardwoods) for one growing season in 1971. Pre- irradiation evaluation of the characteristics, composition, and description of the communities including trees, shrubs, herbs, microorganisms, small mammals as well as microclimates within the communities is underway. The pre-irradiation studies are designed to permit interpretation of responses within a dose rate gradient, during and following irradiation, in terms of species composition, density, growth, phenology, distribution and diversity, as well as in microenvironments and litter, seed and dry matter production. To provide parameter guidelines for and to complement the radiation research on whole forest communities research on ionizing radiation effects on individual plant, small mammal and microorganism species is simultaneously being carried out under laboratory and cultivated gamma field conditions.

RESULTS: Early results, primarily from gamma field and laboratory studies, show that seed sensitivity of 9 gymnosperm species to gamma radiation varied by a factor of more than 4, but was not related to differences in nuclear parameters previously reported for the same species. Seedlings of 7 of the nine species were 7 to 15 times more radiosensitive than seeds of the same populations. No relation was found between seed and seedling radiosensitivity. White spruce pollen tolerates up to 3 times as much radiation as seeds and more than 10 times as much as young seedlings. Results have been published in Radiation Botany 10 and in 'Induced Mutations in Plants', IAEA, 1969. Other manuscripts are now being processed or in preparation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0770, STUDIES ON THE EFFECTS (BIOCHEMICAL, MORBIDITY AND MORTALITY) OF RADIOACTIVE CONSTITUENTS OF URANIUM ORE ON HEALTH OF WORKERS

M. KILIBARDA, Serbian Inst. Oc. & Rad. Hlth., *Belgrade, Yugoslavia*

The purpose of the project is to obtain data on the health hazards associated with mining and processing uranium ore. The collection of a cohort on whom base-line studies have been made, makes it possible and appropriate to conduct this chronic effects study. Groups of workers who have been exposed to known concentration of radioactive particles and who have been studied during the past six years will be followed for an additional four years.

Specific studies will focus: (1) carcinogenic effects of radioactive particles on the respiratory system of uranium miners, (2) proliferative metaplastic and anaplastic appearances of cellular elements in miners' sputum, (3) respiratory diseases, chronic bronchitis, lung emphysema and pneumoconiotic processes, (4) respiratory function using spirometric methods, eximetric methods, and studies by radioactive gases; (5) lung clearance after radon inhalation under influence of various factors, (e.g. climate, smoking); (6) changes in the hematopoietic system, changes in erythropoiesis and leucogenesis; (7) appearance of binuclear-multinuclear cells (lymphocytes) and appearance of chromosome aberration; (8) other morphologic and biochemical changes in various enzymatic systems (e.g. alkaline phosphatase, peroxidase change in DNA, RNA, changes in resistance of leucocytes); (9) changes in endocrinological system, especially in adrenals in exposure to radioactive particles.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0771, RADON AND SILICON DIOXIDE TOXICITY ON RATS' LUNGS

D. PANOV, Serbian Inst. Oc. & Rad. Hlth., *Belgrade, Yugoslavia*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

C. MEASUREMENT

Instrumentation, Dosimetry, Monitoring, Equipment. Includes Bioindicators.

5.0772, WHOLE BODY COUNTING OF POPULATION LIVING IN AREAS OF HIGH NATURAL RADIOACTIVITY

T.L. CULLEN, Pontificia Univ. Catolica, *Rio De Janeiro, Brazil*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0773, THE DETECTION AND ANALYSIS OF MUTAGENS

B.N. AMES, Univ. of California, Graduate School, *Berkeley, California* 94720 (AT(04-3)34,0156)

1. It is proposed to assemble a set of bacterial mutants to use for the specific detection and analysis of the different classes of mutagenic agents. I have two objectives in mind. One is to have a set of strains that can be used by government agencies, and other interested parties, to screen pesticides, herbicides, food additives, drugs, etc. as mutagens. Humans are constantly being exposed to a variety of compounds that have not been tested as mutagens. My second objective is to use these strains for investigating the mode of action of various mutagens and in particular for finding mutagens that made specific changes in the DNA.

2. The mutations that one observes after mutagenizing a cell are only a small fraction of the total number of DNA changes that are made. We are trying to estimate the unobserved mutations in several ways. These mutations consist of changes in a gene that do not destroy the ability of the corresponding protein to function. In addition we are trying to estimate the proportion of genes in bacteria which, when destroyed, are not noticed on the usual media on which the bacteria are growing at the time.

Results: A variety of bacterial tester strains have been developed, many of which are lacking the excision repair system, that are specific and extremely sensitive to various types of mutagens. A specific system has been developed for detecting deletion mutations.

A theory has been proposed that the ultraviolet component of sunlight is the evolutionary force that determines the DNA base ratios of bacteria.

SUPPORTED BY U.S. Atomic Energy Commission

5.0774, CHARACTERIZATION OF RADIOPROTECTIVE FACTOR IN ALFALFA

D.H. CALLOWAY, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B0-NTS-2267)

OBJECTIVE: Isolate and characterize the radioprotective factor from alfalfa, discover the mechanism by which increased

resistance to radiation injury is accomplished; and determine the importance of this mechanism in a variety of animal species. To aid in isolational studies, effort will be directed toward development of a more rapid assay requiring smaller amounts of material.

APPROACH: Isolation and identification work will continue during the next year. Spectral analysis and chemical tests for unsaturation and specific reactive groups will be made. A summary of these tests will be used to design a column chromatographic separation based upon chemical structure. However, the PHS grant has expired and is not being renewed, so biassay of fractions will be delayed until funds are available from a new source.

PROGRESS: Attempts to process alfalfa fraction beyond the steps of cold-water extraction and freeze-drying have resulted in substantial loss of radioprotective (RP) activity. Earlier studies have shown RP factor to be sensitive to oxygen, and it is probable that oxidation occurs after the factor is separated from the antioxidants naturally present in alfalfa. Antioxidants that have RP activity for rats, BHT and propylgallate, were added to guinea pig diet to determine if these could be used as processing additives during isolation of RP factor. In contrast to the rat, guinea pigs did not tolerate the substances well. Mortality was greater after irradiation with 0.5 percent BHT in the diet than with the bran-oats diet alone. Addition of alfalfa both diminished radiation sensitivity and offset the detrimental effect of BHT. Ash of whole alfalfa improves response to radiation but a mixture of Ca, Mg, Na, K, and Cl salts does not account for the entire effect. Ash prepared from the water-soluble RP fraction is not as effective as whole alfalfa ash. In irradiated animals, the effects of RP fraction and ash are additive, indicating that some mineral(s) is deficient or imbalanced in the basal diet and that RP factor is not an inorganic compound.

SUPPORTED BY California State Government - Sacramento

5.0775, BIOPHYSICAL EXPERIMENTS WITH POSITIVE AND NEGATIVE PIONS

S.B. CURTIS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

Negative pions produced by high-energy protons over an energy of about 400 MeV have the property of penetrating into tissue with relatively low ionization density. After the particles come to rest, they interact with the nuclei of atoms and produce stars consisting of short-range protons, alpha particles, nuclear fragments, and neutrons. The highly ionizing short-range particles cause a large local dose deposition, thus enhancing the peak-to-plateau dose ratio of the usual Bragg curve. This project aims to evaluate by direct experimentation the physical properties of high-energy pion beams produced at the 184' cyclotron, especially the dose and LET distribution of the beam, and to study important radiobiological parameters, such as RBE and OER, with suitable biological test objects.

Results: The relative biological effectiveness (RBE) and the oxygen enhancement ration (OER) of pi negative mesons at the peak of the depth-dose distribution was measured for induction of arginine reversions in diploid yeast. The mutation-induction efficiencies for dose rates of 40 rad/hr and 40 rad/min of 60 Co-gamma rays are about the same. The OER for 60 Co-gamma rays was 2.4. For pi negative mesons at the peak of the depth-dose distribution, an RBE value of 1.5 and an OER of 1.8 were obtained.

SUPPORTED BY U.S. Atomic Energy Commission

5.0776, BIOPHYSICAL EXPERIMENTS WITH POSITIVE AND NEGATIVE PIONS

S.B. CURTIS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

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Results: A method for 'in vitro' culturing of human blood lymphocytes was standardized. Radial responses to cobalt gamma radiation and negative pions were determined. The shape of the six-day survival curve with gamma dose indicated the existence of two population of lymphocytes with different radiation sensitivities. The survival of the sensitive fraction was exponential in nature and has a D sub zero value of about 80 rads. The value for the other insensitive population was around 270 rads.

SUPPORTED BY U.S. Atomic Energy Commission

5.0777, BIOPHYSICAL EXPERIMENTS WITH POSITIVE AND NEGATIVE PIONS

C. RICHMAN, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

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Results: A dose rate of 60 rad/hr was obtained by focussing the beam to a size of 2x4 cms. This beam is of sufficient intensity for biological experiments. Measurements of depth-dose distributions of negative pions indicate no significant variations. About 2 percent of stopping pions produce high energy gamma rays. By detecting these gamma rays using spark chambers, it is possible to map the stopping pion region.

SUPPORTED BY U.S. Atomic Energy Commission

5.0778, BIOMEDICAL RESEARCH USING HUMAN WHOLE-BODY COUNTER

T.W. SARGENT, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7045-ENG-48)

Rapid diagnosis of accidental human radionuclide contamination with regard to identity and total body burden of the isotope, and study of the progress of treatment or natural loss rate in cases where a burden has been acquired. Routine whole-body counting of LRL employees with a potential of exposure to radionuclide contamination. Use of isotopic tracers in studies of metabolism in normal volunteers and in patients with various diseases, utilizing small amounts of tracer giving a minimal radiation dose to the patient. Development of computer programs to utilize the data from metabolism studies in compartmental analysis. Clinical application of iron absorption and blood loss tests using Fe59 has continued. The patient who was found to be heterozygous for Wilson's disease is being studied further. We found that zinc is incorporated into one of the molecules which also contains copper, and on the supposition that this molecule may be the one affected by the gene for this disease, the whole-body turnover of zinc is being studied in our heterozygous patient.

RESULTS: Eight patients with hemochromatosis were studied before, during, and after phlebotomy therapy. After completion of therapy, when the patient's serum iron and all other blood indices were normal, the absorption of oral iron was in all cases above normal. Patients on diuretic therapy are counted periodically to determine whether they are becoming potassium depleted, because serum potassium does not fall until intracellular potassium has been considerably depleted, whole-body K40 measurements have made it possible to detect depletion before serum potassium measurements all

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0779, SCINTIGRAPHY USING THE SCINTILLATION CAMERA, POSITRON CAMERA, MARK II WHOLE BODY SCANNER AND MULTIPLANE TOMOGRAPHIC SCANNER (ABBREV)

D.C. VANDYKE, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

This project is concerned with application of new devices and improvement in the techniques for obtaining and quantitating scintigrams showing the 'in vivo' distribution of radioisotopes in the human body.

Part of the program includes development of supplemental techniques which increase the usefulness of such organ-imaging devices. These include the 80-lens sequence camera attachment for recording dynamic studies, a videotape system to record the data from the scintillation camera for subsequent quantitative analysis and reply, and area-of- interest shielding devices for sequential digital readout using either the scintillation camera or Mark II whole-body scanner.

A high priority aspect of this project is the constant search for methods of reducing the radiation dose to the patient without sacrificing quality of the information obtained. This can be accomplished by development of better isotopes, increased sensitivity of imaging devices and larger fields of view.

Areas of investigative interest include improvement of techniques for visualization and quantitation of the perfusion and ventilation of the lungs; improvement of techniques for hepatic, renal, and brain scintigraphy; and extension of studies of the distribution of erythropoietic bone marrow; and evaluation of regional blood flow to bone and bone marrow disorders.

Results: A scintillation camera with 16-inch crystal and 13-1/2 inch field of view has been perfected and is in clinical use. The tomographic scanner which shows the distribution of radioisotopes in the body in three-dimensional space has been evaluated. The Mark II whole- body scanner has proven to be an extemely valuable and versatile clinical diagnostic and research instrument.

SUPPORTED BY U.S. Atomic Energy Commission

5.0780, THE APPLICATION OF SOLID-STATE LITHIUM-DRIFTED GERMANIUM DETECTORS TO THE ANALYSIS OF RADIONUCLIDES IN BIOLOGICAL AND ENVIRONMENTAL SAMPLES

A.E. BRADLEY, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

Primary to the objective of decreasing the minimum detectable levels of radionuclides in biological and environmental materials will be the development of a solid-state lithium-drifted germanium detector array having an equivalent surface area of approximately 80 square centimeters and an active depth of one centimeter. System resolution, measured at the energy of Co-60, 1.33 MeV is expected to be less than 3.5 keV. Counting efficiency will be one of the main goals. Independent cryogenic chambers for each detector will be developed, with up to four detectors in the system. The initial signal conditioning will be done by field effect transistors to liquid nitrogen. Signal processing to maintain high resolution will be of prime consideration. Initial uses will be for detecting trace radionuclides in various biota and whole- body small animal counting. Future uses may include collaborative studies with other AEC laboratories and medical facilities for detection of human tumors.

Results: We have gained extensive insight into problems associated with small and medium size detectors as applied to biological and environmental counting. A small (28 square centimeters) four-detector array has been constructed. Resolution was 2.9 keV at 1.33 MeV. Whole- body counting of small animals showed the feasibility of analyzing complex mixtures of radionuclides in vivo.

SUPPORTED BY U.S. Atomic Energy Commission

5.0781, DETERMINATION OF UPTAKE RATES, ORGAN SPECIFICITIES, AND BIOLOGICAL LIFETIMES OF RADIOISOTOPES AND ELEMENTAL SPECIES IN THE RAT

D. FLESHMAN, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

These experiments are designed to evaluate the relative efficacy of several chemical countermeasures in reducing the absorption of ingested radionuclides from the gastrointestinal tract and/or increasing the excretion rate of those already deposited within various tissues. By reducing absorption or increasing the removal rate of radioactive materials, radiation exposure and the possible associated hazards are reduced. Data from these experiments may lead to prescribed treatment procedures for any radionuclide which may present a problem to man. Control and experimental groups of rats are stomach-fed a mixture of the radionuclides; treatment is begun on the experimental groups and whole- body counting is carried out on a lithium-drifted germanium diode at preestablished intervals during the experiment. A high-resolution gamma-ray spectrometer makes possible the quantitative and qualitative determination of complex, low-level mixtures of gamma-emitting radionuclides in small animals. Countermeasures to be evaluated include sodium alginate, penicillamine, diethylene-triaminepentaacetic acid 2,3-dimercaptoethanol, 2,3-dimercaptopropionic acid, and 2,3- dimercaptosuccinic acid. Studies are also carried out on the deposition and retention of selected radionuclides in the rat.

Results: Orally administered sodium alginate was shown to be effective in reducing the retention of several radionuclides in rats in the following descending order: Ba, Sr, Cs, Zn, Hg, Sn, Mn, Co. The Ba- 133 levels were reduced to 3 percent of control values and Cd-109, Hg- 203 levels to be about 50 percent. Co-60 levels were not affected.

Orally administered tantalum was found to be only slightly absorbed - less than 1 percent - the principal accumulation sites being bone and pelt.

SUPPORTED BY U.S. Atomic Energy Commission

5.0782, QUANTITATION OF LOW LEVELS OF TRITIUM IN BIOLOGICAL AND ENVIRONMENTAL MATERIAL

E. MORIMOTO, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

A number of the Bio-Medical Division's research projects require the quantitation of low levels of tritium in biological and environmental samples, particularly the studies of human organs and foodstuffs in the chain leading to man, and the radioecological studies on the fate of low levels of tritium liberated to biosphere at the sites of Plowshare gas-stimulation programs and at nuclear power reactors. Conventional liquid scintillation techniques are not sensitive enough for most of these biological and environmental samples; consequently, it is necessary to develop specialized systems.

Four specialized systems are being developed and assembled. The first is a system to enrich by electrolysis tritium content of samples. The second system will combust hydrogen in organic matter to water; the water so produced will be trapped cryogenically. The third converts water as water vapor to hydrogen for gas-counting. The last is a gas- counting system for counting tritium as hydrogen gas.

Results: Some preliminary work has been done on the development and assembly of the four specialized systems described.

SUPPORTED BY U.S. Atomic Energy Commission

5.0783, ANALYSIS OF RADIONUCLIDE PRODUCTION FOR PREDICTION OF UPTAKE AND DOSES FROM RELEASE OF RADIONUCLIDES

Y.C. NG, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

This analysis of radionuclide production is a main category of a predictive program designed to provide the following kinds of information: (1) guidance for radiation safety analysis of

proposed applications involving nuclear energy, (2) guidance for documentation of the release of radionuclides to the biosphere, and (3) guidance for design in applications involving nuclear energy. The objective of this phase is to predict the maximum quantity of any given radionuclide that could be produced and subsequently be released to the environment. Estimates of radionuclide production and radionuclide inventory as a function of time are evaluated in relation to their possible release to the biosphere and transfer to man by way of the food chain. Estimates are made of the internal dosage to man that could result from a variety of situations involving acute and continuous release. The overall approach is described in a series of reports. Radionuclide production and inventories in various applications, such as reactors and their waste storage facilities and fuel reprocessing plants, will be considered and integrated in the overall program.

Results: The application of this approach to the Plowshare cratering program revealed the relative importance of device activation to the bone and whole body dosages and the importance of fission by virtue of the estimated dosage to the child's thyroid from Iodine-131. It also revealed the potential biological gain that could be achieved by using separated isotopes for the fabrication of nuclear explosives for peaceful purposes.

SUPPORTED BY U.S. Atomic Energy Commission

5.0784, PREDICTION OF BIOLOGICAL FATE AND RADIATION DOSES FROM RADIONUCLIDES RELEASED TO THE BIOSPHERE

Y.C. NG, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

This analysis of the biological fate and radiation doses from radionuclides released to the biosphere is a main category of a predictive program designed to provide the following kinds of information: (1) guidance for radiation safety analysis of proposed applications involving nuclear energy, (2) guidance for documentation of the release of radionuclides to the biospheres, and (3) guidance for design in applications involving nuclear energy. This portion of the prediction effort is oriented toward prediction of the radiation dose to man from any release of radionuclides into his environment. Biological uptake relationships are combined with estimates of radionuclide production and transport into terrestrial and aquatic ecosystems to arrive at estimates of the burden and dosage to man. An important aspect of the predictive approach is the collection, storage, and recall of documents that provide either data on these parameters or useful collateral information. A revision of the Handbook for Estimating the Maximum Internal Dose from Radionuclides Released to the Biosphere, which is in progress, should improve the prediction of the dosages that could result from a single release of radionuclides from any source. It should also enhance the overall validity of estimates of the dose-rate and steady-state concentration of nuclides resulting from the continuous release of radionuclides to the biosphere. The program will also include the application of our predictive approach to specific ongoing or proposed nuclear projects.

Results: The overall approach is described in a series of reports. One of these reports is a continuously updated Handbook that lists the input parameters required for estimation of dose.

SUPPORTED BY U.S. Atomic Energy Commission

5.0785, SOMATIC EFFECTS OF LOW-DOSE RADIATION - CHROMOSOME ANALYSIS AND ANALYTICAL METHODOLOGY

S.P. STONE, Univ. of California, Lawrence Radiation Laboratory, *Livermore, California* 94551 (W-7405-ENG-48)

Objective is to provide, through the acquisition and development of image processing devices and the development of associated computer programs, suitable systems for automated processing and analysis of large numbers of chromosome metaphase spreads. Measured parameters obtained are statistically evaluated for valid conclusions pertaining to qualitative and quantitative aspects of somatic effects of chronic low- dose irradiation of humans.

For three years, a film reader (8 gray levels) has been used to digitize data from photographs of idealized representations of spreads. Computer programs in pattern recognition, result merging and statistics were built and used to analyze such data. Presently under development is a facility using a small computer with, 1) a film reader (64 gray levels), 2) and image dissector system for projected microscope image scanning, and 3) display devices and computer peripherals attached. This facility may operate independently or as a terminal with a large time- shared computer through a direct data link. Pattern-recognition techniques are being extended to analyze data from this system with an emphasis on data from 35-mm photomicrographs of normal or near normal spreads.

Results: Our first system has been fully developed into a reliable and efficient tool which was successfully used in analyzing nearly 7000 idealized metaphase representations and in obtaining conclusions. Our new film reader has demonstrated superior capability. The new system is sufficiently complete that it has replaced the older one. Present efforts will continue in full development of this system, particularly in terminal-type operation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0786, HIGH ALTITUDE RADIATION INSTRUMENT SYSTEM

H.S. KATZENSTEIN, Solid State Radiations Inc., *Los Angeles, California* 90064 (000577)

This program is for the development and manufacturing of 4 units of a High Altitude Radiation Instrument System (HARIS) which was fabricated by Radiation, Inc., Los Angeles, Calif. It will be used in the High Altitude Radiation Environment Study (HARES) to obtain measurements of ionizing radiation at SST cruising altitudes. The instruments meet the specifications of the 3 agencies participating in this program; namely, the FAA, NASA, and the USAF. The HARIS package will be installed in aircraft flying at various altitudes and latitudes.

Four HARIS units of the type specified above have been developed and are being flown in USAF and NASA aircraft. The instuments were calibrated with various radiation sources in order to obtain reliable measurements. The intruments were delivered to and accepted by personnel from the AF Weapons Laboratory at Kirtland AFB, N.M., who are the technical monitors of this project. Several units were calibrated using the Brookhaven National Laboratory medical research reactor, and gamma and neutron sources available at Kirtland. More than 60 flights were made from Kirtland AFB, Moffitt Field, Calif., and Eielson AFB, Alaska in which the HARIS was used. A computer program was developed at the AF Weapons Laboratory to analyze the data. Contract FS-65-24 to produce the 4 HARIS units was completed and the warranty has expired. The current contract covers maintenance and modification costs of the instruments during the data collection period.

No additional funding is presently planned or anticipated.

Document provided by the Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

5.0787, PRECIPITATION, AIR TEMPERATURES, SOIL MOISTURE, & GAMMA RADIATION, IN 68 MOJAVE & GREAT BASIN ECOSYSTEMS, NEVADA TEST SITE, 1962-70 (ABBREV)

J.C. BEATLEY, Univ. of California, Lab. of Nucl. Med. Rad. Biol., *Los Angeles, California* 90024 (AT(04-1)GEN-12)

As minimal documentation of the seasonally fluctuating physical environmental variables of sites of biological studies, measurements have been made weekly or bi-weekly, from 1962 to the present, on the sites of 68 selected ecosystems in eight drainage basins of the Nevada Test Site. Variables measured are rainfall, maximum and minimum air temperatures at the 1-foot level, soil moisture and temperature at the 3-, 6-, and 10 inch levels, and gamma radiation. In addition to their use in understandings of the behavior and distributions of biological populations in this region of southern Nevada, the data-which are the most areally intensive and extensive and have the longest continuous record of any meteorological sampling program over this 100 square mile area-are expected to be of utility in Nevada hydrologic studies, and storm patterns, and other. The soil moisture record is a pioneer effort in desert ecosystem studies.

5. RADIATION

SUPPORTED BY U.S. Atomic Energy Commission

5.0788, THERMOLUNINESCENCE OF GAMMA- AND NEUTRON-IRRADIATED SOILS
H. NISHITA, Univ. of California, Lab. of Nucl. Med. Rad. Biol., *Los Angeles, California* 90024 (AT(04-1)GEN-12)

The objective of this study is to determine the characteristics of soil thermoluminescence, in order to determine whether or not soil can be used as a radiation dosimeter. At present,several kinds of manufactured thermoluminescent dosimeters are being used in gamma radiation fields established to study the effect of radiation on ecosystems. In such a radiation field, the dosimeters can be placed at the selected sites before exposure to radiation. The pre-irradiation placement, however, may not have been done always at the appropriate sites or in sufficient number to fully assess the radiation field. In areas exposed to an unexpected nuclear detonation, pre-irradiation placement of dosimeters certainly will not have been done. Under these circumstances it may be advantageous if the soil or other materials in the environment could be used to estimate the radiation exposure. Experiments are in progress using Cs137 and Co60 sources. Some experiments are also being conducted under conditions of actual nuclear detonation at Nevada Test Site.

Experiments in the laboratory have shown that a number of factors need to be considered in using soil as a dosimeter. Some of these factors are decay, spurious effects, heating rate, temperature during sample irradition, particle size distribution of the samples, mineral composition of the samples, etc.

SUPPORTED BY U.S. Atomic Energy Commission

5.0789, CALCULATION OF BETA DOSES FROM FALLOUT
J.L. MACKIN, Stanford Research Institute, *Menlo Park, California* 94025 (DAHC20-70-C-0395)

Technical Objective: To improve the capability for computing and measuring beta radiation dose for civil defense applications.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0790, MEASUREMENTS OF NATURAL RADIOCARBON AND TRITIUM
H.E. SUESS, Univ. of California, Graduate School, *San Diego, California* 92038

The project is a continuation of NSF Grants GA-17689 and GA004481. The two previous grants are now combined into one. The objectives of this project are multi-disciplinary in character, involving determinations of carbon-14 in samples of known age for the purpose of establishing the radiocarbon time scale and determining dendrochronologically-calibrated radiocarbon ages. The various studies include: 1) Distribution of natural radiocarbon in bicarbonate of the deep oceans for the investigation of the movement of deep ocean water masses. 2) Distribution of artificial radiocarbon in the surface water of the Pacific Ocean for the purpose of investigating mixing through the thermocline. 3) Secular variations of the radiocarbon level in the atmosphere derived from measurements of carbon-14 in wood, dated from its tree rings, investigated as a geophysical parameter for the study of variations in the cosmic ray intensity and of changes in the terrestrial carbon distribution. 4) Measurements of carbon-14 in wood of known age for the purpose of establishing calibration data for the conversion of radiocarbon ages into true ages. Another aspect of the program is making measurements of tritium in ocean water and in precipitation. Emphasis will be placed on: 1) Measurements of interest in connection with the mixing rates of the oceans. 2) Measurements in connection with problems of general hydrology. 3) Measurements in connection with the problem of the pre-bomb natural tritium level and its variations.

SUPPORTED BY U.S. National Science Foundation

5.0791, REPAIR OF RADIATION-DAMAGED DNA IN HUMAN AND OTHER MAMMALIAN CELLS
J.E. CLEAVER, Univ. of California, Laboratory of Radiobiology, *San Francisco, California* 94122 (AT(11-1)-GEN)

The DNA of human cells which has been damaged by ultraviolet (UV) light is repaired by excision of the damaged regions and synthesis of a replacement region (excision repair). We will determine the size, genomal distribution, and integrity of the repaired regions in human cells and study the connection between the failure of excision repair in skin and subsequent actinic carcinogenesis in the human hereditary disease xeroderma pigmentosum. An animal model for this disease is being sought amongst inbred Hereford cattle which show a high incidence of actinic cancer of the eye. Excision repair is more complex in rodent than in human cells, but with repair in the latter serving as a heuristic model we will ascertain the biological importance of excision repair in rodent cells. We will then isolate mutant cell lines in culture which are analogues of xeroderma pigmentosum cells. Using these mutants we will perform somatic hybridization between excision repair deficient rodent cells and normal human cells to locate the excision repair genes on a particular human chromosome.

Results: We have found that excision repair of UV damage in human fibroblasts isolated from the skin occurs by the following enzymatic sequence: (1) an enzymatic break is made in UV-damaged DNA, (2) the UV damage is excised, and (3) a replacement region is synthesized. Cells from human patients with xeroderma pigmentosum are homozygous for a gene which causes a defect in step (1) of the excision repair system. This defect renders the cells three to ten times as sensitive as normal cells to killing by UV light.

SUPPORTED BY U.S. Atomic Energy Commission

5.0792, STUDIES OF ENDOGENOUS SULFHYDRYL GROUPS
J.W. HARRIS, Univ. of California, Laboratory of Radiobiology, *San Francisco, California* 94122 (AT(11-1)-GEN)

Our earlier observation that the reduced glutathione (GSH) content of mammalian cells varies according to their position in the cell cycle has been pursued with reference to the relationship between cellular GSH and cellular radiosensitivity. Present research is directed to three major questions: (1) Does GSH play a role in radiation injury and repair? (2) What specific functions does GSH serve in the economy of mammalian cells, e.g., with respect to macromolecular synthesis or mitosis? (3) Do protein sulfhydryl and disulfide groups contribute to cyclic radiosensitivity? These studies involve assay of GSH in synchronized cells and are facilitated by two reagents that are specific oxidants for low molecular weight thiols (e.g., GSH): methyl phenyldiazenecarboxylate and diazenedicarboxylic acid bis (N,N- dimethylamide). These reagents can completely and reversibly oxidize cellular GSH to the disulfide without affecting protein thiol groups, and they are being used to test the so-called 'mixed disulfide' hypothesis of chemical radioprotection. These studies are presently confined to cellular systems in vitro, but may be extended to in vivo systems.

Results: The bulk of endogenous cellular GSH does not play a prominent role in cellular radiosensitivity, at least at doses below 1000 R. Although GSH clearly protects enzyme SH groups against other oxidants (e.g., molecular oxygen), our results do not support a radioprotective role for endogenous GSH. There is some evidence that GSH may participate in repair of radiation damage, but this has not yet been firmly established.

SUPPORTED BY U.S. Atomic Energy Commission

5.0793, NEUTRON DOSE BELOW 500 KEV IN A CRITICALITY ACCIDENT (PART OF A COORDINATED PROGRAMME ON NUCLEAR ACCIDENT DOSIMETRY) (ABBREV)
W. CROSS, Atomic Energy of Canada Ltd., *Chalk River, Ontario, Canada*

In a criticality accident an important fraction of the neutron dose may be delivered by neutrons with energies between 30 and 500 keV. Because it is not feasible for individuals to wear dosimeters that measure the dose from these neutrons, this must be determined either from more comprehensive, installed monitors or estimated from measurements on neutrons of higher and lower energies, using some assumptions about the spectrum. In order to

develop the latter approach, we are studying data on the spectra of neutrons escaping from a variety of reacting cores and moderating and shielding materials. The conventional approximation of an unmoderated fission spectrum and '1/E' component is often seriously in error. Both measurements and calculations of spectra in this energy region, made for reactor physics purposes, have improved considerably in the last few years, and the results are generally in good agreement. From these results it appears that, in several important criticality situations, the escape spectra depend primarily on the moderating material (and to a much smaller extent on its geometry and thickness) and that simple calculations will determine these spectra with adequate accuracy for estimating fast neutron doses from neutrons below 500 keV. The objective of our work is to develop a simple and rapid method for estimating the dose delivered by such neutrons, from a knowledge of the moderating materials and from dose measurements made at higher and lower energies. Such estimates should help to reduce the uncertainty in the neutron dose delivered to individuals exposed in a criticality accident to the recommended value of less than 25 percent.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0794, BIOCHEMICAL ASSAYS IN RADIATION RESPONSE
J.A. COLLINS, Ontario Cancer Tr. & Res. Fdn., *London, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Ontario Cancer Treatment & Research Found.

5.0795, BETATRON DOSIMETRY
J.C. MACDONALD, Ontario Cancer Tr. & Res. Fdn., *London, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Ontario Cancer Treatment & Research Found.

5.0796, SULPHYDRYL COMPOUNDS AND PROTECTION AGAINST RADIOMIMETIC ALKYLATING AGENTS
I.G. WALKER, Univ. of Western Ontario, School of Medicine, *London, Ontario, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0797, DEPTH DOSE PARAMETERS FOR FAST NEUTRONS IN TISSUE
D.E. CHARLTON, Sir George Williams University, Graduate School, *Montreal, Quebec, Canada*

Collimation and shielding studies of 14 Mev neutrons will be carried out using various combinations of moderaters and absorbers.

Depth doses in tissue-equivalent media exposed to 14 Mev neutrons will be determined using tissue-equivalent ionization chambers and tissue-equivalent scintillation detectors. The variation of RBE and OER for yeast cells will be determined as a function of depth so that isodose patterns in terms of REM may be established.

SUPPORTED BY Canadian Government - Ottawa

5.0798, PERSONNEL SPECIALISE ET ENTRETIEN DES APPAREILS D'IRRADIATION ET DE MESURE DE LA RADIATION SUR GRANDS VOLUMES
L.L. COUTU, Univ. of Montreal, *Montreal, Quebec, Canada*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Canadian Government - Ottawa

5.0799, DEVELOP ELECTROMAGNETIC HAZARD METER
R.R. BOWMAN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Boulder, Colorado*

Objectives: To extend the development of a new type of E-M hazard meter for use by the Navy on board ships. In FY 70 we developed a prototype meter that has unique characteristics even though it is not yet optimized. It has nearly perfect isotropic response; a dynamic range of 0.2 mW/per sq. cm to 2000 mW/per sq. cm; is broadband from 3 GHz to some as yet undetermined frequency below 1 GHz; has a 90 percent response time of less than 300 microseconds accurately measures fields with arbitrary polarization, multipath components, and re-active near-field components; does not perturb the field being measured; is virtually burn-out proof and is small, lightweight, inexpensive, rugged, and battery operated (low-drain). EM hazard meters with such capability are urgently needed in both the military and civilian areas. The present effort is to extend the frequency range to 6 GHz or more, improve the response time to less than 30 microseconds, improve the sensitivity, and improve and simplify the circuitry. This development will have great impact on research into the effects of EM fields on humans and other biological subjects as well as vastly improving survey measurements of hazardous EM fields. The meter is also very useful for many measurements for EM capability.

Approach: To fully realize the capabilities of this new type of meter, radical changes are necessary in the telemetry lines used to transmit the signal from the sensor to the instrument case. However, time and funds will not permit this development. Instead, the present type of telemetry line will be re-designed and optimized to allow an anticipated improvement of at least ten times in the response speed of the instrument. New circuitry will be developed to handle the increased signal speed. Also, the sensor size will be reduced by a factor of two by using ultra-miniature beam-lead diodes and a new design.

Outputs Expected: Greatly improved instrumentation for research into the biological effects of EM fields and for survey measurements of hazardous EM fields. Indirect: Instrumentation for some electromagnetic compatibility measurements (for instance, ordinance detonation problems on board ships); more effective control of EM pollution.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

5.0800, HIGH FREQUENCY ELECTROMAGNETIC HAZARD MEASUREMENTS
R.R. BOWMAN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Boulder, Colorado*

Objective: (1) Develop probes and the associated instrumentation and measurement techniques required for a variety of tests involving the exposure of monkeys to high intensity pulsed EM fields. These tests are being conducted by the USAF School of Aerospace Medicine (USAFSAM) in order to determine the biological hazards to personnel exposed to strong EM fields. The needed instruments are not available commercially. (2) Provide technical consultation to USAFSAM in support of their overall study program. As a result of this work, NBS will enhance its ability to perform EM field measurements under difficult near-field conditions and considerable knowledge of the biological effects of EM radiation will be gained.

Approach: During FY 70 both fixed and portable E-and-H field probes were developed for measuring pulsed EM fields from 200-2000 v/meter over the frequency range 10-30 MHz to an accuracy of 1 DB. USAFSAM has requested that we modify these probes to measure up to 10,000 v/meter. This will be accomplished by modifying the plug-in capacitive divider network of the fixed probe and by reducing the sensitivity of the portable probes. We will also study the feasibility of constructing a phantom dosimeter and a miniature implantable probe for measuring the fields inside a body. The main technical problem will be the development of a suitable transmission line or telemetering

scheme to extract the information from the probe. Consultation will be provided on the design of the USAFSAM experimental apparatus and a theoretical study of possible resonance effects in people may be undertaken.

Outputs Expected: Specialized field strength measuring instrumentation and a greater understanding of the potential hazards of EM radiation.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

5.0801, GAMMA-RAY SPECTROMETRY

J.A. PITKIN, U.S. Dept. of the Interior, Geological Survey, *Denver, Colorado* 80225

Area(s) to which the work listed herein pertains: U. S.

Airborne and ground gamma-ray spectrometer surveys measure the components of natural terrestrial radioactivity and apply their relative distributions to geologic studies. These studies emphasize aiding geologic mapping; however, the application of spectrometer surveying to mineral exploration, both radioactive and nonradioactive, is being investigated.

Principal tools will be computer-produced contour maps of both radioelement and radioelement-ratio quantities. Initial studies to be made in areas of well-known geology and geochemistry, and later extended into less well known areas as experience is gained.

Long range goal is to establish gamma-ray spectrometer surveys as a meaningful geologic tool in most geologic provinces.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

5.0802, RADON PROGENY INHALATION STUDY

K.J. SCHIAGER, Colorado State University, School of Veterinary Medicine, *Fort Collins, Colorado* 80521 (AT(11-1)-1500)

Objectives: To investigate the relationships between the physical characteristics of airborne radon progeny in uranium mines and their deposition patterns in the human respiratory tract; to evaluate methods of measurement and control of inhalation exposures to uranium miners.

Scientific Background: Radon progeny nuclides have been found to exist as submicron aerosols in uranium mine atmospheres; upon deposition in the tracheobronchial tree, these aerosols may produce substantial alpha-particle exposures and are believed to be the cause of the excessive incidence of lung cancers observed in uranium miners.

Procedures: Analyses of aerosol particle-size distributions in uranium mine atmospheres, under various working conditions and ventilation patterns, will be made with diffusion tube batteries and a variable gradient thermal precipitator which is being developed. The exposure conditions in a mine will then be correlated with patterns of aerosol deposition in the respiratory tract determined by in vivo gamma- ray counting of subjects exposed either in actual mine spaces or in a laboratory exposure chamber.

Results: Measurements of radon concentrations and radon progeny concentrations and particle-size distributions were made during various operating and shut-down conditions along a complete ventilation route in an operating mine. Seven locations, from the air inlet shaft to the exhaust vent raise, were studied. Variations of exposure conditions along the air course were investigated as a function of the time of day and the nature of the mining operations being performed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0803, RADON PROGENY EXPOSURE CONTROL IN BUILDINGS

K.J. SCHIAGER, Colorado State University, School of Veterinary Medicine, *Fort Collins, Colorado* 80521

The overall objective of this research is to devise and evaluate methods for treating or modifying structures so as to eliminate, or at least significantly reduce, the radon progeny inhalation exposures to occupants of the buildings caused by uranium mill tailings used as fill under or around the buildings. The types of structures to be used for the evaluation are typical of commercial and residential buildings found in Grand Junction, Colorado. The exposure control methods to be evaluated will range from simple, inexpensive methods to complex methods just short of demolition of the buildings. This study is expected to provide methods for eliminating any biologically significant exposures to people who live or work in buildings having abnormally high radon progeny concentrations as a result of the mill tailings used in construction.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0804, STUDIES OF APPLICATIONS OF RADIOISOTOPES FOR PROCESS CONTROL AND POLLUTION ABATEMENT

R.A. MICHELSON, Whyco Chromium Company Inc., *Thomaston, Connecticut* 06787 (AT-(30-1)-4008)

Whyco Chromium Company, Inc., under Contract No. AT(30-1)-4008, is undertaking the study of the feasibility of using low-level tracer radioisotopes as the measuring parameter in a chromium recovery unit, utilizing a cation exchange system for the removal of metallic impurities from chromium-plating baths. A radioisotope, such as Zn-65, will act as a metallic contaminant and be retained on the ion exchange resin. Both loading of the resin and eluting from the resin will be controlled by the use of such a radioisotope tracer. The advantages of using such a tracer has greatly improved operation of the ion exchange bed plus minimizing the amount of acid necessary to elute the bed, thereby effecting a savings in operation. This technique was proven to be feasible in a previous contract and was proven to be economically sound and having a cost advantage. The present system will apply the principles to a 400 gallon per hour evaporative system utilizing a cation exchange resin of from eight to sixteen cubic ft. capacity.

SUPPORTED BY U.S. Atomic Energy Commission

5.0805, BIOLOGICAL INDICATORS OF RADIATION INJURY

Z. DIENSTBIER, Univ. Karlova, *Prague, Czechoslovakia*

In agreement with the conclusions of the Panel on Biochemical Indicators of Radiation organized by IAEA and by WHO in June (Paris) a separate study of deoxycytidine excretion by urine, chromosomal changes in bone marrow and the activity of lysosomal enzymes in blood serum after irradiation will be carried out. Various kinds of animals will be used in order to prove the specificity of these changes and the dependence on the dose.

Within the course of the year these changes will be under observation in the same species of animals in order to compare their sensitivity after the application of individual radiation doses. The results will be compared also with hematological changes after irradiation because of the fact that these are elaborated in most details. Due to the possibilities, the changes indicated above will be further studied in individual cases in chosen, locally irradiated patients.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0806, METHODS FOR CHECKING RADIATION DOSE RECEIVED BY IRRADIATED FOOD IN THE 0.005 - 5 MRAD REGION

N.W. HOLM, Danske Atomic Energy Comm., *Riso, Denmark*

Methods for checking radiation dose received by irradiated food in the 0.00 5 - 5 mrad region (part of a coordinated program in the aspects of tissue physiology in food preservation by irradiation).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0807, U.S. PARTICIPATION IN FOURTH INTERNATIONAL CONGRESS OF RADIATION RESEARCH

G.W. WOOD, Natl. Academy of Sciences, *Washington, District of Columbia* 20037

The Division of Physical Sciences of the National Research Council with the cooperation of the Radiation Research Society, proposes to ensure appropriate United States participation in the IVth International Congress of Radiation Research to be held in Evain, France, in June 1970. To accomplish this, the National

Academy of Sciences, on behalf of the Division and the Society, is seeking partial support from the National Institutes of Health.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0808, RADIATION PROTECTION AND MEASUREMENT

L.S. TAYLOR, Natl. Coun. on Rad. Protectn., *Washington, District of Columbia* 20008

It is proposed that the work for the period 1/1 to 12/31/70 will be a continuation of that in which the Council was engaged during 1969, which work is described below: 1. Basic radiation protection criteria. 2. Specification for radium substitute. 3. Protection against neutron radiation. 4. Monitoring methods and instruments. 5. Incineration of radioactive waste. 6. Shielding against accelerator produced radiation. 7. Exposure from patients with radioactive materials in their bodies. 8. X-ray protection in dental offices. 9. Radiation protection in veterinary practice. 10. Dosimetry models for strontium. 11. Radiation protection in the use of small neutron generators. 12. High energy X- ray dosimetry. 13. Medical X and gamma-ray protection. 14. Radiation exposure from consumer products.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0809, THEORETICAL DOSIMETRY AND RADIOLOGICAL PHYSICS

M.J. BERGER, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Theoretical studies and calculations in dosimetry, radiation effects, and penetration of electrons and photons. Included are: calculations pertinent to absorbed-dose calibrations; determination of the response functions of solid state detectors; development of cavity- chamber theory; dosimetry of gamma and beta rays from internally administered radionuclides; microdosimetry calculations for electrons and photons; investigation of charged-particle track structure for the evaluation of radiation effects; determination of radiation quality (spectra, LET distributions, etc.) in irradiated media; transmission of electrons through shields; production of bremsstrahlung and photoneutrons in thick targets. The results will find application in medical dosimetry, manufacture of radiation detectors, and shielding of materials and people against radiation.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

5.0810, RADIATION SAMPLING IN ANTARCTICA

A. SCHWEBEL, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

This project is a continuation of the environmental radiological survey of the glacier area on which the nuclear reactor located at McMurdo Bay, Antarctica, empties its low level radioactive waste.

Twenty sampling sites will be selected. Twice yearly, 3 samples at each point, taken from varying depths, will be submitted for analysis.

All samples will counted for gross gamma emitters and a report submitted 30 days from receipt of the samples at NBS.

Selected samples will then be analyzed for specific radionuclides by gamma ray spectroscopy using solid state detectors. A rough estimate of the nuclides found will be submitted 60 days from receipt of samples. A final report based on a computer analysis of the data will be submitted 90 days after receipt of the samples.

A radiochemical assay of selected samples for such radionuclides as ^{90}Sr will be performed as necessary. Such analyses will be completed 120 days after receipt of the samples.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

5.0811, CELLULAR PREDICTORS OF RADIOSENSITIVITY

H.L. CROMROY, Univ. of Florida, Graduate School, *Gainesville, Florida* 32601 (DAHC20-69-C-0291)

Technical Objective: Continue research with the objective of identifying biological indicators in food-web species which would serve as predictors of their radiosensitivity.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0812, VISUAL CELLULAR STIMULATION BY HIGH ENERGY QUANTA

W.W. DAWSON, Univ. of Florida, School of Medicine, *Gainesville, Florida* 32601 (AT-(40-1)-3599)

The project will identify the retinal layers and cellular units responsible for the transduction of X-ray quanta into afferent information as transmitted by the optic nerve. It will examine further the relationships between retinal radiation pathology, local ischemia, vasomobility and the electroretinogram b-wave. It will explore the generality of the retinal transducer so that a beginning may be made toward the formulation of a body of theory which will treat ionizing ray induced changes in other portions of the nervous system.

Results to data: (1) Tests with physiologically equated X-ray and light stimuli produce distinct adaptation curves. (2) Mammalian eyes in the neuroblast stage of receptor development exhibit equivalent responses to X-ray and light stimuli. (3) Cone and rod receptors can atrophy under cold stress.

SUPPORTED BY U.S. Atomic Energy Commission

5.0813, TRITIATED HYDROGEN IN THE ATMOSPHERE - OF A NEW ULTRA-SENSITIVE TECHNIQUE FOR ENVIRONMENTAL SAMPLING IN NATURE AND INDUSTRY (ABBREV.)

H.G. OSTLUND, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149 (AT-(40-1)-3944)

With our newly developed system, tritiated hydrogen in the atmosphere can be sampled in 5 to 40 minute intervals. The sampling can be performed at the laboratory or with a mobile unit, operated in an automobile or an aircraft.

With this system we want to monitor the atmospheric HT and HTO contents at two fixed stations in the United States. We want to establish if there are synoptic, vertical, and geographical variations in the HT concentrations. Background information will be collected on present environmental tritium levels in the vicinity of the Turkey Point nuclear power plant, now under construction on the shore of Biscayne Bay, Florida. Our input to the IAEA-WMO Global Tritium Network will be continued.

Results: Research work to start 15 May 1970. In previous contract year the sampling method was developed. It is based on adding tritium free hydrogen as carrier to the air, and catalytic combustion and absorption of the water on a Pd-Molecular Sieve catalyst.

SUPPORTED BY U.S. Atomic Energy Commission

5.0814, STUDIES IN THE USE OF IONIZING RADIATION AS STIMULI

J.C. SMITH, Florida State University, Graduate School, *Tallahassee, Florida* 32306 (AT(40-1)-2903)

Conditions under which animals make both immediate and delayed behavioral reactions to beta, gamma and X-rays will be explored. Three types of experiments will be conducted. 1. A pigeon, rat or monkey can be trained to suppress some ongoing response such as lever pressing by using X-rays as a warning stimulus for electric shock. This X-ray detection has been thought to depend solely on olfaction, but recent evidence indicates that vision also plays a role. Using anosmic animals, the conditions under which an animal can 'see' X-rays will be studied. 2. Gamma rays are aversive to the rat, i.e., if a preferred taste solution is presented and sampled during irradiation, this solution is avoided on subsequent presentations. This year we will determine the time intervals necessary for the pairing of the taste substance and the gamma rays, i.e., how long does the rat have to have access to the fluid (one lick or many minutes), how long the exposure (exposure rate) and the interaction of these times. In addition, a detailed analysis will be made on the development of the aversion by the use of lick measuring circuits and a computer. 3. Work will

continue studying the response of the eye of the moth Heliothesis Zea to beta and gamma rays and light. Some behavioral work will be conducted, but most of the data will be collected using the electroretinogram.

Results: Radiation perception has been shown to be mediated by the olfactory sense and the visual sense. In addition, there seems to be some radiation detection mediated by the humoral system with the abdominal area most sensitive. Exposure rate thresholds for X-ray detection are as low as 3-8 mr/sec in rhesus monkeys. A moth has been shown to respond to a pulse of X-rays to a total exposure of 0.25 mr.

SUPPORTED BY U.S. Atomic Energy Commission

5.0815, USE OF IONIZING RADIATIONS AS STIMULI

J.C. SMITH, Florida State University, Graduate School, *Tallahassee, Florida* 32306 (AT-(40-1)-2690)

Work has been conducted demonstrating the conditions under which animals can elicit an immediate reaction to the onset of an X-ray beam. It has been shown that both the visual and olfactory system are involved in this 'ionizing radiation perception' in pigeons, rats and rhesus monkeys. In addition, work has been conducted showing an immediate response by the moth to beta, gamma and X- rays.

It is proposed that work be continued studying the perception of X- rays by living organisms. Specifically, the proposed work will be divided into two areas: 1. Further studies of the role of vision in X- ray detection and, 2. further studies of the use of ionizing irradiations to condition aversions to taste solutions.

1. It has been shown that the anosmic rat cannot detect X-ray in the presence of high illumination. Rats will be made anosmic by ablation of the olfactory bulbs and will be trained to respond to X-rays in total darkness. Illumination levels will be manipulated and X-ray exposure- rates will be determined at each illumination level. In addition, these anosmic rats will be trained for X-ray detection in various monochromatic illuminations in an effort to ascertain which wavelengths most inhibit the X-ray detection. It is hoped that these studies will help in the understanding of how this X-ray detection is mediated by the visual route. 2. Solutions such as saccharine, are avoided by the rat if they have been previously presented one time in the presence of a sublethal X or gamma ray exposure. Animals exposed to water in the presence of the ionizing rays or animals which are sham exposed drink the saccharine in large quantities. Studies will be continued in our effort to understand this rather prompt aversive aspect of irradiation. The maximum time interval between ingestion of taste substance and exposure which still results in aversion will be determined. Efforts will be made to determine the number of licks of the taste substance and the absolute total X-ray exposure which is required to produce the aversion. Attempts will be made to relate these aversion studies to the typical anorexia noted in radiation therapy patients.

SUPPORTED BY U.S. Atomic Energy Commission

5.0816, RADIOACTIVE TRACER STUDIES OF SOIL AND LITTER ARTHROPOD FOOD CHAINS

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Soil and litter arthropods contribute to breakdown and decomposition processes of dead organic matter in soils, but their importance remains poorly understood. Radioactive tracer techniques permit the measurement of mineral and energy transport along soil arthropod food chains. Input-output models are used to describe the accumulation of radioisotopes in links of food chains, as a means of estimating rates of trophic exchange among biota. Laboratory studies are comparing radionuclide excretion patterns of soil arthropods with those previously reported for above-ground herbivorous arthropods. Field research is centered on granitic outcrop ecosystems of the Georgia piedmont, which are known to accumulate concentrations of fallout radionuclides. Microcosm studies using pine needle litter or soil from granitic outcrop 'island communities' are utilized in describing transient behavior of radioisotopes in arthropod food chains.

Results: A set of samples of soils and biota from granitic outcrop ecosystems has been prepared and is awaiting analysis. Studies of radionuclide turnover by microarthropods have demonstrated comparatively low assimilation and slow excretion of radiocesium.

SUPPORTED BY U.S. Atomic Energy Commission

5.0817, RADIATION LEVELS FROM RADIOISOTOPE THERAPY PATIENTS

A.F. DRATZ, U.S. Veterans Administration, Hospital, *Atlanta, Georgia* 30329

Our study of radiation levels in the rooms of patients following oral I-131 therapy has been completed and a manuscript for publication is being prepared. Ambient radiation level measurements were corrected for decay to the time for I-131 administration, and expressed in mr-cm squared/mCi(adm)-hr dose rate units to normalize for the dosage administered and distance from the point of maximum activity. A highly significant correlation was found to exist between 24 hour thyroid uptakes done before therapy and dose rate measurements taken one to four days after therapy. Linear regressions of dose rate on thyroid uptake for both one day and pooled 2-4 day data indicated that if 100% of the I-131 were concentrated in the thyroid, the ambient radiation level (with 95% confidence limits) would be 2200 plus or minus 850. These regressions also indicated that if the thyroid uptake is 0%, the radiation level would differ significantly from zero, having mean values of 615 and 245 units, respectively, for the one day and pooled 2-4 day data. When allowance is made for geometry, these activity levels represent at least 40 and 16%, respectively, of the administered dose. These non-thyroidal iodine levels acquire additional importance when one considers the fact that patients with thyroid carcinoma and low uptakes usually get the highest administered doses.

Radiation level measurements taken shortly after I-131 administration had a mean and 95% confidence limits of 1600 plus or minus 865 dose rate units. These radiation levels are lower than those observed at later times near patients having high thyroid uptakes due to the difference in the relative distribution of I-131.

A nomogram incorporating these data has been designed. It provides a simple means for predicting, prior to therapy, what the radiation levels will be near the individual patient. Such predictions can obviate undue restrictions on both bedside care and isolation of hospitalized patients. They also will provide a more specific basis from which to make recommendations to the families of those patients not hospitalized for I-131 therapy.

SUPPORTED BY U.S. Veterans Administration

5.0818, TRACING RADIONUCLIDES IN HUMANS AND ANIMALS BY HELICAL SCANNING

J.I. ANDERSON, U.S. Atomic Energy Commission, Health Services Laboratory, *Idaho Falls, Idaho*

The object of this investigation is to provide a more accurate method for measurement of quantity and distribution of various types of radioactive contaminants in the body, and to utilize this method to determine the fate of these contaminants as a function of their physical and chemical states and mode of entrance into the body.

Previously animal experimentation has been used for establishing most of the criteria for the calculation of internal dose from radioactivity in men. The purpose of this study is to determine better parameters for this calculation from results of actual human exposures. Gamma emitting nuclides in various states will be traced in humans and animals by helical scanning and rectilinear scanning. Large areas of the body will be scanned by detectors that rotate around the body to determine the sites of increased gamma-ray intensity. Once these positions on the body are determined, section scans will be done with high-resolution focusing collimaters to further localize the nuclides in specific organs of the body. The results will be a determination of translocation of radioactive elements and their associated materials in the body from the blood stream, pulmonary system and digestive system.

SUPPORTED BY U.S. Atomic Energy Commission

5.0819, THE DETERMINATION OF PLUTONIUM 239 IN LUNG TISSUE BY ACTIVATION ANALYSIS

D.G. OLSON, U.S. Atomic Energy Commission, Health Services Laboratory, *Idaho Falls, Idaho*

The detection limit for plutonium-239 can be lowered significantly by fissioning the plutonium and measuring the activity of a specific short-lived fission product. For example, 20 disintegrations per hour of plutonium-239 irradiated in a neutron flux for 18 hours will yield 1000 disintegrations per minute of zirconium-95. A large share of the plutonium released to the atmosphere has been high-fired and will not dissolve in body fluids; therefore plutonium taken into the lungs may remain there for long periods of time. Such a system might provide a method of monitoring lung levels arising from sources such as fallout.

The lung is decomposed with acids and the plutonium separated from the remaining inorganic salts by liquid extraction. Plutonium is then precipitated and collected on bismuth phosphate. The phosphate precipitate is dried on a polyethylene film which is then irradiated in a neutron field. After irradiation the sample is decomposed in acids and zirconium separated out for counting. The number of plutonium target atoms is then calculated from the known neutron flux, cross section, fission yield and irradiation time. Preliminary work using elk and deer lung tissue is in progress.

SUPPORTED BY U.S. Atomic Energy Commission

5.0820, SEQUENTIAL RADIOCHEMICAL DETERMINATION OF RADIUM-226, 228, ACTINIUM-227 AND THORIUM-230 IN ENVIRONMENTAL AND PROCESS WASTE SAMPLES

D. PERCIVAL, U.S. Atomic Energy Commission, Health Services Laboratory, *Idaho Falls, Idaho*

A procedure has been developed for the sequential determination of radium-226, 228, actinium-227, and thorium-230 which permits their detection in a single sample at 0.1 to 0.001 of the concentration guides specified by federal regulations for uncontrolled areas. The increasing concern over possible pollution of the environment with these radioactive wastes from the uranium mining and milling industries makes the development of such a procedure most timely. The capability of performing several different analyses on a single sample provides a significant reduction in cost and analysis time.

An initial separation of the three elements from gross sample constituents is achieved by carrying them on lead sulfate precipitated from a system with high sulfuric acid and potassium sulfate concentrations. Subsequent separation of radium, actinium, and thorium from one another is simply and rapidly achieved by dissolving the lead sulfate with a complexing agent. Radium isotopes are separated from the solution on a small quantity of barium sulfate from which radium-226 and/or radium-228 are determined. Actinium-227 and/or thorium isotopes are then separated directly from the solution by extraction into an organophosphorous reagent under easily controlled pH conditions. The method is versatile since any one or more of the radionuclides may be excluded from the analysis by omitting certain independent steps, thus shortening the working time. Final studies on accuracy, precision, and the effects of both chemical and radiochemical interferences are presently being conducted. Determination of the radionuclides involves the use of alpha scintillation detectors, alpha spectrometers, beta counters, gross gamma counters and radon scintillation cells. The procedure has been tested on air dusts, up to 1000 ml of aqueous and up to 1 g of mill tailing or ores. Application of the procedure has recently been extended to 10-g soil samples and future efforts will be made to include vegetation, urine, feces, blood, tissue and bone ash.

SUPPORTED BY U.S. Atomic Energy Commission

5.0821, THE DETERMINATION OF PLUTONIUM IN SOIL

C.W. SILL, U.S. Atomic Energy Commission, Health Services Laboratory, *Idaho Falls, Idaho*

The sensitive and reliable determination of plutonium in soil is becoming increasingly important because of the public attention being focused on current radioactive waste burial practices and the public health impact of releases of plutonium to the environment. Because of the high sensitivity required, large samples must be used which introduces certain difficulties. Plutonium oxide is an extremely refractory material, particularly when heated strongly, and requires very powerful methods of attack for its complete and reliable dissolution. Reliability requires that a method be used that gives complete decomposition of the siliceous matrix with complete elimination of insoluble material and that guarantees complete conversion of the plutonium to a soluble monomeric ionic form capable of undergoing chemical reactions characteristic of plutonium before any separations are attempted. Any procedure giving less than complete sample decomposition is almost certain to give low and erratic results for plutonium when applied to these complex materials. At best, the reliability of the determination would remain in doubt. Most available analytical procedures applicable to adequately large samples depend on selective leaching with acids to remove plutonium from the insoluble matrix. Use of a tracer such as plutonium 236 is obviously of no assistance in correcting for the quantity of plutonium remaining undissolved.

Results: The present procedure has been designed to permit total decomposition of soils using the combined potassium fluoride and pyrosulfate fusions with subsequent volatilization of both fluoride and silica. The large alpha-emitting ions present in the solution are then precipitated on barium sulfate and combined with those present in the barium sulfate indigenous to the sample. The entire problem then reduces to one of separating the plutonium from the single compound sulfate for which several excellent procedures are available.

SUPPORTED BY U.S. Atomic Energy Commission

5.0822, INSTRUMENTATION FOR IN VIVO DETERMINATION OF INSOLUBLE PLUTONIUM IN THE LUNG

M. WILHELMSEN, U.S. Atomic Energy Commission, Health Services Laboratory, *Idaho Falls, Idaho*

The objective is to research and develop instrumentation for the in vivo detection, identification and quantitative determination of radioactive plutonium in the human lung. Such instrumentation is needed since more people in the atomic energy industry are working with plutonium and since determination of dose is essential to the control of personnel in hazardous areas.

As isotopes of plutonium are alpha emitters with about 4 percent of the alpha-particle events producing X-rays in the 10 to 20 KeV energy range, the basic problem is one of detecting and counting the low energy X-rays at intensities lower than maximum permissible lung-burden levels. Because of the low X-ray field and high absorption by the chest-walls, an extremely sensitive detecting system is required.

Results: Special self contained gas proportional counters have been designed and purchased from a company which custom-built them according to specifications. A small computer has been programmed to enhance data gathering and processing. Plotting, recording and printing peripheral units have been interfaced to the systems. Evaluation of the system is in progress. The immediate objective is to build a practical operational detector if the system proves satisfactory as expected.

SUPPORTED BY U.S. Atomic Energy Commission

5.0823, GROSS ALPHA DETERMINATION IN ENVIRONMENTAL AND BIOLOGICAL SAMPLES

R.L. WILLIAMS, U.S. Atomic Energy Commission, Health Services Laboratory, *Idaho Falls, Idaho*

The objective of the present research is to develop procedures which can be used to determine the alpha activity in

all environmental and biological samples. A quantitative as well as a qualitative analysis is desired for all alpha emitters from radium to californium, including polonium and bismuth.

An increasing interest in determining smaller and smaller amounts of alpha activity in samples has led to this investigation. The basic problem in analyzing samples that have a very low alpha activity is that the sample size must increase, thereby increasing the problems of decomposition and interferences in subsequent chemical separations.

The decomposition consists of wet ashing with nitric and perchloric acids to remove organic materials, followed by a combination of potassium fluoride and sulfate fusions to dissolve siliceous materials and refractory compounds with simultaneous volatilizations of hydrogen fluoride and silica. The alpha activity is carried out of solution on barium sulfate with individual elements being separated or a gross alpha obtained by selective oxidation or reduction. The barium sulfate is deposited uniformly on a vinyl metricel filter, covered with a zinc sulfide phosphor and counted in a scintillation counter. After counting, the barium sulfate is dissolved, the alpha activity electro- deposited, and an alpha spectrum obtained, thus producing both a quantitative and qualitative alpha analysis of the original sample.

Results: Methods for using up to 10 grams of soil, bone, blood, feces, urines, ores and liquid effluents are being developed for alpha analysis. A method is presently under investigation which would deposit the alpha emitters uniformly on a plate as the hydroxide. This hydroxide precipitation would allow scintillation counting as well as alpha spectrometry without further treatment. Samples of up to 1000 milliliters of liquids and 50 milligrams of solids (soils, sediments and ores) have been analyzed with a recovery of better than 99.95%.

SUPPORTED BY U.S. Atomic Energy Commission

5.0824. SOLID STATE RADIATION DOSIMETRY

J. KASTNER, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

Solid state detectors of small dimensions could prove useful as receptors of microdosimetric information, especially in vivo.

An effort has been made to correlate the spectrum of the light from thermoluminescent materials with various kinds of ionizing radiations. It has been determined that the spectrum of LiF is different for alpha rays than for electrons.

Results: Electro-optical equipment was designed and assembled in conjunction with a UV laser to carry out sensitive fluorescent decay studies on a variety of radiophotoluminescent material. It is possible to use time discrimination to reduce the intrinsic background luminescence of silver doped glass.

SUPPORTED BY U.S. Atomic Energy Commission

5.0825. LOCALIZATION OF LOW CONCENTRATIONS OF GAMMA RAY EMITTERS IN MAN

L.D. MARINELLI, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

Localization of gamma-ray emitters is essential to the clarification of effects produced by internal emitters. Its realization in vivo by means of time-of-flight techniques has been investigated by measuring at the ends of a scintillating rod the difference in time of arrival of light from scintillations produced by gamma-radiation anywhere along the rod.

The principles of light transmission by plastic rods and of the time resolution ensuing from scintillations within it have been investigated. The influence of the following factors has been studied: a) type and dimensions of plastic rods, b) the type of photomultiplier, and c) the fraction of the light pulse utilized. Some difficulties have been experienced in the electronic stability of a multi-rod system. The possibility of using very fast liquid scintillators has been considered and to this end, the optical properties of various solutes have been studied.

A beginning has been made in the problem of determining the radioactivity in vivo from the scintillation distribution in the rod. The properties of various experimental parameters (including collimation) entering into the pertinent Fredholm's equation are being investigated.

Results: Fairly satisfactory resolutions have been obtained with lengths up to 3' and cross sections of 2' with either a 8575 or a C31000D photomultiplier. Some satisfactory solutions to Fredholm's equation have resulted.

SUPPORTED BY U.S. Atomic Energy Commission

5.0826. FLUX AND SPECTRUM OF FAST NEURTONS IN NATURAL ENVIRONMENT

B.G. OLTMAN, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

Instrumentation and techniques necessary to determine quantitatively the neutron component of the environmental radiation to which man is exposed are being developed. The range of neutrons below about 2 MeV is being explored by means of hydrogen gas counters and by Li6 loaded scintillators. The thermal neutron flux is being measured by means of etched-tract sandwiches consisting of either U-235 and mica or Li6/B10 and plastic foils. The effect of soil and water on neutron environment is being evaluated and compared with theoretical prediction. Based on our results, we have proposed a passive soil moisture meter.

SUPPORTED BY U.S. Atomic Energy Commission

5.0827. SINUS DOSIMETRY IN RADIUM POISONING CASES

R.A. SCHLENKER, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

Sinus carcinomas in radium cases appear to result from the bombardment of sinus epithelium by alpha particles from underlying radium-bearing bone. In order to evaluate the dose rate in sinus epithelium, the energy distribution of alpha particles emitted from the surfaces of sinus bone samples is measured in vitro using semiconductor detectors. The in vivo energy distribution is determined from the in vitro distribution by using assumptions about the behavior of radium and its daughter products in bone. The dose rate to the overlying epithelium is calculated from the in vivo energy distribution.

Results: Preliminary results are that the dose in sinus epithelium averaged throughout the time of radium burden is greater than 1 rad/day, and the total dose from the time of initial burden to death is greater than 10,000 rads.

SUPPORTED BY U.S. Atomic Energy Commission

5.0828. RELATIVE BIOLOGICAL EFFECTIVENESS

W.K. SINCLAIR, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

This project concerns the establishment of the relative biological effectiveness of various ionizing radiations of differing physical properties and their rise in developing theories of radiation action. Information is collected on various endpoints in various test systems and results related to various physical parameters, primarily linear energy transfer (LET), for determining mechanisms of action. In addition, specific investigations with monoenergetic neutrons and with fission neutrons are undertaken in test systems such as (1) testes weight loss in the mouse, (2) mammalian cells in culture using survival, division delay and chromosome aberrations as endpoints, (3) lethality in the mouse, (4) lethality in Tribolium larvae, (5) growth inhibition on seedlings of Hordeum.

Results: Computations of LET spectra and various energies of neutrons and californium 252 have been made. Contributions have also been made to the determination of which physical parameter to use in describing the variation of biological effectiveness with physical properties of the radiation. RBE studies in all of the test systems indicated above have been conducted at one or another neutron energy or spectrum and some unnusual features noted which indicate that RBE studies in a wide range of endpoints over a broad neutron energy range (and LET range) could be most informative.

SUPPORTED BY U.S. Atomic Energy Commission

5.0829, PHYSICAL AND PHYSIOLOGICAL COMPONENTS OF RADIATION EFFECTS IN CELLS
R.B. WEBB, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-ENG-38)

Parallel studies are being made on the dormant bacterial endospore and nondormant vegetative cells to distinguish physical and chemical events from metabolic processes in X-ray effects on biological systems. The dormant bacterial endospore is unique in that it shows an extremely low level of metabolic activity, even in the fully hydrated state, until germination is induced. Modification of the radiation response of the dormant endospore by physical and chemical treatments likely affects chemical and physical events rather than metabolic processes.

Oxygen enhancement, nitric oxide enhancement and protection, carbon monoxide sensitization, protection by sulfhydryls and alcohol in the X- ray inactivation of the spore of 'Bacillus megaterium' and the nondormant cells of various bacteria are studied over a wide range of controlled hydration levels. Complete dose response curves are obtained using the ability of the cell to produce a visible colony as the primary biological end-point.

Results: At equilibrium aqueous vapor pressures below 5 torr cells of 'Staphylococcus aureus' show a pattern of response to X-rays very similar to that of 'B. megaterium' spores, suggesting that inactivation mechanisms are the same in both systems. The two systems differ somewhat in their X-ray response above 5 torr. Both nitric oxide and carbon monoxide substantially increase the X-ray sensitivity of 'S. aureus' at hydration levels above 5 torr, when the gas is present during irradiation. In this range nitric oxide has only a small sensitizing effect on the spore. Carbon monoxide has no effect on the spore. These results implicate metabolic processes in the sensitizing effects of carbon monoxide and nitric oxide on the X-ray response of 'S. aureus'.

SUPPORTED BY U.S. Atomic Energy Commission

5.0830, DOSIMETRY
F.S. WILLIAMSON, Argonne National Laboratory, *Argonne, Illinois* 60439 (W-31-109-eng-38)

Evaluates the absorbed dose to biological specimens in common exposure situations for X and gamma rays and neutrons, so that standard factors may be derived to determine absorbed dose in these circumstances. The goal is to assure that informaton needed for a given experiment may be obtained from a single measurement. While calculations can establish a relation between absorbed X- and gamma-ray dose and exposure (rads/R), uncertainties become numerous in larger animals. Chemical dosimeters in polyethylene containers simulate the range of exposure volumes, and doses are determined as a function of volume. Maximum and minimum doses, as a function of volume, are measured from small vials in front and behind each vessel. Absolute values for neutron absorbed dose rate will be attempted by calorimetry; calibration of our ionization chambers against Pu-Be and Po-Be (or Am- Be) standards; against calibrated tissue-equivalent chambers of the Rossi type; and by comparison of Hurst counters, HF3 counters, and gel chambers, at necessary representative points. Studies of depth-dose distribution in tissue-equivalent phantoms of various sizes are studied and phantoms correct in both geometry and composition. The distribution of absorbed dose due to gamma rays from internal emitters in large animals is examined theoretically, starting with the geometrical factor approach and modifying for various conditions of scatter.

Results: Major effort has been directed at completion of the modified JANUS biological reactor for neutron toxicity studies. The reactor operated at low power (December 1969) and at full power--200 MW (March 1970). Magnesium ionization chambers of 0.05 cc collection volume with argon gas filling will be used in conjunction with tissue- equivalent version to resolve neutron and gamma-ray depth doses within mouse phantoms. Monte Carlo computations of neutron and gamma-ray depth doses and LET distributions in mouse phantoms have been completed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0831, PRACTICAL HIGH SENSITIVITY THERMOLUMINESCENT DOSIMETRY
R.M. JOHNSON, U.S. Veterans Administration, Research Hospital, *Chicago, Illinois* 60611

Results: The results of this project have been to develop an instrument capable of measuring the light output from irradiated crystals of various insulating materials (calcite, LiF, CaF2, Li2, B204, and commercial thermoluminescent dosimeters now available). This light output has been proved proportional to the amount of ionizing radiation received. The proportionality has been shown here to hold over a temperature range of irradiation from liquid nitrogen temperature to room temperature.

The apparatus developed may be used with a broad range of physical formats for the active material including loose powder, silicone rubber discs, extrusions, pressings, crystal chips or commercial packaged glass tubes with internal material. This equipment is usable therefore for measurement of X or gamma ray doses in body cavities for therapy purposes or for measurement of the lower doses encountered in routine work with radioisotopes or diagnostic X-rays.

Presentations: The original instrument design conceptions were reported at a meeting of the Radiological Society of North America and the later work with a range of phosphors at cryogenic temperatures was reported at the Midwest Chapter Meeting of the American Association of Physicists in Medicine.

Terminated due to the resignation of the investigator.

SUPPORTED BY U.S. Veterans Administration

5.0832, TOTAL-BODY COUNTING FACILITY
D.B. CHARLESTON, Univ. of Chicago, School of Medicine, *Chicago, Illinois* 60637 (AT(11-1)-69)

The scope of this project embraces the development of the total- body counting facility with a flexible quantitative imaging device and its use in metabolic studies in laboratory animals and human beings. These include investigations of factors that stimulate hyperplasia of the parathyroid glands such as pancreatic inflammation and thiazide diuretics; investigations of calcium kinetics in various disorders of calcium metabolism, retention and dosimetric studies on developmental radiopharmaceuticals.

A single linear camera scintillation detection system will replace the 4 separate detectors presently in use for whole-body scanning as soon as the necessary funds are available.

Results: Studies on the metabolism of calcium showed that ablation of the thyroid gland in rabbits abolishes the hypocalcemic action of glucagon; that prolonged administration of thiazide diuretics to dogs produces hypertrophy and hyperplasia accompanied by increased serum calcium, decreased serum PO4 and increased Se75 uptake by the glands; that there is a marked decrease in urinary Ca and PO4 in dogs when thiazides are administered.

SUPPORTED BY U.S. Atomic Energy Commission

5.0833, PHYSICAL AND BIOLOGICAL INVESTIGATIONS OF HIGH ENERGY RADIATION DIRECTED MAINLY TOWARD THERAPY
L.H. LANZL, Univ. of Chicago, School of Medicine, *Chicago, Illinois* 60637 (AT(11-1)-69)

The purpose of this project is to evaluate the physical factors and biological effects of high energy radiations, especially electrons from the linear accelerator and to compare them with the more conventionally used X-rays and gamma rays. New methods of treatment planning are worked out.

Radiation dosimetry, computer uses, radiation protection and estimation of bone mineral changes are all part of the program.

Present problems involve installation of a carbon calorimeter for absolute calibration of radiation beams; manufacture of a patient- simulator and treatment planning device; installation of a simulator for treatment of large treatment fields such as those required for Hodgkin's disease.

Results: A remote terminal for calculation of dosimetry data has been acquired by lease and placed into service. An automatic contour measuring device for use with the cobalt-60 machine has been placed in routine service in the clinics. Further dosimetry studies for Hodgkin's disease have been carried out.

SUPPORTED BY U.S. Atomic Energy Commission

5.0834, THE PHYSICAL BASIS OF IONIZING-RADIATION ACTION

R.L. PLATZMAN, Univ. of Chicago, Graduate School, *Chicago, Illinois* 60637 (AT(11-1)-2100)

The objective of this research is the theoretical calculation and interpretation of yields of the initial ('primary') events in the absorption of various ionizing radiations by matter. These events are equally crucial for the physical, chemical, and biological action of the radiations. The work will start with 'electronic' radiations and a few representative varieties of matter. The first stage for each medium is assembly of a complete set of cross-sections for all relevant inelastic processes (excitation and ionization) induced in the atoms or molecules by electron impact, at all electron velocities. These will be obtained from analysis of optical data (oscillator-strength distributions) and of experimental cross-section determinations, together with theoretical calcualation. The electron degradation- spectrum will then be calculated. Initial yields will be calculated therafter from the cross- sections and the degradiation-spectrum. The first media studied will be selcted from among such simple gases as He, Ne, Ar, H2, CH4, and H2O. With degradation spectra that include the contribution of glancing collisions, as these will, the factors that determine the role of the degradation spectrum in establishing the qualitative and quantitative character of radiation effects will be sought. New knowledge of the primary events will eventually be applied toward elucidating the early temporal stages in the response of the medium to its exposure to radiation.

SUPPORTED BY U.S. Atomic Energy Commission

5.0835, DEVELOPMENT AND APPLICATION OF MULTICHANNEL SCANNING

E. KAPLAN, U.S. Veterans Administration, Hospital, *Hines, Illinois* 60141

Purpose: The selenated amino acids selenocystine and 75selenomethionine are under study to evaluate their localization and quantitative distribution to better understand the physiology and pathophysiology of these compounds. Plan: To determine effective biologic half life of the two selenated compounds using the whole body counter; to determine body distribution when comparing intravenous versus oral administration; to utilize dual channel subtraction and energy modulated color display to scan pancreas, myocardium and brain; to determine localization of selenocystine in the hypothalamus; to compare distribution of 75selenomethionine with distribution of 75selenomethionine labeled peptides. Results: The biologic half life of 75selenomethionine has been determined as a three phase curve consisting of 8 hours, 17 days and 93 days. The radiation exposure, whole body, for 250 Ci dose is determined as 1.63 rad. The I.V. versus oral route results in very similar distribution. After G.I. absorption is complete, the pancreas can be effectively scanned using the dual channel technique referred to. Selenocystine when injected into the carotid artery of the dog with 2.5% saline results in hypothalamic concentration of 12 to 1 as compared with the other areas in the brain. This has been visualized by scintiscanning. Preliminary comparison of selenomethionine distribution compared to selenomethionine peptides results in difference in quantitative localization.

SUPPORTED BY U.S. Veterans Administration

5.0836, RADIOPROTECTIVE AND TUMORICIDAL EFFECTS OF TWO NEUROTROPIC DRUGS

J. LEVAN, U.S. Veterans Administration, Hospital, *Hines, Illinois* 60141

A number of substances classified as stimulants or depressants of the central nervous system (CNS) have been reported to possess radioprotective properties. While studying the effects of Magnesium Pemoline (M.P., 5-phenyl-pseudo-hydantoin), a mild CNS stimulant, on conditioned avoidance response using X-irradiation as an unconditioned stimulus: we observed significant radio-protection in mice. Further experimentation showed up to 40% survival in several groups of mice exposed to lethal whole-body X-irradiation: while none of the control animals survived 14 days. More significantly, an 18%/30 day survival was observed when M.P. was given shortly after lethal irradiation. We also found that M.P. had a cytotoxic effect on Ehrlich tumor cells, thus prolonging the life span of the tumor bearing animals.

Since M.P. is still an experimental drug in the U. S. we investigated the radioprotective potency of a chemically related compound already listed in the U.S. Pharmacopeia, namely: Diphenylhydantoin (DPH). DPH, in contrast to M.P., has an anticonvulsant, and depressive CNS effect. Laird and Fonner have reported a protective effect of DPH in mice exposed to high doses of irradiation which causes CNS death in the immediate period following exposure. We were able to demonstrate in our initial studies that DPH afforded a 60% survival at 30 days when given before 75 or X-irradiation, while no control animals survived. And similarly to the described tumoricidal effect of M.P., Ehrlich tumor bearing mice treated with DPH survived longer than untreated controls.

We propose to study the mechanism of radioprotection afforded by M. P. and DPH and evaluate their tumoricidal potential by studying preselected criteria as determinants of survival. The residual viability of the treated tumor cells will be tested by transplantation to an untreated group of mice.

Moreover, it was observed that both M.P. and DPH were overall more cytotoxic to leukemic than to normal lymphocytes. As expected, the survival of treated and untreated cells decreased with increasing doses of X- irradiation. But the initial results of combiningg DPH and X- irradiation showed a synergistic toxic effect on normal lymphocytes: while DPH treated leukemic cells seemed to be more radioresistant than control leukemic cells.

SUPPORTED BY U.S. Veterans Administration

5.0837, SERUM OSMOLALITY AND INTRACRANIAL PRESSURE

A.P. REMENCHIK, U.S. Veterans Administration, Hospital, *Hines, Illinois* 60141

Application of the whole body counter has provided a means to quantify small amounts of radioactivity in the human body. This activity may indicate naturally occurring radionuclides, contamination from fallout or a deliberate administration of a tracer dosage of radionuclide to determine its absorption, elimination or metabolic behavior in specific context. This may be accomplished without trauma to the patient and does not require the collection of the particle excretions.

The specific studies proposed at the low level counting facility of this hospital are concerned with the employment of this system for more precise definition of several relevant problems exemplified below: 1. The study of vitamin B12 metabolism in Addisonian pernicious anemia and that associated with immunoglobulin deficiency. 2. The study of thyroxine metabolism and its partition between the vascular, extravascular, and cellular compartments. 3. The study of body content of potassium in congestive heart failure and hypertension. 4. The study of the effect of chronic hemodialysis upon trace mineral, iron and calcium metabolism. 5. The study and definition of individuals at risk for neoplastic disease.

SUPPORTED BY U.S. Veterans Administration

5.0838, SPECIAL PROBLEMS IN NUCLEAR INSTRUMENTATION AND MEASUREMENT OF W IN GASES

F.R. SHONKA, Saint Procopius College, Undergraduate School, *Lisle, Illinois* 60532 (AT(11-1)-323)

Work has been completed on the isotope ratio for hydrocarbon gases as a function of alpha-particle energies in the range 5.8 - 1.6 MeV. For the hydrocarbons methane, ethane, acetylene, and ethylene there was found to be a very small increase of the order of 1% - 3% in the isotope ratio as one decreased the alpha-particle energy from 5 to 1.6 MeV.

The principle area of interest is the formulating of the materials which simulate muscle, bone etc. for all types of nuclear radiations and the construction of ionization chambers for precision measurements of radiation dose. These ionization chambers vary in ionizing volumes from 0.01 ml, used principally in measurement of high energy beams, to 16 liters, used for measurement of background and environmental radiation. This year our major advance had been made in the welding of the conducting plastic materials. These methods include; 1. heating of the parts to be welded under pressure in a closely fitted mold, 2. a torch blowing superheated gas instead of a flame, 3. the so called 'flying seal' method, similar to that used in glass blowing, 4. resistive welding by passing an electric current through the joint to be welded, 5. percussive welding by discharge of condensers through the joint to be welded, 6. ultrasonic welding, and 7. friction welding. Friction and sonic welding are our most useful methods.

SUPPORTED BY U.S. Atomic Energy Commission

5.0839, RESEARCH WITHIN THE FRAMEWORK OF A COORDINATED PROGRAMME ON NUCLEAR ACCIDENT DOSIMETRY

P.N. KRISHNAMOORTHY, Bhabha Atomic Research Centre, *Bombay, Mahrashtra, India*

Investigations will be continued on the use of appropriate foils for both area and personnel monitoring systems for accident dosimetric purposes.

Work on a foil-cum-plastic track recorder system for covering a large part of the intermediate energy neutron range which is already underway, will be continued.

Several chemical dosimetric systems for accident dosimetric purposes have already been developed. These systems are being tested under field conditions. Further investigations on the energy dependence, neutron response and time dependent stability characteristics will continue. In addition, investigations on the suitability of other chemical systems for accident dosimetric purposes are underway.

A number of indigenous glass and TLD systems which are being developed are being investigated for suitability for use in accident dosimetric systems. Some promising results have already been obtained. The reader systems for these dosimeters are also being locally designed and fabricated.

Studies have been initiated on activation analysis of appropriate elements present in the body such as sulphur in hair and nail, and sodium in the blood.

Some work has also been initiated in the promising area of TSEE systems to investigate its potential for accident dosimetric purposes.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0840, PERCEPTION OF IONIZING RADIATION BY SENSORY SYSTEMS

S. MIZELL, Indiana University, School of Arts, *Bloomington, Indiana* 47401

We are investigating the possibility of the perception of ionizing radiation by sensory systems in the organism. We are using rhythms of activity as a test system to measure the effects of these stimuli with and without operating sensory receptors.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0841, ISOLATION OF A FACTOR PREVENTING X-RAY INDUCED LEUKEMIA

M.E. HODES, Indiana University, School of Medicine, *Indianapolis, Indiana* 46202 (AT(11-1))

Fractionation of commercial Cohn fractions on DEAE-cellulose and Sephadex in order to isolate RLP, the radiation-leukemia protection factor, continue. The fractions are characterized by polyacrylamide gel electrophoresis and immunoelectrophoresis.

Whole serum, in addition to its leukemia-preventing properties, is able to reverse certain biochemical abnormalities that follow exposure to 200-300 r doses of X-ray. This ability is not shared by serum albumin and certain other serum proteins. The various fractions prepared for RLP testing are also being assayed for their ability to reverse these biochemical abnormalities. Particular attention is being paid to alpha-2-macroglobulin, a protein reported to have both leukemia- preventing and chemotherapeutic effects.

SUPPORTED BY U.S. Atomic Energy Commission

5.0842, DISPLACEMENT REACTIONS OF ANTI-RADIATION DRUGS

R.E. DAVIS, Purdue University, School of Science, *Lafayette, Indiana* 47907

The Oxibase Scale has been applied with success to displacement reactions of numerous nucleophiles including the anti-radiation drug, MEA, on sulfur-sulfur, oxygen-oxygen, and carbon-X bonds. It is concluded that the ease of oxidation of the nucleophile is of prime importance to obtain fast reaction rates and favorable equilibria. Of secondary importance is the base character of the nucleophile. The quantitative scale relating these two terms has been called the Oxibase Scale.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0843, BIOCHEMICAL EVALUATION OF 'SHIR-KHECHT', NATURAL NON-TOXIC CHEMICAL PROTECTOR

N. ROUHANIZADEH, Nuclear Studies Centre, *Teheran, Iran*

The aim of this work is mainly to investigate the radioprotective action of 'Shir-khecht', a non-toxic natural substance. This is done by a biochemical evaluation of the DNP complex of the irradiated animal both with and without application of 'Shir-khecht'.

The investigation is further extended for the detailed search for the active compound of 'Shir-khecht' which is performed by a thorough chemical analysis of the compound. A part of this work has been accomplished and 'Shir-khecht' has been shown to have 25-30% radio protective action.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0844, DIRECT INTERNAL RADIATION DOSIMETRY OF RADIOPHARMACEUTICALS BY IMPROVED NEEDLE TYPE FLUOROGLASS DOSIMETER

M. HO, Univ. of Tokyo, *Tokyo, Japan*

Present internal radiation doses by radiopharmaceuticals have been calculated based on assumptions and the development of direct sensitive method is desired. Our group investigated the possibility of such direct in vivo measurement of internal radiation and, under the contract, is now performing the improvement of fluoro dosimetry.

In the first year new silver activated phosphate glass with smaller energy dependence and predose than the conventional one has been developed. Dimension was 1 mm and 6 mm in length. Because of its extremely small predose it enables one to measure such a low radiation dose as 3 m rad, provided that new equipment for this measurement is to be developed.

This new instrument was also constructed in the first year. By this the glass rod is able to be stimulated by the ultra violet light (365 mu) quite strongly. Most important improvements were the adoption of the ellipsoidal reflecting mirror as well as special mercury lamp.

Further improvement of dosimeter glass with higher sensitivity, lower energy dependence, smaller predose is being planned in the second year.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0845, MODELS AND MECHANISMS OF THE EFFECTS OF LASER RADIATION ON BIOLOGICAL SYSTEMS

A.S. BROWNELL, U.S. Army, Med. Research Laboratory, *Fort Knox, Kentucky*

Technical Objective: To study the mechanisms of interaction of laser radiation with biological cells and tissues and to correlate these changes with respect to mathematical models that will serve to predict when laser injury can be expected to occur. This knowledge will be applied to the development of laser safety stan-

dards for military personnel employing laser systems. The mathematical models will be defined and modified to conform to the experimental requirement.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0846, EVALUATION OF THERMOLUMINESCENT DOSIMETERS AS A HEALTH PHYSICS TOOL
O.R. CZERWONKA, U.S. Veterans Administration, Hospital, *Louisville, Kentucky* 40202

Report on Major items of equipment to be used in this project: 1. A cobalt-60 irradiator facility was constructed adjacent to Animal Research Building No. 12. Construction was completed in February, 1969. The installation of a Bar-Ray Model M-FC, cobalt-60 unit capable of housing a maximum of 1000 curies of cobalt-60 was completed in April, 1969. To date this facility is pending final approval by the Atomic Energy Commission. 2. A Madison Research Thermoluminescent Dosimeter Reader System with Recorder and other accessories, including a variety of Lithium Fluoride Thermoluminescent Dosimeters have been received and presently are being standardized and calibrated.

Plans for Future Allied Research and Estimated Timing: 1. A complete survey of entire VA's film badge personnel monitoring methods will be made and a study for replacing current film badges with T.L.D.'S will be made and a report with recommendations will be completed. 2. Thermoluminescent Dosimeters will be standardized and selected for use in making dose determinations on all VA Hospital patients treated at the University of Louisville Radiation Center. Compilation of research data will include skin dose, tumor dose, vital organ dose and comparative data of T.L.D. vs present conventinal methods for patients receiving radiation therapy. 3. Thermoluminescent Dosimeters will be selected and standardized for use in personnel monitoring of occupationally exposed personnel. 4. Various items and tools will be developed for holding T.L.D.'S at precise sites within the human body, and for determining radiation field uniformity, isodose curves and primary beam outputs. 5. Possibility of working a mail order T.L.D. service into the regional medical program will also be explored. This service would be strictly centered around tumor dose and vital organ dose determinations of radiation therapy patients, and the results compiled and also submitted to the referring therapeutic radiologist. 6. A publication or report on the cobalt irradiator facility will be prepared during the coming year.

There has been a curtailment of research activity during this reporting period due mainly to the construction of facilities and the procurement of major equipment to be used for this research project. However, most equipment has been installed and is presently being standardized.

SUPPORTED BY U.S. Veterans Administration

5.0847, STUDIES ON ANTIRADIATION AGENTS
J.L. WONG, Univ. of Louisville, School of Arts, *Louisville, Kentucky* 40208

To develop practical antiradiation agents which can provide effective protection to human beings against ionizing radiation damage.

To study the mechanism of how antiradiation agents work at the physiological level.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0848, ENERGY LOSS AND RANGES OF HEAVY IONS IN SOLIDS
R. SHNIDMAN, U.S. Army, Nuclear Effects Laboratory, *Aberdeen Proving Ground, Maryland* 21005

Technical Objective: A new method to measure the stopping powers for low energy heavy ions will be investigated. The method based on measurements of recoil which leave a target following elastic scattering, can be used to measure both range and stopping power, and can be used to study the atomic collision processes responsible for multiple scattering. More comprehensive studies of range, energy loss processes and deviations from theory are needed to improve calculated vulnerabilities of Army systems and to initiate application of this new method will be made to these problems.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0849, ARMY PULSE RADIATION FACILITY (REACTOR OPERATION)
H.P. YOCKEY, U.S. Army, Ballistic Research Labs., *Aberdeen Proving Ground, Maryland* 21005

Technical Objective: To support engineering and scientific requirements arising in the establishment of APRF including development and executive of technical criteria, coordination of final engineering design, supervision of nuclear core construction contract (ORNL). Preparation of specifications for capital equipment, area diagnostic and control equipment, reactor transport device, preparation and combination of safeguards report. Operations manual, ecological studies , shielding and other studies to meet army AEC and other requirements to ensure radiological safety and operation of the facility.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0850, THE MODULATION TRANSFER FUNCTION OF X-RAY SYSTEMS
R.H. MORGAN, Johns Hopkins University, School of Public Health, *Baltimore, Maryland* 21205

The aim of this research is the development of a standard method for the measurement of the spatial modulation transfer functions of radiological systems and/or system elements. Currently, methods for the measurement of this parameter yield results which are inconsistent from one laboratory to another. Because (a) the information transfer capability of a radiological system, (b) the extent to which quantum fluctuation may restrict this capability and (c) the patient exposure requirements of medical X-ray procedures are markedly influenced by modulation transfer function values, it is important that improved methods yielding reproducible MTF values be developed as soon as possible. Precise MTF data are a basic requirement of the design of systems which give maximum diagnostic information at minimum levels of patient exposure.

Recently, the International Commission on Radiological Units established a Task Group to stimulate research in methods to measure the spatial modulation transfer functions of radiological systems and, from this research, to develop an international standard by which such measurements may be carried out with a high level of reproducibility. This project constitutes one part of this international effort.

In this project, the factors which cause inconsistency in current methods of MTF measurement will be examined systematically and quantitatively. From the information gained from these studies, it is expected that within a three-year period enough data will be at hand to permit the formulation of the needed international standard.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0851, RADIOLOGICAL PHYSICS
D.E. HUSAK, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Baltimore, Maryland*

Radiological physics provides calibrations and patient planning for all Radiation Therapy machines and Radiation Therapy isotopes. Radiological Physics is responsible for radiation safety in the Pharmacology Laboratory.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0852, DECONTAMINATION TESTING AND PROCEDURES UNDER COLD WEATHER CONDITIONS
J. MALONEY, U.S. Army, Nuclear Defense Laboratories, *Edgewood Arsenal, Maryland* 21010

Technical Objective: To extend, refine, and evaluate additional techniques developed from previous decontamination data, and to obtain data on the effect of surface roughness and area contribution to the radiation intensity in areas to be decontaminated.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0853, ELECTROMAGNETIC RADIATION MEASUREMENT METHODS AND CALIBRATION
G. ANDERSON, U.S. Environ. Protection Agcy., Twinbrook Research Laboratory, *Rockville, Maryland* 20852

Priority objectives of this program are to: 1) Develop laboratory exposure-calibration facilities for the electromagnetic spectrum bands of 1-10 MHz, 100-400 MHz, and 1-10 GHz as well as a field measurement system for these same frequencies. 2) Determine theoretical estimates of population exposure from electromagnetic radiation sources based on available data. 3) Develop and evaluate the use of liquid crystals, microthermocouples, and infra-red emission sensors as a means of determining absorbed dose from electromagnetic field exposures in phantoms, i.e., the eye and the skull. 4) Provide nuclear instrumentation such as the development and evaluation of the suitability thermoluminescent dosimetry for environmental radiation surveillance. 5) Theoretical solution of plane wave interaction with a finite slab geometry for various complex permittivities and thermal properties. 6) Begin development of an electric field probe for direct measurement of field strength in the phantom system.

In order to formulate meaningful population exposure standards for electromagnetic radiation, it is essential that current background be established. A means of interpreting these values will then provide a baseline for biological effects studies as well as future exposure measurements. Since standards are based on the evaluation of the dose- effect relationships, it is imperative that the biological effects research be derived from a sound dose measurements program.

Engineering-physics techniques will be applied in the area of electromagnetic radiation measurement. The range of project activity will encompass areas of applied dosimetry, theory, calibration, and facility support. Specifically, methods will be developed and evaluated from fundamental bases, keeping in mind the theoretical limitations and the engineering approximations involved. Estimates of uncertainty will be established. This program will produce a description of a unique controlled environment exposure facility, theoretical and experimental exposure considerations from RF pollution, a method for using liquid crystals for nonionizing radiation dosimetry in biological systems, and a quantitative assessment of errors and artifacts involved in using TLD for environmental surveillance of nuclear facilities.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0854, NAVY RADIOLOGICAL CONTROL TEAM
J.B. BEASLEY, U.S. Navy, Ordnance Laboratory, *Silver Spring, Maryland* 20910

Technical Objective: To establish, equip and maintain at NOL a composite Navy Radiological Control Team capable of rapid worldwide deployment when requested in response to radiological accidents involving nuclear weapons. This team consists of personnel from NOL, NNSY, Bethesda, and NAVEODFAC Indian Head.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0855, RECOVERY PROCESSES IN AN AMEBOID CELL
J.B. LITTLE, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

The basic objective of this research program is to gain further understanding of the nature and importance of intracellular recovery or repair processes in irradiated cells, particularly as they may affect radiosensitivity at lower doses. The cell we are studying is an ameboid cell belonging to the genus Hartmannella of small free-living amoebae. The gamma-ray survival curve for these cells shows a very prominent shoulder compared to the slope of its linear portion, yielding a threshold dose of 600,000 rads, but a D-subzero of only 27,000 rads. The ultraviolet irradiation survival curve, on the other hand, is nearly a simple exponential function of dose with a very small shoulder. Split-dose experiments suggest that these cells possess a highly effecient repair mechanism for gamma radiation damage; the effects of 500,000 rads are largely repaired within 6 hours after exposure, and by 24 hours the cells respond as if they had received no prior irradiation. Current experiments are designed to further examine the kinetics of the recovery from radiation damage, and to determine more precisely the nature of the repair process. The inter-relations between the effects of ultraviolet and gamma radiation will also be studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0856, ABSORBED DOSE DUE TO INTERNAL RADIATION EMITTERS
G.L. BROWNELL, Mass. General Hospital, *Boston, Massachusetts* 02114

The aim of this project is to investigate advanced methods of dose calculation and to compare the results of these calculations with experimental observations. Gamma-ray dose calculations are based principally on Monte Carlo methods of gamma-ray diffusion. Several existing programs will be extended to permit calculation of gamma-ray dose for a wide variety of geometrical conditions and for inhomogeneous media and for interfaces.

The development of a special Monte Carlo program providing spectral information will permit a wider range of application than has been possible in the past.

The experimental verification of dose calculation methods has been largely lacking in the past. Experiments will be performed to confirm Monte Carlo calculations of dose in various configurations including nonhomogeneous media and media containing interfaces.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0857, NEUTRON ACTIVATION ANALYSIS
J.C. CARDARELLI, U.S. Veterans Administration, Hospital, *Boston, Massachusetts* 02130

We have been continuing our activation analysis research in two directions since our last report. Because of the closing of the nuclear reactor at the Army Materials and Research Center in Watertown, Mass., we have been forced to use the nuclear reactor facility at M.I.T. This nuclear reactor offers a higher neutron flux enabling us to determine more sensitive amounts of Iodine-128. Hence, in conjunction with our investigation of insulin tagged compounds with stable iodine we are now able to investigate stable iodinated compounds of serum such as T-3 (thyroxine) which had been studied in our laboratory for many years by chemical means. This nuclear activation analysis technique affords us a great luxury due to its hypersensitivity as compared to the ordinary chemical determinations.

Preliminary studies of thyroxine measurements show that this method of analysis is feasible, however work is being done to improve and facilitate the method.

SUPPORTED BY U.S. Veterans Administration

5.0858, MANUAL OF ACCELERATOR RADIATION PROTECTION
J.G. MARTIN, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

Technical Objective: There exists within the Army a severe need for the establishment of accurate and comprehensive guidelines for the safe operation of accelerator facilities. The Army is not unique in this need, state after state has been enacting legislation regulating the uses of radiation-producing machinery. Even with these new laws, the ability of personnel to find easily usable guidelines is severely lacking. Capabilities exist at NLABS to produce a manual which would provide guidelines and promote radiation protection throughout the nation.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0859, COUNTER MEASURE STUDIES AGAINST VULNERABILITY OF PERSONNEL AND MATERIALS TO TACTICAL LASER IRRADIATION
J.A. SOUSA, U.S. Army, Natick Laboratories, *Natick, Massachusetts*

5. RADIATION

Technical Objective: Evaluate tunable laser devices for possible surveillance of army materials from natural background. Analyze the mechanisms of spontaneous and stimulated emission in dye systems and to investigate the possibilities of quenching such mechanisms. Dyes that luminesce in the ultraviolet or near-infrared region and that remain non-luminescent to the observer in visible light will be investigated.

SUPPORTED BY U.S. Dept. of Defense - Army

5.0860, TOOTH COLLECTION FOR RADIOACTIVE NUCLIDE STUDY

H.L. ROSENTHAL, Washington University, School of Dentistry, *Saint Louis, Missouri* 63130

Deciduous teeth of children born between 1948 and the present are being collected for measurements of strontium-90 content. Correlations between sound and carious teeth, teeth of children who were breast fed versus teeth of children who were bottle fed, and teeth of children living in other areas of the world are being studied. Additional studies of strontium-90 content of human fetal bone and tooth buds are in progress as are studies of nuclide content of permanent teeth (bicuspids).

The data obtained are being correlated with the dietary strontium- 90 burden of the mother and the children. These correlations show a linear relationship between tooth strontium-90 and dietary nuclide burden. With due regard to discrimination factors and time of tooth formation, the equations make it possible to predict the strontium-90 burden of children from the nuclide concentration of commercial milk sources.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0861, RADIATION DOSIMETRY

A.J. BLOTCKY, U.S. Veterans Administration, Hospital, *Omaha, Nebraska* 68105

Techniques for the utilization of phosphate glass rods in determining gamma dosimetry in an 18-KW Triga reactor have been developed and results compare favorably with thermoluminescent dosimetry. Fast and thermal flux measurements are obtained by the use of threshold detectors, making it necessary to use separate detectors to simultaneously measure the gamma and neutron dose in the reactor.

Since the Yakota glass used in the glass rods contains 33.5 weight % phosphorous, the reaction P-31 (n, alpha) P-32 can be used to determine the thermal neutron dose and P-31 (n, p) Si-31 to determine the fast neutron dose above 2.5 Mev. Thus, by reading the gamma dose on the fluorometer and counting the activity of the P-32 and Si-31 on a radiation counter, the various components of the radiation can be determined with one detector.

Recent work by E. Piesch (1) has indicated that the measurement of the Cerenkov effect of induced beta radiation by a liquid scintillation counter offers advantages over other methods of detection since the measuring geometry is better, and the background lower thereby enabling the detection of lower flux. An additional advantage of utilizing the Cerenkov effect for the detection of gross beta radioactivity is that emitters having energies below 1 Mev are not measured and consequently the beta activity of P-32 (E max equals 1.7 Mev) and Si-31 (E max - 1.5 Mev) can be determined without any influence by low energy spurious radiation components.

The use of the Cerenkov effect for counting will be investigated and a procedure developed for measuring the alpha, thermal and fast neutron dose with one director.

SUPPORTED BY U.S. Veterans Administration

5.0862, HIGH ALTITUDE RADIATION ENVIRONMENT STUDY

M. BARON, U.S. Air Force, Weapons Laboratory, *Albuquerque, New Mexico* 87117 (000578)

This project is being conducted to measure the radiation environment at SST cruising altitudes and at various latitudes using active and passive dosimetry and radiation spectral measuring instrumentation. The information obtained will be used to assess the biological effects of ionizing radiation in the SST and to develop realistic standards for radiation exposure and procedures for SST operations in order to provide maximum protection to the air crews and the flying population.

The 4 HARIS units procured under contract FS-65-24 are employed in RB-57F aircraft which are currently operating from both Kirtland AFB, N.M. and Eielson AFB, Alaska. Radiation measurements are also made at lower altitudes but at high latitudes employing other jet aircraft. Alert/Scramble missions were authorized in 1968 for recording data for measuring solar protons at high altitude. Data are being reduced and analyzed by means of a computer program at Kirtland AFB. The results of these measurements will be used by radiation biologists in order to advise the Federal Air Surgeon on radiation biology measures to be taken in case of critical dose levels. A Standing Committee on Radiation Biology Aspects of the SST was established in 1967 which provides guidance in conducting the HARIS project and advice to the FAA on the application of the results obtained. Data were obtained from about 60 flights. An aircraft is now being operated out of Alaska on a special assignment to insure an improved opportunity to obtain information at polar latitudes during solar flare conditions. NASA is cooperating in funding for this effort. Data collection should be completed by 1970.

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5.0863, HIGH ALTITUDE RADIATION ENVIRONMENT STUDY

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This project is being conducted to measure the radiation environment at SST cruising altitudes and at various latitudes using active and passive dosimetry and radiation spectral measuring instrumentation. The information obtained will be used to assess the biological effects of ionizing radiation in the SST and to develop realistic standards for radiation exposure and procedures for SST operations in order to provide maximum protection to the air crews and the flying population.

The 4 HARIS units procured under contract FA-SS-65-24 are employed in two RB-57F aircraft which are currently operating out of Eielson AFB, Alaska, on a special assignment designated 'Project Cold Flare'. Radiation measurements are also made at lower altitudes and at high latitudes employing other jet aircraft. Alert/Scramble missons were authorized in 1968 for recording data for measuring solar protons at high altitude. Data are being reduced and analyzed by the Bioastronautics Branch of the AFWL by means of a computer program at Kirtland AFB. The results of these measurements will be used by radiation biologists in order to advise the Federal Air Surgeon on radiation biology measures to be taken in case of critical dose levels. A Standing Committee on Radiation Biology Aspects of the SST was established in 1967 which provides guidance in conducting the HARIS project and advice to the FAA on the application of the results obtained. NASA is cooperating by flying a neutron spectrometer and in funding the project. Data collection should be completed by 1970. During FY 1969 the instruments were calibrated at Los Alamos and Oak Ridge. An Am-Be neutron source is being used for pre-flight calibration of each package. An interim report on the HARES was given by AFWL personnel in June of 11969. Two aircraft and four crews are available at EAFB for Alert/Scramble missions.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

5.0864, CALIBRATION OF RESPIRABLE DUST SAMPLERS FOR INHALATION HAZARD EVALUATION

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Properly calibrated 'respirable' dust samplers are required to evaluate the hazard from inhalation of radioactive or toxic particles. Depending on aerodynamic size, particles will either be trapped in the upper respiratory tract and rapidly clear from the body, or deposit in the lower respiratory tract and undergo long term body retention. While several standards have been adopted defining particle sizes which constitute an inhalation hazard, air

samplers measuring this hazard had not been adequately calibrated. Several two-stage air samplers designed to separate particulates into one fraction representing material trapped in man's upper respiratory tract, and a second fraction which penetrates to man's lower respiratory tract, were calibrated using monodisperse test aerosols in the size range of 2 to 10 microns.

Results: Calibration data for the two cyclone samplers used to estimate 'respirable dust' show that initially recommended operating procedures will underestimate potential inhalation hazards. Proper sampling flow rates should be approximately one half those recommended by previous calibrations based on microscopic particle size.

SUPPORTED BY U.S. Atomic Energy Commission

5.0865, BASAL METABOLIC RATES AND EXCRETION OF RADIONUCLIDES

J.E. FURCHNER, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

In the absence of data derived from humans, data derived from experimental animals have been used in this laboratory to estimate radiation protection guides. Such estimates are derived from extrapolations based on the assumption that the excretion rates of the elements in question are related to the basal metabolic rates of the various species. Because basal metabolic rates are found to be a power function of body weight, extrapolations from the retention-excretion parameters of experimental animals are made on the basis of body weight. The purpose of this project is to determine if artificially-induced alterations in basal metabolic rates (e.g., oxygen consumption) are accompanied by proportionate alterations in the excretion rates of test radionuclides.

Results to Date: Triiodothyronine administered via the drinking water to Sprague-Dawley rats, RF mice, and African white-tailed rats had no perceptible effect on the exretion rate of cesium-137.

SUPPORTED BY U.S. Atomic Energy Commission

5.0866, FALLOUT CESIUM-137 IN A NORMAL POPULATION

J.E. FURCHNER, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

Measurement of temporal changes in cesium-137 body burdens of local control subjects is continuing on a weekly and monthly schedule with a total of 40 subjects. Data for this project have been collected without interruption since 1956. Radiation doses are calculated for the sample based on the measured cesium-137 burdens for monthly or quarterly increments. The data are used to establish a relation between dietary levels and body burdens and to test models for the time-course of activity in a normal population. Whole-body radioactivity measurements are made in a large-volume liquid scintillation counter of almost 4 pi geometry. Gamma-ray spectrometry is used occasionally to detect the presence or to confirm the absence of gamma-emitting isotopes other than cesium-137 and naturally-occurring potassium-40.

Results: A parent-daughter model gave a reasonably accurate description of cesium-137 body burdens during the period of rapid increase, the 1964 peak, and the subsequent decrease. The model needs further modification to describe a relatively stable body burden of approximately 2 to 3 nCi in the measured population.

SUPPORTED BY U.S. Atomic Energy Commission

5.0867, CHARACTERISTICS OF A WITHIN-STRAIN RADIATION RESISTANCE FACTOR

J F. SPALDING, Univ. of California, Los Alamos Scientific Lab., *Los Alamos, New Mexico* (W-7405-ENG-36)

The relationship between radiation resistance and other phenotypic and genotypic traits in the mammal is of considerable interest and is extremely useful to an understanding of the mechanisms involved in radiation injury and repair kinetics. A within-strain radiation resistance factor has been isolated and preserved in an RFM colony of mice. Investigations are being carried out to determine the possible relationship between radioresistance and activity, life span, and reproductive efficiency. The genetic inheritance of this radiation resistance factor is also under study.

Results: The factor for radiation resistance has been shown to be effective at the bone marrow level, dominant to sensitivity, consistent with a single gene hypothesis, and inversely related to voluntary activity.

SUPPORTED BY U.S. Atomic Energy Commission

5.0868, THE CYCLING OF MICRONUTRIENTS IN GEOCHEMICAL AND BIOLOGICAL SYSTEMS

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OBJECTIVE: Identify and characterize the processes involved in the movement of trace elements from soils to plants to animals, to ascertain the factors influencing the rate and pathways of these movements and to evaluate procedures for their control.

APPROACH: The chemical forms of trace elements in rocks and soils are determined. Factors affecting the uptake of trace elements by plants and the translocation, chemical forms and metabolism of these elements within plants are studied. The absorption and excretion by animals of different forms of trace elements in the diet are measured, and the extent and pathways of recycling of excreted trace elements through soils and water back into biological systems are evaluated.

PROGRESS. A survey was made of regional variations in the zinc content of plant tissue with the objective of evaluating the possibility of endemic differences of Zn in the human population. There is a growing body of evidence that the supply of Zn to the human population is marginal for optimum rates of wound healing. The survey of Zn in plants revealed a small but distinct regional pattern of variation in the Zn content of plant tissue. In general, the Great Plains and the South had the lowest level, 25 to 33 ppm Zn, in alfalfa. This is compared with 33 to 45 ppm Zn in alfalfa from the Northeast and North Central States. In an earlier study, a somewhat similar geographic pattern in the concentration of Zn in the blood of residents of different parts of the U.S. was noted - i.e., people residing in the Northeastern U.S. had generally higher levels of blood Zn than did residents of the Southeast. This suggests that even small differences in levels of Zn in plants from different regions may possibly be reflected in differences in the level of Zn in human diets. Experiments to test the value of dietary selenium (Se) in the protection of intact animals from damage due to free radicals generated by ionizing radiation have been conducted in cooperation with the Cornell Animal Science Department. Although radiation protective effects of Se noted to date have not been pronounced, they do indicate that more definitive effects may become evident in experiments that provide a sensitive measure of radiation damage.

SUPPORTED BY U.S. Dept. of Agriculture

5.0869, THEORETICAL ASPECTS OF MICRODOSIMETRY

A.M. KELLERER, Columbia University, School of Medicine, *New York, New York* 10032 (AT-(30-1)-2740)

The theory of energy straggling which is central in the analysis of microdosimetric functions has been further developed. A new computer program uses Fourier-analysis to derive straggling distributions for arbitrary absorber thickness from a distribution for a given thickness. The program can also derive the underlying collision spectrum if a straggling distribution is known with sufficient accuracy. Fourier- analysis is also used in a technique to derive LET-spectra from pulse height spectra obtained in proportional counters. The problem of chord- length distributions resulting from the random traversal of convex bodies has been solved by a computer program which is applicable to arbitrary shapes of the traversed body and to arbitrary angular distributions of fluence. A systematic listing of distributions for circular and square cylinders and of their moments is now available. The study of the distribution of segment lengths in a body has been extended to tracks which are neither straight nor infinite, and it has been possible to generalize the so-called theorem of CAUCHY on the mean traversal length to the general case. Methods of pattern

analysis are presently being applied to the problem of track structure. These studies indicate that probability distributions of the distance between collision events may offer an alternative to the microdosimetric functions. Part 3 of 5.

SUPPORTED BY U.S. Atomic Energy Commission

5.0870, DOSIMETRY OF IONIZING RADIATION, RADIATION BIOPHYSICS AND RADIOBIOLOGY
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It is the primary objective to establish the connection between energy absorption and biological effect. Theoretical research includes stochastic theory, reaction kinetics and the development of biophysical models; physics research includes dosimetry, microdosimetry and radiological physics, including experimental and theoretical research on electron diffusion in gas mixtures and performance characteristics of proportional counters. The biophysical research is concerned with radiation effects on opacification of the murine lens, aberrations in Tradescantia stem hairs, and genetic effects in both Drosophila and Zea mays. Biological research includes effects of radiation on mammalian cells in tissue culture, including effects on resting phase cells and continuous irradiation of cultures; and radioembryology of the mouse. A Van de Graaff accelerator is being developed for this research with appropriate modifications and the initiation of general dosimetry systems. Other radiation sources employed in this research include X- rays, gamma rays, alpha rays, Cf-252 sources, and heavy ions.

SUPPORTED BY U.S. Atomic Energy Commission

5.0871, RADIOACTIVITY STUDIES
M. EISENBUD, New York University, School of Medicine, *New York, New York* 10016 (AT(30-1))

This is a continuation of a program of research that has been underway for several years. The studies involve measurement of naturally occurring radionuclides in the environment and human tissues and the investigation of the transport of the heavy radionuclides following ingestion or inhalation by experimental animals. The accumulation of stable elements in bone is also being studied under this contract.

Results: The results to date are summarized in the September, 1969 progress report number NYO-3086-8.

SUPPORTED BY U.S. Atomic Energy Commission

5.0872, BIOLOGICAL AND CLINICAL DOSIMETRY
J.S. LAUGHLIN, Sloan Kett. Inst. Cancer Res., *New York, New York* (AT(30-1))

The further dosimetric evaluation of neutron beams produced by a small cyclotron for radiobiological and clinical applications is proposed. This will include the continued development of a tissue equivalent calorimeter and its application to the calibration of other dosimeters as well as the determination of the neutron spectra and Linear Energy Transfer distributions for a variety of reactions.

Ultra-high dose rate dosimetry studies will be continued using the 30 nanosecond and dual channel 3 nanosecond 600 KeV field emission pulsed electron sources. They will be used to study dose rate dependence of thermoluminescent dosimeter materials in the range from less than 10 to the 11th power rads/sec to greater than 10 to the 13th power rads/sec. Monitoring techniques for the 3 nanosecond pulse source will be extended to measure beam energy fluctuations.

Arrays of lithium drifted germanium diodes will be constructed in an orthogonal strip geometry and tested for use in a semiconductor gamma camera.

The energy spectrum of fast neutrons generated by a cyclotron will be obtained from measurements of secondary protons using a lithium drifted diode.

Results: Preliminary dosimetry evaluation of a variety of neutron spectra produced by a small cyclotron for dosimetric and radiobiological studies has been accomplished utilizing tissue equivalent ion chambers, thermoluminescent dosimeters and activation techniques. Dose rates obtainable are adequate for absorbed dose microcalorimetry and radiobiology research.

The current transformer monitor system developed for the 30 nanosecond electron source has been improved significantly.

The use of specially constructed miniature in vivo silicon diode probes will be extend to radiation dose measurements in the urethra and nasopharynx.

A monitor system for the 3 nanosecond field emission electron source has been developed using a beam current pick-up loop. The correlation between this monitor and a Faraday cup has been demonstrated to an accuracy of plus or minus 1 percent. drifting of germanium diode have been completed. These include construction of conventional and special cryogenics. Specially constructed miniature silicon diode probes have been employed successfully in vivo as radiation dose monitors.

SUPPORTED BY U.S. Atomic Energy Commission

5.0873, RADIATION DOSE FROM DIAGNOSTIC ISOTOPE PROCEDURES
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The objective of the Medical Internal Radiation Dose Committee is to estimate the absorbed dose received by patients from various radiopharmaceuticals used in nuclear medicine. To date the Committee has published three separate Supplements to the Journal of Nuclear Medicine. These Supplements have contained pamphlets on the formalism for absorbed dose calculations, energy build-up factors, absorbed fractions for photon dosimetry including those for simple geometrical shapes and those for various organs of a heterogeneous phantom. In addition, the nuclear and decay scheme data for 24 radionuclides of medical importance was published. A fourth Supplement to be published in February, 1970 contains the decay scheme and nuclear parameters for thirty additional radionuclides. During the early part of 1970 a Supplement was to be published containing absorbed dose estimates to humans from mercury-197 and mercury-203 as labeled chlormerodrin and selenium-75, as l-selenomethionine and technetium-99 as pertechnetate ion, various isotopes of iodine administered as the iodide ion, as well as several other radiopharmaceuticals. Additional reports on absorbed fraction data for both photons and monoenergetic electrons as well as for the beta spectra for various radionuclides will be published. The committee is working on the collection of biological data for many different radiopharmaceuticals, and the absorbed dose to humans from each of these radiopharmaceuticals will appear in separate pamphlets. The work of the MIRD committee is open ended, and will continue as long as new radiopharmaceuticals are developed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S

5.0874, RELATIONSHIP BETWEEN THE PHYSICAL PROPERTIES OF INHALED AEROSOLS AND RESPIRATORY DEPOSITION
A.J. BRESLIN, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

Measurements of respiratory deposition as a function of particle size and other variables are being made both under controlled conditions in the laboratory and in occupational environments. These measurements are obtained to check the validity of current lung models and to extend the range of empirical data.

Predictions of the fate of inhaled radioactive particles in the respiratory system and calculations of internal dose depend on specific knowledge of the influence of the physical properties of particles on deposition. Moreover, quantitative knowledge of these influences is needed to design field instruments that accurately measure the hazard of occupational dust exposures.

The development of methods for generating homogeneous aerosols in sizes from 0.1 mu to 10 mu and the availability of reliable methods for the rapid measurement of the aerosols makes it feasible to perform deposition studies simply and efficiently. Complementary measurements in the actual work atmospheres provide a means of confirming laboratory findings.

Results: Respiratory deposition of radon daughters has been measured in the laboratory and in uranium mines. A pilot study proved the feasibility of measuring respiratory deposition and excretion of inhaled uranium dust.

SUPPORTED BY U.S. Atomic Energy Commission

5.0875, CHARACTERISTICS OF URANIUM MINE ATMOSPHERES
A.J. BRESLIN, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

The radiological characteristics of mine air and the physical properties of radon daughters and other aerosols are being measured in uranium mines to provide more reliable procedures for monitoring occupational exposures, improved monitoring instrumentation, and more accurate estimates of internal dose received by miners. Radiological characteristics under investigation include the magnitude and variation of radon gas concentration, working level, radon daughter ratio and ore dust concentration. Aerosol properties being measured are the particle size distribution of radon daughters and condensation nuclei, the unattached fraction of radon daughters, and the relationship between unattached fraction and the concentration of condensation nuclei. Instrumentation of several types has been developed to achieve convenient and reliable measurements in mine environments. Measurements are performed in representative mines in each of several geological formations to cover a variety of mining conditions.

Results: Radiological characteristics of nine uranium mines were intensively surveyed. The particle size distribution of radon daughters in a uranium mine was reported.

SUPPORTED BY U.S. Atomic Energy Commission

5.0876, INSTRUMENTATION AND METHODS FOR THE MEASUREMENT OF RADIOACTIVE AIR CONTAMINANTS
A.J. BRESLIN, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

Instruments and methods for the measurement of radioactive air contaminants are developed when needed for specific research objectives at the Health and Safety Laboratory or for more general applications in the AEC program. Early products of this effort were portable air sampling instruments of various types for use in industrial hygiene surveys at feed materials plants. Present efforts are focused mainly on instrumentation for use in uranium mines. A simple field method for the measurement of radon gas (two-filter method) was developed and has been used extensively in uranium mine studies. For determination of the particle size of radon daughters, several compact, highly efficient diffusion batteries were developed and are presently used both in the laboratory and in the field. In another approach to measuring the particle size of radon daughters, a differential diffusion filter is under development, consisting of a cylinder containing a series of identical filters, all operating in the diffusion regime. The particle size distribution can be obtained by a mathematical analysis of fractional penetration through the successive filters.

Results: Several radon dosimeters developed by other groups for monitoring the exposures of uranium miners have been evaluated with respect to accuracy and durability.

SUPPORTED BY U.S. Atomic Energy Commission

5.0877, MONITORING OCCUPATIONAL EXPOSURES TO RADIOACTIVE AIR CONTAMINANTS
A.J. BRESLIN, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

Increased accuracy and efficiency in measurements of occupational exposures to air contaminants is being sought through investigations of the temporal and spatial variation of atmospheric concentrations, measurements of the physical properties of radioactive air contaminants, and the evaluation of monitoring instruments. In particular, the physical properties (size, density, charge) of the contaminant influence the site and magnitude of internal dose. A systematic study of concentration variation in typical occupational environments is planned to derive relationships of sampling frequency and location to the error in an estimate of exposure. From this information, monitoring procedures can be devised for specific circumstances from objective criteria.

Measurements of particle size and other properties of air contaminants in work environments can be used to check the validity of assumptions in MPC calculations.

The reliability, accuracy and precision of available sampling instrumentation are evaluated in the laboratory and actual occupational environments.

Results: Several papers on the influence of instrumental error and of environmental variance on the accuracy of exposure monitoring were published.

SUPPORTED BY U.S. Atomic Energy Commission

5.0878, ANALYTICAL INSTRUMENTATION FOR MEASUREMENT OF ENVIRONMENTAL SAMPLES
R.T. GRAVESON, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

The identification and measurement of radionuclides in the environment requires specialized equipment for sample analysis. Since the levels of activity normally are low, the instrumentation must have unusually high sensitivity and low background.

Standard high resolution spectroscopy has been established for qualitative and quantitative isotopic identification, but special shielding and guard logic techniques are being developed to achieve low background. Thin detectors, anti-Compton guard detectors, and dual detectors for Compton acceptance are being developed to minimize the obscuring effects of higher energy interactions.

Developmental activities include the application of scintillation, solid state, and gas proportional detectors to the measurement of trace radioactive elements in soil, air, and biological samples.

Results: Two lithium drifted germanium detectors have been installed in graded shielding for low background operation. On one unit, a large scintillation anticoincidence guard rejects Compton induced events. This increases the usual 33 to 1 Peak-to-Compton ratio of the coaxial detector to 195 to 1. Both units have been interfaced to a small digital computer for data acquisition and display, and for output which is compatible with computer center format.

SUPPORTED BY U.S. Atomic Energy Commission

5.0879, INSTRUMENTATION FOR FIELD OPERATIONS IN RADIOLOGICAL PHYSICS
R.T. GRAVESON, U.S. Atomic Energy Commission, Health & Safety Laboratory, *New York, New York* 10014

Environmental radiation measurements require instrumentation which will operate reliably under difficult field conditions. The project objectives are to develop experimental equipment for determining the characteristics of penetrating radiation and of air-borne particulates.

The short half-life of radon daughter products requires that the measurements be carried out in the field. Personal air samplers, alpha counting systems, and aerosol particle size separators are being designed for experiments in characterizing the atmosphere and exposures in uranium mines.

Detectors for cosmic-ray and environmental gamma flux analysis also are provided. As the measurement systems become more complex, extensive data must be recorded and battery-operated magnetic tape storage equipment is being developed to provide simultaneous recording of time- correlated information. Also, this technique will use computer compatible methods and allow simplified data reduction on return to the laboratory.

Results: A miniaturized field scaler and a battery-operated alpha spectrometer using a semi-conductor detector have been developed for use in uranium mine surveys. Cosmic-ray experiments have been provided with a group of instruments developed for operation on high altitude balloon flights. These include a highly stable electrometer for the measurement of ionization chamber currents and a charged particle detector system. The data is recorded on self-synchronized impulse driven strip-chart recorders developed for this application.

SUPPORTED BY U.S. Atomic Energy Commission

5.0880, NUCLEONIC TRANSPORT STUDIES
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5. RADIATION

We develop calculational and measurement techniques for nucleonic cascades in matter to aid in radiation shield design and in determining the response of detectors, the propagation of cosmic-rays in the atmosphere, and depth-dose curves in tissue.

Analytical solutions to the Boltzman equation are obtained by the straight-ahead approximation at high-energies, and by polynomial approximations at low energies. In addition, the use of the LASL discrete ordinates code (DTF-IV) is planned to study nucleonic cascades over a very wide range of energies (10 to the minus 2nd power to 10 to the 13th power eV). Neutron yield and shield transmission measurements are made to provide benchmark data.

Results: Calculations of ionization from cosmic-rays have been compared with balloon-measurements over a wide range of elevations with good results. The components contributing to cosmic-rays at sea-level have been computed and will be published.

Two-dimensional nucleonic cascade calculations have been carried out for comparison with measurements made at the Stanford Linear Accelerator of the cascade in tin. Extension to depth dose curves in tissue from hadrons at cosmic-ray energies is planned.

SUPPORTED BY U.S. Atomic Energy Commission

5.0881, ENVIRONMENTAL RADIATION STUDIES

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We investigate the properties of ionizing radiation in the environment that are significant for human population exposure and develop techniques for quantitative analyses of complex low-level radiation fields.

Experiments require the measurement of cosmic-ray ionization, particle flux, and dose rate in the atmosphere; thermoluminescent dosimetry for determining the exposure of individuals to environmental gamma radiation; and the study of the distribution of naturally occurring and artificially-produced radionuclides in the environment. The related transport calculations are important in the data interpretation.

Future environmental radiation studies include: (1) a correlation of all experimental and calculational results into a comprehensive analysis of the significant properties of cosmic radiation within the atmosphere, (2) field studies of population exposure to environmental radiation in selected areas, (3) development of techniques for the detection and quantitative analysis of levels of radioactivity around nuclear facilities.

Results: Balloon flights have been made with ionization chambers, and an ionization profile in the atmosphere has been obtained which is in general agreement with our nucleonic cascade calculations. Monte Carlo calculations of the electromagnetic cascade have provided quantitative estimates of wall perturbations in these chambers.

Procedures for measuring personnel doses with LiF dosimeters down to 1.5 mR have been developed, and several such dosimeters have been tested.

SUPPORTED BY U.S. Atomic Energy Commission

5.0882, GLOBAL DISTRIBUTION AND INVENTORY OF SR-90 AND OTHER FISSION PRODUCTS

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Since 1959, about 140 stations have been collecting monthly precipitation which is analyzed for Sr-90 and Sr-89. The collectors are either high-walled stainless steel pots or funnel-ion exchange columns. The global fallout rate distribution of radiostrontium and deposit increments, for assessing the fallout inventory, are derived from this project.

Deposition of Pu-238 from the SNAP-9A satellite re-entry in April 1964 is measured monthly in New York City, Melbourne, Seattle and Rio de Janeiro.

Soil sampling is carried out near nuclear installations when there is a need to inventory the integrated amount of a specific radionuclide that may have been released either routinely or accidently.

Results: In the first half of 1969, about 150 kilocuries of Sr-90 were deposited on the earth's surface, about 54% of which was in the northern hemisphere. The cumulative burden of Sr-90 in the northern hemisphere decreased as radioactive decay continued to exceed the fallout rate; in June 1969 the deposit was about 9.5 MCi. In the southern hemisphere the deposit was gradually increased, reaching 2.7 MCi in June.

SUPPORTED BY U.S. Atomic Energy Commission

5.0883, DEVELOPMENT STUDIES IN LOW LEVEL RADIOCHEMICAL ANALYSES AND TRACE STABLE ELEMENTS IN BIOLOGICAL AND ENVIRONMENTAL MATERIALS

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This program develops radiochemical, radiometric, and other methods of analysis to determine the levels of radionuclides and stable elements in man and his environment. This program is required to increase sensitivity, accuracy, and precision of existing methods and provide methods where they do not exist. This is accomplished by investigating and applying both classical and new techniques to low level radiochemical and trace element analysis.

Newer analytical techniques and instrumentation are periodically investigated for our application. Presently, some of these are atomic absorption spectrophotometry, ion exchange in mixed solvent systems, gas chromatography, paper and electro chromatography, X-ray spectrometry, Cerenkov counting methods, and stable element determination using radio- reagents.

Results: The stable alkaline earth metals have been determined sequentially in a variety of biological matrices. A method for leaching and determination of small amounts of the plutonium isotopes in kilogram quantities of soil has been developed. Stable lead has been documented in air and biological material in New York City.

Carbon-14 and tritium (tritiated water) have been documented in New York City air. A method for gas counting using a thin plastic beta phosphor has been developed. High resolution Ge(Li) gamma ray spectrometer systems, recently installed, confirmed the introduction of cobalt-57 and cobalt-58 into the stratosphere by foreign nuclear tests.

SUPPORTED BY U.S. Atomic Energy Commission

5.0884, CHEMICAL DOSIMETRY

H.L. ANDREWS, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620 (AT(30-1)49)

Objective: To determine the usefulness of some organic halogen compounds as chemical dosimeters for ionizing radiation and for microwaves.

Scientific Background: Organic halogen compounds are known to be sensitive to radiolysis by ionizing radiations. The usual reaction leads to the production of hydrocholoric acid with a resulting sharp change in the electrical properties of the aqueous solution. Indicators have been incorporated into the solution to give a visual indication of the pH change and hence of the radiation dose. The addition of a gelling agent permits a three-dimensional visualization of a radiation beam. Previous work with chloral hydrate-methyl rad-agar systems showed promise but lacked the desired sensitivity.

Procedure: To determine the capabilities of the system it is necessary to optimize the proportions of the three components after having selected the most suitable indicator and gelling agent. A limited number of indicators were selected and compounded with a series of agents such as styrene and acrylamide which gel by polymerization. Results were uniformly disappointing because the radiation sensitivity of these polymers was poorer than the agar gels previously used. It seems unprofitable to pursue this work further. It remains to explore the possibility of using the organic halogens as a detector of microwave radiation. A segment of a toroid is filled with the solution and the circuit is completed with a diode rectifier. A D.C. current will be produced and this will produce electrolytic products in an amount proportional to the integrated field intensity.

RESULTS: The results of the gel systems have been disappointing. Any gelling agent tried reduces the system sensitivity to an unacceptable level. The original agar gel appears to be the most satisfactory, in spite of its variable characteristics from batch to batch.

Suitable electrode materials have been found for the microwave dosimeter, and dose-yield measurements are in progress.

SUPPORTED BY U.S. Atomic Energy Commission

5.0885, STUDIES OF URANIUM MINER HAZARDS ASSOCIATED WITH RADON

W.F. BALE, Univ. of Rochester, School of Medicine, *Rochester, New York* 14620

Objectives: In five separate but closely interrelated projects, senior scientists are conducting the following studies: Project A - Effects on Dogs of Radon Decay Products; Project B-1 - Measurement of 210 Pb Effective Half-life in Dogs; Project B-2 - The Transport of 212 Pb from the Lung in Man; Project C - Research on Attachment of Radon Decay Products to Airborne Particles; Project D - Methods for improved Bioassay of 210 Pb Body Burden by Determination of 210 Pb and 210 Po in Urine and Feces; Project E - A Theoretical Study of Dose-Time Relations for the induction of Lung Cancer in Uranium Miners.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0886, CONTROL OF ION CONTENT OF CELLS

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OBJECTIVE: This study is aimed at understanding the 'molecular pumps' which transport sodium, calcium, and strontium out of living cells and potassium and cesium into cells, and are directly involved in handling a number of ions that may cause damage either by radioactivity (cesium-137, strontium-90) or by chemical toxicity (lead, beryllium). Knowledge of the performance parameters of these pumps contributes to our ability to predict the accumulation of environmental contaminants by all kinds of living organisms. SCOPE OF THE STUDY: (1) Control of monovalent cations: The red cell ghost is used as a model system for a study of uptake of potassium by cells. Potassium transport in many-celled organisms may be regulated through endogenous production of selective pump-blocking inhibitors, and traces of such inhibitors have been discovered in human white cells in this laboratory (Weed, et al., 1963). We will determine the properties of the white cell factor and the mechanism of inhibition of the sodium-potassium pump by this factor. (2) Control of divalent cations: The red cell ghost and the 'inverted' ghost are used as model systems for a study of active transport of calcium out of the cytoplasm. Questions under consideration are (a) which ATPase enzyme is part of the pump, (b) what is the selectivity of the pump for calcium over strontium, and (c) what is the action of lead on the pump. (3) Field study of cation transport: Organisms living in Springville Reservoir in West Valley, New York are continuously exposed to significant concentrations of cesium-137 and strontium-90. We will collect and classify exposed plants and animals (especially phytoplankton and zooplankton) and measure the levels of potassium, cesium, calcium, strontium, and their isotopes in relation to ambient concentrations. First problem is to measure cesium/potassium and strontium/calcium ratios in various species (scintillation counting, sodium iodide well counting, atomic absorption spectrophotometry).

Results: A study of mechanisms of precipitation of lead salts in lead-ATP systems was brought to completion. A white cell factor with glycoside-like properties was discovered in human blood. 'Sodium pump' and 'calcium pump' ATPase were studied in mammlian cells and a functional zinc as a tissue-specific pump inhibitor was demonstrated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0887, AN INVESTIGATION INTO THE PHARMACOLOGICAL PROPERTIES OF ANTI-IRRADIATION DRUGS

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The broad objectives of this research have been to develop antiradiation drugs which are as free as possible from undesirable side effects. Attention has been given to mechanisms of action on whole animal, organ, organelle and enzymatic levels. Particular emphasis has been placed on the effects of a prototype antiradiation compound, mercaptoethylguanidine (MEG), on catecholamine biosynthesis, storage and release. Under the appropriate conditions, the stimulation by MEG of catecholamine release and synthesis appears to account for a significant increase in the radiation protectivity of this agent. Preliminary studies have shown that MEG inhibits the conversion of the precursor dopamine (DA) to norepinephrine (NE) in isolated adrenal catecholamine storage granules. On the other hand, MEG stimulates markedly the formation of NE from DA when preparations of dopamine beta oxidase (DBO) are used. These studies will be extended to include the effects of other protectant thiols related to MEG as well as some of the thioates wich have been shown to be effective in radiation protection. Attempts will also be made to resolve the discrepancy between the effects of MEG on NE synthesis by whole granules and isolated DBO by varying the constitution of the media used in the two systems. The further development of appropriate microanalytical procedures for the determinations of catecholamines and precursors will continue.

Results: Last year it was shown that MEG releases catecholamines from perfused hearts and adrenals; catecholamine biosynthesis is stimulated in the heart. MEG depresses norepinephrine synthesis from dopamine in isolated adrenal chromaffin granules; stimulation of the transformation of dopamine to norepinephrine is observed when dopamine beta oxidase from granules is used. Resolution of this difference will be the the object of work in the coming year.

SUPPORTED BY U.S. Atomic Energy Commission

5.0888, THE MEASUREMENT OF BIOLOGICAL DAMAGE AND ITS RELATIONSHIP TO 'IN-TISSUE' ENERGY ABSORPTION

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Techniques for determining the deposition of energy throughout irradiated animals (including humans) must be developed. Current methods are limited to physical techniques. However, such devices do not lend themselves to the measurement of dose in extremely small loci. The hematopoietic centers in the intramedullary spaces of small animals would be representative of such loci. In addition, accidental human exposures have occurred where depth dose distribution is extremely difficult to interpret due to the lack of adequate physical monitoring devices. This project is directed at examining the response of a biological system to graded doses of ionizing radiation. In particular, in small animals exposed to X-irradiation, the intramedullary doses are determined with small thermoluminescent dosimeters in representative carcasses. Live animals of the same species and of approximately the same size are then exposed in a fashion identical to that used for the carcasses and, at an appropriate time following exposure, the status of the hematopoietic system is examined using Fe59 bone uptake. Quantitiative changes in other physiological systems following irradiation will also be examined.

To date, the rat exposed to X-irradiation has been extensively investigated. Other species exposed to X and gamma rays as well as neutrons will be examined in the future.

Results: The uptake of radiation in the bones of irradiated rats decreases with increasing dose following a curve made up of several exponentials. This is probably due to the differences in radiation sensitivity and iron uptake among the various red cell precursors.

Similar types of response have been noted using 80 kVp, 250 KVp and 1000 kVp X-rays. It is felt that, using the Fe59 uptake

method, the dose to each individual bone can be estimated to plus or minus 15 percent.

SUPPORTED BY U.S. Atomic Energy Commission

5.0889, GENERAL STUDIES IN THE TOXICITY OF RADIOELEMENTS
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This project is aimed primarily at the assembly of biomedical information critical to the setting of and possible revision of maximum permissible body burdens of radioisotopes and the derived concentrations in air and water. Experimental work is being done through other projects at Rochester and elsewhere. It ties closely to the functions of the principal investigator as Chairman of Committee 34 of the National Council on Radiation Protection and Measurements.

Results: This is essentially a new enterprise in its present form. Some effort will still be needed to write up and publish work on the toxicity of radioprotective agents carried out in the past.

SUPPORTED BY U.S. Atomic Energy Commission

5.0890, NAVY ENVIRONMENT--RADIOISOTOPE STUDIES
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Technical Objective: The research will contribute data and understanding of the Navy environment resulting from radiation. Study of radioisotope decay schemes and the slowing down of electrons in matter will generate solutions to shielding problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0891, INFLUENCE OF RADIATION QUALITY AND DOSE RATE ON EARLY AND LATE EFFECTS IN CELL-RENEWAL SYSTEMS IN THE MAMMAL
J.L. BATEMAN, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

This study is conducted to obtain and evaluate experimental data for the development of theories of radiobiologic action. Quantitative information is collected systematically on suitable biological (cell) systems exposed to graded doses of ionizing radiations of selected quality, whose precise physical characteristics are determined by microdosimetric measurements. Clarification of the functional relation of radiation quality and physical modifying factors is fundamental to these considerations. Specific determination of the macro- and micro- distribution of dose in the intact animal and in organs of interest enable continued evaluation of both early and late mammalian radiation effects on the basis of dose-response relationships established for particular cell populations. Studies may deal with either somatic or genetic effects. Exposures of biological material to monoenergetic fast neutrons have been important in these investigations and were initiated on the 3-Mev Van de Graaff generator in the BNL Physics Department. Further work will utilize the Van de Graaff generator, recently modified for radiobiological studies.

Results: An experiment completed this year avaluated lens radiosensitivity to 250 kVp X-rays versus age at exposure. At three to four months sensitivity was found to be several times that at birth or at twelve months, which closely parallels the findings of several other investigators with radio-lethality.

A second experiment utilizing lens opacification compared split versus single doses at several different total doses. Not only were the single doses more effective than the same dose split at 24 hours, but were approximately equal to half the dose followed at 24 hours by the full dose, suggesting the first exposure may have caused an accumulation of lens epithelial cells in a resistant phase of their cycle.

SUPPORTED BY U.S. Atomic Energy Commission

5.0892, RADIOLOGICAL PHYSICS
J.W. BAUM, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

Interaction of radiation with matter and fundamental dosimetry concepts are investigated. Emphasis is placed on studies which improve our knowledge and understanding of the mechanisms and space and time relations of energy deposition and degradation in irradiated tissue. Studies of dose in sub-cellular sized regions of tissue are used for correlation with available data on biological effects and to further our insights into possible mechanisms of radiobiological damage. Theoretical models relating microdosimetry, LET, and biological effects are being developed in an effort to explain variations of RBE with LET, oxygen tension, dose rate and other factors; to understand mechanisms responsible for radiation induced tumors; and to determine if a threshold dose exists for various effects.

The 3 foot long cylindrical ionization chamber with internal movable probe chamber was used to obtain LET results for He-4 beams of 1, 2, and 3 MeV obtained from the Van de Graaff accelerator. (Results for proton beams of these energies were obtained last year.)

The repair model for cell inactivation by radiation was developed further. It was shown that this model correctly predicts that extrapolation numbers (n) may vary with LET and for suitable ratios of target parameters a minimum n may occur at intermediate values of LET. At very large values of LET the model predicts that n should be greater than or equal to 1.0.

Analysis of pulse height data from a Rossi-type LET spectrometer generally depends on an assumed triangular distribution from mono-LET particles. For sources with large divergence, this assumption is no longer accurate. For example, a point source located on the inside wall of the detector would produce a rectangular pulse-height spectrum. Tests were made to determine the importance of this parameter using Pu- Be neutron sources. Average LET was in error by more than 10% for source to detector distances of less than a few detector diameters.

SUPPORTED BY U.S. Atomic Energy Commission

5.0893, HEALTH PHYSICS
J.W. BAUM, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

Emphasis is placed on the development of new methods of dosimetry for analysis of accelerator radiation fields of complex composition.

The output from a tissue-equivalent (TE) Rossi-type LET spectrometer contains the necessary information for measurement of dose, dose equivalent and quality factor in fields containing mixed types of ionizing radiations. The development of practical portable survey instruments based on a Rossi detector requires elimination of the multichannel analyzer and gas flow system. A simple electronic system was described earlier which satisfactorily replaces the analyzer. The system employs an electrometer and two biased amplifiers to provide pulse weighting for quality factor. Output can be read directly in rad/hr or rem/hr.

Elimination of the gas flow system required studies of contaminates released by the plastic walls of the detector into the counting gas. The principal contaminants found were water vapor and oxygen. For a typical 4 inch diameter detector filled to 20 mm Hg pressure with TE gas, we have demonstrated that these effects can be minimized by (a) employing a few grams of P_2O_5 desiccant to continuously remove water vapor and (b) thoroughly outgassing the chamber after construction. After the chamber had been used for several months, only small changes were exhibited. These were attributed to small pressure increases attributed to diffusion of air through the chamber walls. The 0.6% change in pulse size per day which results can be compensated for by periodic adjustments of the high voltage. Apparent QF for Pu-Be neutrons changed by only 0.2% per day during a 112 day test. It is therefore concluded that gas purity and gas pressure changes can be adequately controlled in sealed detectors employed in portable spectrometers and survey meters. Refilling on a monthly or bi-monthly basis should be adequate for most survey situations.

SUPPORTED BY U.S. Atomic Energy Commission

5.0894, IN-VIVO MEASUREMENT OF RADIONUCLIDES IN MAN
S.H. COHEN, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

The sensitivity, precision and accuracy of the whole-body counter permits the measurement of the long-term biological turnover of various elements in man using low levels of tracer. Knowledge of these turnover rates is required for the assessment of the radiation hazard to man from Sr90 and Cs-137.

Both the absolute levels and spatial distribution of various radionuclides in man are determined. These measurements employ an empirical technique, using an 'on-line' computer to correct for the variable counting response to both geometry and attenuation of gamma photons in individual subjects.

A stochastic model was fitted to long-term strontium retention in a group of men. This model is derived from both a causal path analysis and a maximum likelihood function.

The burdens of Cs137 in a selected population of ten staff members have been measured at monthly intervals for the past 9 years. These data provide information as to the changes in the level of radioactive fallout in the environment. In addition, 450 of the BNL staff have been counted and their absolute levels of Cs137 and K40 measured as a function of age and sex.

As part of a study of grossly obese children, the whole-body K40 was measured in 35 children in order to determine their lean body mass. The total cell mass is correlated with total fat cell mass and other parameters in these children (in collaboration with Knittle).

SUPPORTED BY U.S. Atomic Energy Commission

5.0895, IN VIVO MEASUREMENT OF RADIOACTIVE BODY BURDENS IN SELECTED POPULATIONS

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(AT(30-2)GEN-16)

The technique of gamma-ray measurement by pulse-height analysis provides the most rapid and accurate determination of internally- deposited radionuclide abundance in man. Scintillation spectrometer pulse-height distribution data are analyzed to quantify the levels of cesium-137, zinc-65, potassium-40, and other radionuclides in Brookhaven personnel. In a large-scale study of this kind, constant effort is made to improve the automatic data-handling techniques and the computer analysis of the spectral data.

A 54-detector whole body counter utilizing an on-line computer was constructed and calibrated. The counter is unique in that it incorporates the following properties: high sensitivity and spectral resolution, an invariant response to both the spatial distribution of radionuclides and to body size. The counter also has the ability to provide data on the spatial distribution of rapidly translocating radionuclides in the body.

Results: The operational characteristics of this counter and its associated computer facility were studied, using point sources and distributed sources in a phantom. An empirical technique employing the computer was developed to correct for the variable response to both geometry and attentuation of gamma-photons by the human body. A series of clinical studies were carried out to provide data for the evaluation of the response of the system to variations in counting geometry, body size and weight, and to rapidly translocating radionuclides.

SUPPORTED BY U.S. Atomic Energy Commission

5.0896, IN-VIVO NEUTRON ACTIVATION

S.H. COHN, Brookhaven Natl. Lab., *Upton, New York* 11973

A technique for in-vivo neutron activation analysis of elements in the man has been developed. It is possible with a whole-body dose to the subject of less than 0.25 rad (from fast neutrons) to measure in-vivo whole-body concentrations of Ca, Na, Cl, I, N and P. In the initial effort of measuring the concentration of Ca (49Ca) in the whole body, the first step is to obtain a uniform thermal neutron distribution in order to expose the body uniformly to a standardized quantity of neutrons. The second step is to quantitatively measure the induced activity of 49Ca in the body with a whole-body counter. A 54-crystal whole-body counter and on-line computer is used in the second step to provide a measure of the induced activity independent of its location in the body and the size of the body itself.

Results: Thermal neutron flux densities generated in both tissue- equivalent and water phantoms have been investigated for a number of neutron sources. These have included PuBe, PoBe, and AmBe (alpha,n) sources, and 14-MeV neutrons from a neutron generator. Both the relative and absolute thermal neutron densities have been evaluated. Depth-flux curves obtained from the (alpha,n) sources using bilateral irradiations have given satisfactory curves similar to those generated by 14-MeV neutrons. The new whole-body counter has been used to measure absolute levels of induced 49Ca independent of its localization in the body and the size of the patient.

SUPPORTED BY U.S. Atomic Energy Commission

5.0897, COMPUTER APPLICATIONS

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(AT(30-2)GEN-16)

The SDS Sigma 2 digital computer is expected to be linked via Brooknet to the central facilities' CDC-6600 computers during the next year. Implementation of this will require programming for communication between the two computers. This will extend the on-line data processing capabilities for the whole-body counter and the EPR systems and will give the Medical Department a remote control terminal for batch processing.

Results: The SDS Sigma 2 computer system has become fully operational for on-line data acquisition and data processing for the whole-body counter and the EPR systems within the limitations of its capabilities. New programs developed during the year include CALDOS for computing the dose rates from arrays of Californium-252 sources at any set of selected points in a 21 x 21 x 21 lattice. Calculations for Californium-252 differ from corresponding ones for radium sources because the attenuation factors for neutrons do not correspond to those for gamma rays.

SUPPORTED BY U.S. Atomic Energy Commission

5.0898, A COMPREHENSIVE APPROACH TO MAJOR FACTORS DETERMINING RADIOSENSITIVITY

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(AT(30-2)GEN-16)

The goal is to determine whether radiobiological responses of various groups of organisms are dependent on common variables which would allow the radiosensitivity of different types of organisms to be put into a proper perspective with regard to each other. D sub 37 values of a large number of organisms (viruses to higher plants and animals) are being studied to see if the relative radiosensitivities of these organisms can be explained in terms of various chromosomal parameters and of target theory concepts. These parameters include chromosome and nuclear volume, nucleic acid content and concentration, and molecular weight of the nucleic acid. These variables are being related to the D sub 37 values and to each other. The fine structural morphology of nuclei and chromosomes of higher organisms is under study to see if there are any basic differences which could be useful in explaining relative radiosensitivities.

Results: Data based on the above parameters indicate the existence of eight groups of organisms. Species within each group were not necessarily related according to taxonomical schemes. It was found that: 1) within each group D sub 37 was inversely proportional to chromosome volume; 2) energy absoprtion per chromosome at D sub 37 was nearly the same for each of the organisms within each group but different for each group; 3) the ratio of chromosome volume to the theoretical target volume increased from group to group but was nearly the same for organisms within each group. For the small RNA viruses the ratio of the volume of RNA to target volume was approximately 1, hence, the volume of the radiosensitive target corresponds to the calculated volume of the RNA molecular weight. In other organisms the calculated target volumes were smaller than either the chromosome volumes or the calculated volumes of the DNA. Work under way suggests that certain mathematical transformations may improve the usefulness of the relationship for predicting radiosensitivities.

SUPPORTED BY U.S. Atomic Energy Commission

5.0899, RELATIONSHIP OF PLOIDY, CHROMOSOME SIZE AND RADIOSENSITIVITY

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(AT(30-2)GEN-16)

5. RADIATION

The effect of increased ploidy on radioresistance was examined in whole plants (haploids to 20-ploids) and in single-meristematic-cell systems (diploid to 12-ploid). LD sub 50s for whole plants were determined from survival curves and D sub 37 values from terminal stamen hair cells or pollen of several Tradescantia species after exposure to appropriate amounts of super 137 Cs, super 60 Co gamma rays or monoenergetic neutrons. Interphase chromosome volumes (ICV) were determined for all species at the time of irradiation. Mean survival time varies greatly among species. The cellular basis of this variation is being sought.

Results: It was found that the LD sub 50 and D sub 37 values were inversely proportional to the corresponding ICVs. The absorbed energy per chromosome at specified end points for each species was relatively constant for each end point. In several genera investigated, high levels of ploidy 'per se' did not have a radioprotective effect but a small ICV was often, if not always, found in high polyploids. Thus the 'apparent' protective effect seen in some genera can best be explained in the light of a reduced target volume of the chromosome rather than as a consequence of genetic redundancy. However, the latter may influence mean survival time as well as variation in ICV. In cases where diploids and polyploids did not differ in sensitivities ICVs were very similar. So far there are no significant differences between auto- and allo- polyploids. Data on more species are being assembled.

SUPPORTED BY U.S. Atomic Energy Commission

5.0900, ENVIRONMENTAL BIOLOGY - METABOLISM AND PRODUCTION OF A FOREST
G.M. WOODWELL, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

The objective is measurement of the primary productivity of a forest exposed to a gradient of ionizing radiation. Primary productivity is especially useful in appraising effects of any disturbance because it integrates all the physiological processes of the system, providing a single measurement of function useful in both rapid and long-term analyses of function at the ecosystem level. Technical difficulties have prevented widespread use of productivity measurements in terrestrial vegetations. At Brookhaven National Laboratory techniques for measurement of productivity are being developed using both measurements of metabolism under field conditions and growth analysis techniques; gas exchange data, used as an index of metabolism, together with measurement of appropriate environmental variables are punched on tape, a process which allows rapid machine tabulation and correlation of data.

Results: From this work we know now: (1) that CO 2 measurements under field conditions can be used as an index of metabolic rates and, if maintained through long periods, can probably provide an index of productivity as well; (2) exposure to ionizing radiation reduced the efficiency of C fixation proportionately more than it depresses respiration, an effect which introduces one mechanism of death due to irradiation of plants as simply an unfavorable Ps/Rs ratio. This mechanism applies especially to woody plants. (3) That CO 2 fluctuations at night within the Long Island oak-pine forest are frequently great and regular enough to offer the possibility of measuring respiration of the total forest directly by simply monitoring CO 2 concentrations and temperature on a 50 ft. tower. (4) There is a reasonable possibility of developing a simplified sampling system for determining the productivity and nutrient inventory of other forests which have trees of similar form.

SUPPORTED BY U.S. Atomic Energy Commission

5.0901, ENDOTOXIN EFFECTS ON MOUSE COLONY-FORMING UNITS
G.E. HANKS, Univ. of North Carolina, School of Medicine, *Chapel Hill, North Carolina* 27514

1. To more clearly establish the pattern of colony-forming unit (CFU-stem cell) migration, compartmentalization and proliferation in the normal mouse. 2. Extend dose-response and recovery observations on non- cycling (G-O) bone-marrow colony-forming units. 3. Define the alterations in these CFU population kinetics that correlate with the radioprotective effects of bacterial endotoxins. 4. Gain information about the correlation of CFU content and whole body radiation sensitivity, with particular attention to the period of bone marrow repopulation following sublethal irradiation.

Human subjects will not be involved in any phase of these studies.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0902, MICROWAVE EXPOSURE SYSTEM AND MICROWAVE DOSIMETRY
D.I. MCREE, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The objectives of this project are to develop a microwave exposure system for biological material which has a well-defined, uniform field characteristic, to study the mechanisms of interaction of microwave radiation with matter, and to develop dosimetric relationships for energy absorption.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0903, ULTRAVIOLET DOSIMETRY
D.I. MCREE, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The objectives of this research are to measure the actual dose to the cells when exposed to ultraviolet radiation and to develop analytical dose-response relationships. A comparison of the relative biological effectiveness of the ultraviolet radiation with ionizing radiation will be studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0904, RESPIRATORY TRACT DOSE MODEL FOR URANIUM MINERS
P.J. WALSH, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The objective of this project is to develop a respiratory tract dose model for the calculation of dose to the bronchial epithelium in the case of inhalation of alpha emitters attached to respirable condensation nuclei. Such a model would, if combined with biological effect data, provide a basis for maximum permissible exposure guidance. The model will initially be applied to the inhallation of radon daughters by uranium miners.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0905, INVESTIGATION OF THE THICKNESS OF BRONCHIAL EPITHELIUM
P.J. WALSH, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Durham, North Carolina* 27709

The objective of this study was to determine the location of the basal cells in the bronchial epithelium of the tracheobronchial tree for purposes of dose estimation in the case of inhalation of alpha emitting radon daughters.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0906, OPERATE A RADIATION ALERT NETWORK
M. GEORGEVICH, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: Collect daily air samples to determine radiation levels in all states and territories of the U.S. and alert other agencies, concerned with radiation health and safety, when high levels occur.

Approach: Collect air samples for gross-beta using a 0.5 m3/min air flow and a charcoal impregnated filter.

Goal: Analyze daily samples Monday through Thursday and composites on Friday through Sunday for gross-beta at 73 sites throughout the U.S. and its territories.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

5.0907, ANALYZE SELECTED HI-VOL SAMPLES FOR GROSS-BETA RADIATION
UNKNOWN, U.S. Environ. Protection Agcy., Air Pollution Control Office, *Durham, North Carolina* 27709

Objective: To determine the gross-beta radiation in collected particulate samples.

Approach: The particulates collected on glass-fiber filters on the West Coast and in selected areas where nuclear power generation is projected are measured for gross-beta radioactivity.

Goal: To determine the gross-beta radiation in particulate samples collected at some 26 stations 26 times per year.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

5.0908, RADIOCHEMICAL METHODS AND MEASUREMENTS

B. KAHN, U.S. Environ. Protection Agcy., Natl. Environ. Research Center, *Cincinnati, Ohio* 45213

The objective of this program element is to improve and develop methods of radioanalysis for various media, particularly, air, water, soil, vegetation, and biologic material. In addition, effective techniques for measuring environmental radiation and for sampling environmental media containing radionuclides are to be developed and evaluated.

To assess the movement of radioactive materials in the environment and to evaluate their potential radiation exposure to man, samples of environmental media are collected for analysis of radioactive content, or direct measurements of environmental radiation levels are made in the environs of certain facilities such as nuclear power reactor installations. Efficient, accurate, and reliable analytical and radiation measuring methodologies are therefore of major importance in evaluating environmental radiation exposure to man.

Radiochemical procedures will be evaluated in the laboratory on environmental samples collected from selected sites such as at reactor installations and on laboratory control samples. This evaluation will be conducted for the purpose of refining or developing needed analytical procedures for determining radioactive concentrations in sampled media. Because of their growing use, nuclear power reactor installations primarily will be studied for their contribution to environmental radiation. Assessment and development of analytical means for determining the concentration of radioactive waste products discharged from reactors to the air and water in the environment will be based on samples of waste effluent collected from the reactor site. Environmental radiation levels may be evaluated by use of thermoluminescent dosimeters placed in the field and also on direct field measurements made by electronic instruments.

SUPPORTED BY U.S. Environ. Protect. Agency - O.R.M.

5.0909, ROLE OF 2-DEOXYGLUCOSE AND OTHER METABOLIC INHIBITORS ON THE RADIATION SENSITIVITY OF CULTURED MAMMALIAN CELLS

H.L. FRIEDELL, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (W-31-109-ENG-78)

The metabolic inhibitor 2-deoxyglucose is being used to alter the metabolism of Chinese hamster and Strain L cells before, during, and after irradiation of the cells with X-rays. The purpose of this study is to evaluate the role of metabolism in cell injury and recovery from X-radiation. As an extension of this work, environmental factors such as serum and pH will be examined for their possible influence on the effectivenss of metabolic inhibitors and similarly classed agents as radiation modifiers. Part 10 of 22.

SUPPORTED BY U.S. Atomic Energy Commission

5.0910, PULSED ELECTRON BEAM DOSIMETRY

E.C. GREGG, Case Western Reserve Univ., School of Medicine, *Cleveland, Ohio* 44106 (W-31-109-ENG-78)

Absolute beam currents and total delivered charge in a pulsed electron beam have been determined by means of an absorption calorimeter, Faraday cup and Toroidal beam transformer. All these methods agreed to better than 3% on an absolute basis. While these methods suffer from the disadvantage of requiring a vacuum for reasonable accuracy, they can be used as primary reference standards for other devices and techniques that may be used in air or phantoms. Devices under investigation are thermoluminescent LiF-loaded Teflon sheet and rods as well as silicon solar cells. The LiF-loaded Teflon sheet is the most promising for insertion in phantoms while the Toroidal current transformer is most useful for transmission monitoring of electron beams in therapy. We also plan to extend the electron energy range from 0.7 to 7 mev. Part 1 of 16.

SUPPORTED BY U.S. Atomic Energy Commission

5.0911, MERCAPTOCYCLOPROPYLAMINES RADIATION-PROTECTIVE AGENTS

D.T. WITIAK, Ohio State University, School of Pharmacy, *Columbus, Ohio* 43210

Our program is designed to study the synthesis of beta- mercaptocyclopropylamines and related systems and to evaluate these compounds in terms of their ability to protect mice from the effects of ionizing radiation. The proposal discusses theoretical reasons for the desirability of testing such compounds as well as a number of approaches to the stereoselective synthesis of cis and trans isomers of the types desired. It is expected that biological data obtained will be complementary to the work of others relative to the mechanism of action of low molecular weight omega-mercaptoalkylamines.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0912, CONCORDE RADIATION WARNING DEVICE TESTS

W. FRIEDBERG, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma*

This task will be conducted to (a) measure levels of radiation from galactic and solar sources by means of the Concorde radiation warning device, and (b) to compare the data recorded by the British instrument with those obtained by the High Altitude Radiation Instrument System (HARIS) manufactured by Solid State Radiations, Inc., Los Angeles, California. The information obtained will be used to evaluate the sensitivity, accuracy and reliability of the Concorde instrument, to validate its performance in relation to the HARIS package, and to determine its validity and usefulness for the inflight recording of radiation at SST altitude.

Present prototype equipment devices were developed at the Atomic Weapons Research Establishment, Berkshire, England. One of these instruments is on loan to the Office of Aviation Medicine for flight testing, preferably in conjunction with the HARIS package, using the USAF RB-57F aircraft. These aircraft which were previously operating from Kirtland AFB, N.M., are presently assigned to alert/scramble missions at Eielson AFB, Alaska. The operational plan for the deployment of the two aircraft and three crews is authorized by the 59th Weather Wing and monitored by personnel from the Air Force Weapons Laboratory at Kirtland AFB, N.M.

Accomplishments on this project include the following: 1) Concorde instrument modified so that it will operate as a hermetically sealed unit; 2) Rustrak recorder coupled to the Concorde instrument and the recorder modified so that it will operate in a cold compartment at SST altitudes; 3) Dose response relationships of the radiation detectors checked; 4) Aircraft shock-mounts modified so that the Concorde instrument could be installed in an RB-57; 5) Performed pull tests, temperature sensitivity tests and electrical tests to meet FAA standards and Air Force regulations; 6) Consulted with representatives of the Air Force, General Dynamics Corp., and Los Alamos Scientific Laboratory and obtained space for the Concorde instrument next to the HARIS package; 7) Missions are now being flown with the Concorde instrument out of Eielson Air Force Base. We recently received 21 data tapes and they are being analyzed.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

5.0913, NAVY ENVIRONMENT - MEASUREMENT OF TISSUE DAMAGE IN NAVY PERSONNEL EXPOSED TO IONIZING RADIATION IN THE LINE OF DUTY

W.H. ELLETT, Oregon State University, Radiation Center, *Corvallis, Oregon* 97331 (N00014-67-0369-0006)

Technical Objective: Measure the local energy distribution and event distribution of individual gamma rays and other ioniz-

ing radiation in microscopic volumes of tissue. The emphasis will be placed on evaluation of individual ionizing events which destroy or disrupt cell function and which are encountered by naval personnel during normal and accidental exposure to ionizing radiation.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0914, REMOVAL OF AM-241 FROM HUMANS WITH DTPA

A. BRODSKY, Univ. of Pittsburgh, School of Public Health, *Pittsburgh, Pennsylvania* 15213

The main objectives of this project continue into the fourth year to be aimed at improved understanding and quantitative description of the removal by chelation therapy of americium and plutonium from human cases under treatment. Results already obtained should lead to recommendations for improved treatment for removal of plutonium and transplutonium radionuclides, which are potentially carcinogenic when retained in the body for long periods of time. The studies in this project are particularly focused on an individual who worked with and inhaled americium oxide (Am_2O_3) prior to May, 1967, supplemented by data from other cases, in which both plutonium and americium were taken into the body. In May, 1967, this individual was found by in vivo scintillation counting to have a body burden of about 1.8 microcuries of Am-241, about 1 microcurie of which had already translocated to bone. Measurements of radioactivity in the whole body, body compartments, excreta, and blood showed that infusions of 1 gram DTPA per week were successful in removing more than half the initial body burden during the first two years following treatment. Radioactivity was removed most rapidly from soft tissues, particularly liver, once DTPA infusion was begun in September, 1967. Periods with changed treatment schedules indicate that 1 gram DTPA per week is (after 3-1/2 years) still enhancing the removal rate to about 5 times above that without treatment. Methods for separating chelated from unchelated americium in urine, and summaries of results obtained so far, are in publication. Further studies will aim at elucidating mechanisms of removal of americium and plutonium and development of quantitative models for purposes of risk estimation and treatment planning.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0915, ELECTROMAGNETIC POWER ABSORPTION MEASUREMENTS FOR RADAR HAZARDS ASSESSMENT AD SURVEILLANCE SYSTEMS

A.R. KALL, A.R.K. Corporation, *Willow Grove, Pennsylvania* 19090 (F41609-70-C-0031)

Technical Objective: The USAF requires information on power absorbed by man exposed to radiofrequency fields to determine safety/hazard levels and to develop airborne surveillance systems. Power absorbed from radiofrequency (RF) fields by mongrel dogs in the frequency ranges 0.5 - 30 MHZ and 3 - 12 GHZ will be measured in such a manner that conversion efficiencies to infrared radiation (IR) from the surface of the animal can be determined. The spectral distribution of the infrared energy radiated from the animal in the 2 - 20 micron band is to be determined with each exciting radiofrequency.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0916, RADIATION DETECTORS FOR USE IN NUCLEAR/CRITICALITY ACCIDENT DOSIMETRY

R. SIWICKI, Inst. of Nuclear Research, *Otwock Swierk, Poland*

For work under risk of criticality an individual activation dosimeter was elaborated to enable rapid selection of the exposed individuals and preliminary dose estimation. The procedure is a laboratory one, and is not in routine use.

Systematic work will be carried out with a view to extend the range of methods in routine use: a) luminescent detectors, b) set of activation detectors for various neutron energy ranges, and c) measurements of biological material (i.e., sodium and sulphur activity). A trial will be made of accident dose assessment by evaluation of routinely used personnel dosimeters.

Methods of neutron dose determination by use of particle track detectors: a) neutron fluence measurement in various energy range, using particle track detectors in contact with fissionable materials, and b) use of atom recoil tracks in polymer foil material for neutron detection. The determination of the detection sensitivity. Preliminary analysis of possible leakage - spectra around water - water reactor and graphite critical assembly.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0917, HAIR AS A MEASURE OF INTERNAL CONTAMINATION WITH RADIONUCLIDES

M. KOPEC, Polish Academy of Sciences, *Warsaw, Poland*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0918, USE OF BINUCLEATE LYMPHOCYTES AS BIOLOGICAL DOSIMETERS

N. RACOVEANU, Inst. De Igiena Protec. Munch, *Bucharest, Rumania*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0919, ULTRA LOW LEVEL RADIONUCLIDE ANALYSIS

A.L. BONI, U.S. Atomic Energy Commission, Savannah River Plant & Labs., *Aiken, South Carolina* 29801

The objective of this program is to develop and use ultra low level methods for measurement of trace radioactive and associated nonradioactive materials in the environment of Atomic Energy facilities. The program includes research and development in: 1. Low level counting systems including computer-based programable gamma spectrometry, coordinated high resolution low background (Ge(Li)-NaI) detector systems, high resolution alpha spectrometry, and portable gamma spectrometry for field use. 2. Concentration and separation of radionuclides and trace elements from large volumes of river and ocean water using ion exchange and extraction systems. 3. Gas chromatographic separation and identification of radioactive and nonradioactive organic compounds in liquid effluents. 4. Use of atomic absorption to measure stable elements associated with their radioactive isotopes in environmental samples.

Results to date include establisnment of an ultra low level counting facility with low background counting chambers, on-line digital computer and high resolution, high efficiency, low background detector systems. Basic methods for the concentration of trace radionuclides from large volumes of water have been developed. Preliminary instrumental capabilities for their identification and quantitative measurement have been established.

SUPPORTED BY U.S. Atomic Energy Commission

5.0920, STUDIES IN IODINE METABOLISM

L. VANMIDDLESWORT, Univ. of Tennessee, School of Medicine, *Memphis, Tennessee* 38103 (AT-(40-1)-1643)

We will attempt to identify the iodinated compounds and their rates of turnover in normal and intensely stimulated thyroids of rats and hamsters. Preliminary data suggest that in rats fed a low iodine diet 20-30% of the thyroglobulin has a half-life of 1 to 2 hours. Animals will be used after equilibration of I127 and I125.

Endogenous SCN ion may partially regulate the availibility of iodine to the thyroid and we will measure the alterations in iodinated thyroidal proteins produced by the presence of SCN ion.

The intestinal contents of rats will be examined by paper chromatography to determine the break-down products of biliary thyroxine conjugates. We have shown that thyroxine is absorbed less readily than triiodothyronine and we will search for triiodothyronine production in the intestine.

The I131 from fall-out will be measured each week in animal thyroids from all continents except Africa. This simple procedure

is still an excellent index of biological contamination by fission products.

In rats fed low iodine diets, 20-30% of the thyroidal thyroglobulin has a half-life of 1 to 2 hours; 60% is insoluble and has a much longer half-life. 1% has a half-life longer than 60 days. The distribution of the slowest components has been demonstrated by radioautographs. Preliminary data suggest that SCN ion feeding will increase the quantity of iodine in the pool with the longest half-life.

Radioiodine fall-out has been measured in more that 60,000 animal thyroids during the past 16 years and the data published every 2 to 3 years.

SUPPORTED BY U.S. Atomic Energy Commission

5.0921, BIOLOGICALLY ORIENTED ORGANIC SULFUR CHEMISTRY

L. FIELD, Vanderbilt University, School of Arts, *Nashville, Tennessee* 37203

The chemistry of organic sulfur compounds is being studied, with emphasis on biological relevance. Substances being studied include thiols, aminothiols, sulfenyl derivatives especially iodides, thiolactones, disulfides, and collagen. Biological applications planned, and the relevant chemistry, are as follows: (a) Arthritis - Structural features of penicillamine involved in its diminution of the rheumatoid factor and reduction of rat skin tension are being studied. Mechanisms of these effects also are to receive attention. More effective counterparts of penicillamine will be sought using both derivatives and other thiols. (b) Sulfenyl Derivatives Related to Thyroid Function - Model compounds are being investigated in the hope of understanding the stability and reactions of protein-sulfenyl compounds (i.e. RSX), the nature of RSX reactions with antithyroid substances, possible correlations of antithyroid activity with either reactivity of the agents (to RSX) or stability of the products (RSSR'), and whether RSX can effect substitution of phenols. (c) Histoplasmosis - Numerous classes of sulfur compounds are being screened against H. capsulatum. Emphasis presently is on the chemistry and screening of acyl and related disulfides. (d) Disulfide Linkages - The chemistry will be studied of insertion and multiple-bond reactions with disulfides, of oxidation, of small-ring disulfides, and of unsymmetrical disulfides. In all parts, (a)-(d), appropriate products also are being tested as potential antiradiation drugs.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0922, CLINICAL AND HEMATOLOGIC STUDIES OF IRRADIATION - CLINICAL AND LABORATORY CHANGES AFTER TOTAL-BODY IRRADIATION

C.L. EDWARDS, Oak Ridge Associated Univs., *Oak Ridge, Tennessee* 37830 (AT-(49-1)-GEN-33)

This study is directed at developing better methods of total-body irradiation therapy and for assessing and treating accidental radiation injury. Coincidentally important information is obtained to more precisely define man's response to radiation at different dose rates. Some patients with chronic malignant disorders such as chronic leukemia and lymphomas are treated with whole-body irradiation exposure of 50 to 250 R at a dose rate of 1.5 R per minute (METBI), either as a single acute exposure or in daily exposures of 30 R. Others are treated with 100 to 250 R at 1.5 per hour (LETBI).

Results: Patients exposed to the lower exposure rate radiation (LETBI) had fewer gastrointestinal symptoms than those treated with 1.5 R/min (METBI) whether as a single acute exposure or fractionated into 30 R exposures daily. There appears to be a decided dose-rate effect when comparing the hematologic response of patients with chronic granulocytic leukemic to exposure of 100 R in LETBI compared with 50 R and 100 R exposures in METBI.

SUPPORTED BY U.S. Atomic Energy Commission

5.0923, NUCLEAR MEDICINE AND SCANNING - INSTRUMENTATION

A.C. MORRIS, Oak Ridge Associated Univs., *Oak Ridge, Tennessee* 37830 (AT-(40-1)-GEN-33)

The primary objective of this project is to provide the necessary engineering services and facilities for producing special electronic instruments needed in the Medical Division's clinical and research programs. The new devices are used to locate and measure radioactivity in patients, to monitor the physiologic variables of patients receiving total-body irradiation, and to interface remote instruments to an on- line computer. Current areas of interest include the computer analysis of radionuclide measurements and scans, computer interfacing of a gamma- ray camera system for improved analysis and read-out capabilities, an improved instrument for measuring red-cell fragility, a physiologic monitoring system for measuring radiation effects, and the development of a low-noise preamplifier for red-cell sizing studies.

Secondarily, our project maintains the large variety and number of electronic instruments used at the Medical Division.

Results: Constructed and Operating: whole-body counters (2), physiologic monitoring system, cell-sizing preamplifier, scintillation counter interface to computer 4 miles away, Analytrol densitometer interface to computer, scintillation scan color-recording rescanner, linear scanner, and an improved whole-body scanner.

SUPPORTED BY U.S. Atomic Energy Commission

5.0924, RADIATION DOSIMETRY RESEARCH

J.A. AUXIER, U.S. Atomic Energy Commission, Health Physics Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

The development of dosimetry theories, systems, and techniques for describing the radiation fields in which human exposures have occurred or might occur provides the general objective of this research. Efforts are made specifically to correlate the radiation field with observed biological effect. Theories and calculation are being tested with experiments to determine the dose and the recoil particle energy distributions within tissue equivalent phantoms irradiated by neutrons and gamma rays. With these studies and the refined estimates of air dose in Hiroshima and Nagasaki, it is possible to compute the dose for survivors in utero. Much emphasis is placed on the development of solid state detector systems. In particular, research is directed toward the use of polyester materials for the registration of alpha particles, heavy ions, and fission fragments, and toward the development of better compounds for use in thermally stimulated exoelectron emission studies. Spectrometry research countinues to play a large role in the overall program. Organic scintillators are being purified by zone refining techniques in order to improve the light output of the crystals and to provide good material with which to grow large crystals.

Results: On the basis of medical records of the Atomic Bomb Casualty Commission, the RBE of neutrons for inducing leukemia has been determined based on the current knowledge of the neutron and gamma air dose in both Hiroshima and Nagasaki. Calculations of depth dose and LET distributions in tissue equivalent phantoms were extended to study the dispersion of collimated, incident monoenergetic neutron beams within a cylindrical phantom, and for implanted Cf252 sources. Extensive measurements of neutron and gamma dose have been made near tissue bone interfaces in a tissue equivalent phantom when irradiated with fission neutrons. A very sensitive solid state dosimeter has been developed.

SUPPORTED BY U.S. Atomic Energy Commission

5.0925, HEALTH PHYSICS RESEARCH REACTOR AND MONOENERGETIC RADIATIONS FACILITY

J.A. AUXIER, U.S. Atomic Energy Commission, Health Physics Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

The Health Physics Research Reactor (HPRR) and its related facilities provide a versatile and efficient irradiation center in which dosimetry research and radiobiological research are conducted to the best advantage of each. A dose rate range of approximately 12 orders of magnitude without a change in spectrum or neutron-to-gamma radiation dose ratios is the major advantage of the HPRR. The experimental program covers areas in radiology in addition to the research in dosimetry, radiation physics, and shielding.

5. RADIATION

The major effort in the future will be directed toward more comprehensive documentation of dose and spectrum profiles throughout the exposure for a variety of experimental configurations so that preparation and experimental time for experiments can be shortened. Reactor power and neutron dose rate normalization techniques will be improved for more efficient operation.

The ORNL 3 MV Van de Graaff Facility has been obtained for dosimetry research, stopping power measurements, LET studies, and dosimeter development and evaluation.

Results: Each year, the HPRR is used to implement the experimental programs of about 20 organizations ranging from national laboratories to universities, in addition to its primary role in the ORNL Health Physics Division. Increased emphasis in the area of nuclear accident dosimetry has led to greater confidence in the average laboratory's ability to handle dosimetry of criticalities. Biomedical and health physics research has continued to increase as has the percentage of total irradiations utilizing the pulse mode.

SUPPORTED BY U.S. Atomic Energy Commission

5.0926, RADIOLOGICAL AND HEALTH PHYSICS INFORMATION CENTER FOR INTERNAL EXPOSURE

S.R. BERNARD, U.S. Atomic Energy Commission, Health Physics Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

The Center attempts to index under appropriate key words the significant data relevant to estimation of absorbed dose from radionuclides taken into the body. Included are purely physical data on decay schemes and absorbed fractions of photon energy for body organs, as well as shape, size, density, and elemental composition of organs of the body. Data are accumulated on uptake and residence times in various organs. To be applicable to man, the data on experimental animals require critical review and extrapolation, and this is done to a limited extent.

Results: Over 6600 reports are entered in the system and are indexed by some 1000 key woords.

SUPPORTED BY U.S. Atomic Energy Commission

5.0927, HUMAN CHROMOSOME ABERRATION YIELDS FOLLOWING CHRONIC RADIATION EXPOSURES

J.G. BREWEN, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

Human peripheral lymphocytes are being irradiated with Cs137 gamma rays over periods of time up to 72 hours. The doses employed range from 100-500 rads. The purpose of the experiments is to ascertain, as accurately as possible, the precise hazard to human somatic chromosomes from chronic radiation exposures. Exposure time will be increased until the yield of chromosome aberrations per unit dose no longer decreases significantly. Dose response curves will then be done at these exposure times and coefficients of aberration production calculated. From these coefficients it will be possible to make estimates of the abberration yields expected from very low chronic doses.

Results: Lymphocytes have been exposed to 200 rads over periods up to 24 hours. The yield of aberrations observed after a 24 hour exposure is only 25 per cent of the yield when the same dose is given in 3 to 60 minutes. Preliminary data on a dose response curve with a 24 hour exposure indicate the yield increases predominantly linearly with dose with a small two-track contribution.

SUPPORTED BY U.S. Atomic Energy Commission

5.0928, COMPARATIVE IN VIVO - IN VITRO RADIOSENSITIVITY OF MAMMALIAN PERIPHERAL LYMPHOCYTES

J.G. BREWEN, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

Chromosome aberrations induced by acute radiation exposures to marmoset peripheral lymphocytes are being studied. The radiation exposures are given to the cells after blood is withdrawn from the animal and the animals, themselves, are given whole body exposures following which blood is drawn. The irradiated animals will be monitored for over a year in order to study the kinetics of aberration loss. These studies will finally answer the question of whether cells in the living animal have a different radiosensitivity than cells in tissue culture.

Results: Sufficient 'in vitro' data has been collected to construct a dose response curve. The shape of the curve follows predominantly dose- square kinetics and the yields of aberration production are not significantly different from those obtained when human cells are irradiated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0929, DUAL PURPOSE BLAST SHELTERS IN URBAN TRANSPORTATION SYSTEMS

G.A. CRISTY, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

To develop information on the possible exploitation of major urban development and redevelopment projects on civil defense blast shelters with particular emphasis on underground transportation projects. The information developed will be limited to the 54 SMSAs having more than one-half million persons in the 1960 census and will generally be projected through the 1970-80 time frame. Projected data will also be developed for the number of freeway interchanges planned for these same SMSAs which could be used to incorporate blast shelters. The kind of information to be gathered includes: size and shape of the underground spaces which would be usable as shelters with some attempt to estimate shelter hardness. Comparison of the value of the space potential in these structures will be obtained by comparing the amount of space already available in the same area and by comparing the total number of such spaces with the population in each of five types of areas within each SMSA.

Results: Data has been received and processed for 31 of the 54 SMSAs. A progress report has been issued on the 31 cities. A total of over 5 million potential new blast shelter spaces were located and compared with the population within five area classifications. This compares with nearly 9 million PV-71-81 shelter spaces in the 100 largest SMSAs.

SUPPORTED BY U.S. Atomic Energy Commission

5.0930, RBE OF 60 MEV-PROTONS FOR LATE SOMATIC EFFECTS IN MICE

E.B. DARDEN, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

This is a joint AEC-NASA project set up to study RBE of protons with energies comparable to those found in proton spectra in space, particularly in solar proton events. Approximately 3200 8-week-old female RF mice were irradiated in replicates with single whole-body doses of either 60-MeV protons in the Oak Ridge Isochronous Cyclotron or with 300 kVp X rays. Thirty-day survivors were observed for late somatic effects. A complete necropsy, including cranial contents was performed on dead and moribund animals, and in two hundreds or more tissues obtained for histologic purposes with the intention of making a thorough study of the pathology.

Results: Preliminary results on all major portions of the work are available and suggest that the RBE of 60-MeV protons for life shortening, cataractogenesis, increase in body weight, and oncogenic effects is not greatly different from one, and probably a little less in most instances, in agreement with published findings on acute effects of the same radiation in these animals.

SUPPORTED BY U.S. Atomic Energy Commission

5.0931, CHEMICAL PROTECTION AGAINST IONIZING RADIATION

D.G. DOHERTY, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

The objectives of this program are to develop improved compounds to protect mammals against the damaging effects of ionizing radiation, improve assay systems for their evaluation and investigate their mechanisms of action. The problem of providing chemical protection to mammals against ionizing radiation has been intensively studied over the past 20 years and it has been

firmly established that prior chemical treatment can, in some fashion, reduce radiation damage in both 'in vitro' and 'in vivo' biological systems (mammals, bacteria, phage, DNA, enzyme systems). The radiation dose reduction factor has been raised from slightly better than one to nearly three, broad outlines for structures necessary for protective activity defined and several hypotheses as to their mechanism of action developed. However, the effective compounds in animals suffer some deficiencies such as low therapeutic index, low activity requiring a large dose for effective protection and restricted routes of administration. We propose to utilize and build on this acquired knowledge to develop more effective compounds, and study their modes of action both singly and in combination with other effective treatments such as post radiation bone marrow transplantation. The animal used will be the mouse and its three most important systems: bone marrow, intestinal and immune responses.

Results: We have extended our quantitative marrow cell response study to allogeneic and xenogeneic situations. Allogeneic marrow gave a triphasic response similar to syngeneic with an LD 50 200 r lower. Chimaerism was dependent on both cell and radiation dose. Xenogeneic required large cell doses and gave poor long term survival. With L. H. Smith we have developed an 'in vitro' bone marrow assay system for protective compounds which has the virtues of being relevant to the animals' survival, less complex and dependent on toxicity and easier to interpret mechanistically.

SUPPORTED BY U.S. Atomic Energy Commission

5.0932, CIVIL DEFENSE IN THE SOVIET UNION

J.S. GAILAR, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

Objective: To investigate Soviet civil defense in all its aspects, largely through a thorough survey of the Soviet unclassified literature on the subject, to include, for example: (1) Aims and goals of Soviet civil defense, (2) Methods for reaching these objectives, (3) Extent to which implementation has taken place, (4) Nature and scope of the present program, (5) Degree to which civil defense is endorsed by Government and Party leaders, (6) Organization and administration of the program, (7) Education and training of the population, (8) Methods of warning the population, (9) Shelter construction, (10) Individual means of protection (such as gas masks and protective clothing), (11) Evacuation procedures, (12) Rural civil defense, (13) Drills and exercises, (14) Measures to protect essential industries, transportation, communication, power supplies, (15) Rescue and repair operations in stricken areas, (16) First aid measures for the injured, and (17) Means to prevent panic.

Results: A view of over 100 articles on Soviet civil defense indicates: Mandates from both Party and Government in recent years to strengthen civil defense have led to a substantial civil defense program with emphasis on the protection of essential workers by means of shelters and dispersal, and evacuation of everybody else to the country with provision of fallout protection. Some shelters have already been built in and near plants, and plans for evacuation are both elaborate and detailed. Civil defense instruction is compulsory and widespread with about 100 million Soviet citizens having received formal civil defense training. Manuals such as a 341-page rural CD handbook attest to the comprehensiveness of the program.

SUPPORTED BY U.S Atomic Energy Commission

5.0933, LET DISTRIBUTIONS OF IONIZING RADIATION

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The biological effect of the absorption, in tissue, of a given amount of energy as generally assumed to be related to the linear energy transfer (LET) of the radiation. Consequently, for several years there has been an interest in developing an instrument by which the LET distribution of the radiation can be determined. Spherical proportional counters have been used in the past for this purpose, but the sphere is a particularly inconvenient geometry to use. A study of this problem has been undertaken in order to determine a more convenient and more reliable means for determining LET distributions of ionizing radiation. Monte-Carlo methods are being used to permit LET distributions to be determined from pulse height measurements made with counters of arbitrary geometries and also to allow other factors, such as angular distributions of the incident particles, to be taken into account. This work will permit the use of less expensive, more accurate, and easier to use equipment for monitoring purposes.

Results: Monte-Carlo calculations of the track length distributions of ionizing radiation in cavities of various shapes have been made. A Monte-Carlo method of unfolding LET spectra from pulse-height measurements made with energy proportional counters of various geometries has been developed. Good agreement has been obtained between spectra measured with both cylindrical and Rossi spherical counters.

SUPPORTED BY U.S. Atomic Energy Commission

5.0934, HASTY RURAL SHELTERS AND IMPROVISED LIFE-SUPPORT EQUIPMENT

C.H. KEARNY, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

Objective is to design, build, and evaluate improved hasty shelters (that average rural Americans can build for themselves during an escalating crisis in 48 hrs. or less, that have radiation protection factors of at least 1,000, and that are capable of withstanding blast overpressure up to 10 psi) and also improvised life-support equipment needed by shelter occupants--including improvised shelter ventilating devices, a fallout monitoring instrument, lights, sleeping equipment, a bailing pump, etc. Because rural Americans today lack such knowhow in keeping with the dangers many of them would face (if a massive nuclear attack occurs, even as early as 1970), this updated civil defense knowledge is needed.

We are securing this practical knowledge by first designing and building several versions of each needed item, then having it built for several months of preliminary evaluation, then writing simple illustrated instructions to enable an average rural American family to build the most promising design, then having typical rural families build the item, instructed only by these written instructions. Thus the practicality of the design, the average man-hours of construction time, etc, are determined--always tied in with the abilities and tools of typical rural Americans and the availability of very common building materials. Field work to date has been confined to rural areas of Eastern Tennessee.

Results: Results to date include: (1) Invention of a shelter-ventilating device capable of pumping 500cfm through a typical fallout shelter, yet requiring only 0.05 hp. This is called the 'Kearny Ventilator' by OCD and the Army; military specifications have been approved and distributed, (2) Design and preliminary testing of improved trench shelters, lights, a bailing pump, a '15 cent' electrostatic monitoring instrument, and shelter furnishings.

SUPPORTED BY U.S. Atomic Energy Commission

5.0935, RADIATION-INDUCED MUTATIONS IN MICE

W.L. RUSSELL, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

The objective of this program is the exploration of the basic principles of radiation genetics in the mouse which will help in the evaluation of the genetic hazards of radiation in man. Estimation of these hazards, originally derived from work with 'Drosophila', is now based largely on the experimental findings with mice. This change in evaluation of risks was not merely a substitution of one set of quantitative values for another, it also involved major discoveries at the basic level. Perhaps the most important of these was the finding, from dose-rate studies, that repair of genetic damage can occur when the radiation dose is spread out in time. The discovery of this effect and its subsequent extensive exploration were made using the specific locus method for detecting gene mutations.

The current work is concentrating on an entirely different class of genetic damage, namely, chromosomal aberrations, in order to see if these follow the same pattern of repair. The particular aberration chosen for study, as an example of this class, is X-chromosome loss, which, in man, is the cause of the abnormality known as Turner's syndrome.

Results: Incidence of X-chromosome loss are being scored in the offspring of female mice exposed either to 400R of X rays, at approximately 80R/min, or to 400R of gamma radiation, at approximately 0.6 R/min, from a Cs137 source. The frequency at the low dose rate is significantly below that at the high dose rate, the current ratio being about 0.4. Thus, it would appear that the genetic hazard from this type of chromosomal aberration, like that from gene mutations, will be less at a low dose rate then at a high one.

SUPPORTED BY U.S. Atomic Energy Commission

5.0936, A COMPUTER METHOD FOR ANALYSIS OF DATA ON MOUSE REPRODUCTION

L.J. SERRANO, U.S. Atomic Energy Commission, Biology Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

Objective: To develop a system using a computer to simplify analysis of data on productivity resulting from the operation of a breeder colony or from studies using reproduction as an experimental variable.

Reason: Although reproduction is a commonly used experimental variable in many fields of biology, few experiments can be compared satisfactorily. Although variables that influence fertility in the mouse may be similar to those affecting human fertility data on the biology of reproduction from breeding colonies are infrequently used. This is in part due to the complexity of reproduction, large amount of data usually collected, and the great number of calculations necessary to analyze the data.

Procedure: Utilizing our computer technology resources, we have developed a system for arraying the data in tables that facilitate analysis and permit correlations, groupings, and comparison of data that might not otherwise be feasible.

Test Object: Information from the large breeding colony in a low level radiation experiment and several reproduction experiments will provide the data base.

Results: Computer-prepared analyses have been compared with manually prepared analyses to test the accuracy and cost of the system. The computer system was found to be more accurate, much less expensive, and allows more extensive use of available data.

SUPPORTED BY U.S. Atomic Energy Commission

5.0937, RADIOLOGICAL AND HEALTH PHYSICS - ESTIMATION OF INTERNAL EXPOSURE

W.S. SNYDER, U.S. Atomic Energy Commission, Health Physics Division, *Oak Ridge, Tennessee* 37830 (W-7405-ENG-26)

Estimates of absorbed dose to body organs following intake by inhalation or ingestion are being developed. The studies supply estimates for consideration of committees of the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP) with a view to revision of their recommendations on internal exposure. Procedures are available for estimating dose to lung or to the gastrointestinal tract on the basis of the ICRP lung model ("Health Phys. 12, 173, 1966"). Estimates of dose to bone and bone marrow are under development using the methods of Spiers.

Results: Special studies now substantially complete provide for estimation of dose to red bone marrow for photon emitters and to the bladder wall from radionuclides in urine. The dose distribution in the body from a large 'cloud' of a photon emitter (radioactive gas) is partially complete, and dose from beta emitters is in hand. Dose estimates for a number of radionuclides are in advanced stages of completion; these include tritium, the iodines, cesium, strontium, radium and plutonium.

SUPPORTED BY U.S. Atomic Energy Commission

5.0938, GENERAL CONCEPTS IN RADIATION DOSIMETRY. RESEARCH PROGRAMME ON BIOPHYSICAL ASPECTS OF RADIATION QUALITY

J. TURNER, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0939, THEORETICAL RADIATION DOSIMETRY

H.A. WRIGHT, U.S. Atomic Energy Commission, Oak Ridge National Lab., *Oak Ridge, Tennessee* 37831 (W-7405-ENG-26)

An understanding of the various interactions that high energy particles (e.g., protons, neutrons, and pions) undergo with matter and, particularly, with tissue, is essential in assessing the hazards from these radiations. Detailed Monte-Carlo calculations, taking into account these interactions, are made in order to determine the spatial distribution of the absorbed energy as well as the relative contribution to the absorbed dose from various physical processes. The general concept of radiation dose is under study in order to try to understand the extent to which the purely physical properties of radiation are responsible for its biological effectiveness. Joint work with the Health Physics Group at CERN (European Organization for Nuclear Research) Geneva, Switzerland, is in progress on research problems in the dosimetry of high-energy pions and nucleons and one member of the staff is in Geneva this year. Calculations are made and the results compared with experimental measurements made with beams of pions and nucleons from the CERN accelerators.

Results: An initial study has been made in collaboration with the experimental Health Physics Group at CERN, Geneva, Switzerland, of the absorbed dose in tissue equivalent material due to beams of postive and negative pions. A new 'free-nucleon' model, which neglects the effects of nuclear structure and nuclear binding by considering the nucleons of the target material to be free, initially at rest, and uniformly distributed throughout the medium, has been used to calculate absorbed dose as a function of depth on a tissue slab.

SUPPORTED BY U.S. Atomic Energy Commission

5.0940, NUCLEAR SAFETY INFORMATION CENTER

F.A. GIFFORD, U.S. Dept. of Commerce, Air Reso. Atm. Turb. Dif. Lab., *Oak Ridge, Tennessee* 37830 (AT(40-1))

Objective: To provide the meteorological input to the Nuclear Safety Information Center (NSIC), which serves as the focal point for the collection, storage, evaluation, and dissemination of nuclear safety information. Provide consultant service to the Atomic Energy Commission and its contractors on specific questions, including air pollution, radiation protection, nuclear accidents, reactor hazards, and environmental quality. Prepare summary and state-of-the-art reports on these functions.

Procedure: Continuing review and abstracting of articles for the computer files of NSIC, and continuing preparation of reports and studies as required.

Results: Abstracting of meteorological articles averages 30 per month. Specific questions requiring a meteorological search average several per month.

SUPPORTED BY U.S. Atomic Energy Commission

5.0941, CORRELATION OF DEPTH DOSE DISTRIBUTION PATTERNS WITH BIOLOGICAL EFFECTS IN SWINE FOR CO-60 GAMMA RAYS, 14 MEV NEUTRONS AND FISSION NEUTRONS

L. WADE, Univ. of Tennessee, U.T. A.E.C. Agric. Res. Lab., *Oak Ridge, Tennessee* 37830 (AT-40-1-GEN-242)

There is at present, little or no information available on the relative biological effectiveness of gamma rays and neutrons in producing radiation damage to large animals. Research in this area has been hampered in part by the difficulties involved with determining the neutron dose to a specific target organ in a large animal.

Depth dose distribution patterns will be calculated by computer for each type of radiation and correlated with specific quantitative biological end points in swine which have already been irradiated at the VDRIF, the HPRR, and Project HENRE.

Results: Depth dose distributions were calculated by personnel at Health Physics Division, ORNL, for swine exposed to 14 MeV neutrons or a mixed fission neutron - gamma field. The

depth dose distribution for Co60 gamma irradiation was obtained by measurements with radiophotoluminescent glass rod dosimeters. An RBE of approximately 0.5 was calculated for fission neutrons and 14 MeV neutrons. Calculations were made of the dose delivered to the gastro-intestinal tract and bone marrow for each type of radiation field.

SUPPORTED BY U.S. Atomic Energy Commission

5.0942, DOSIMETRY DEVELOPMENT TO SUPPORT CREW PERFORMANCE DECREMENT-SURVIVABILITY/VULNERABILITY STUDIES

J.B. ASHE, Nuclear Chicago Corporation, *Austin, Texas* 78756 (F41609-71-C-0013)

Technical Objective: Meaningful interpretation of biological response in S/V (survivability/vulnerability) performance decrement studies is dependent on accurate calibration and assessment of the radiation exposures. The primary objective of this effort is to develop guard ring ion chambers to be used as secondary standards to calibrate dosimetry measurements made in support of S/V performance decrement studies.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0943, WHOLE BODY RETENTION AND DISTRIBUTION MEASUREMENT OF RADIOISOTOPES IN MAN

F.J. PIRCHER, U.S. Veterans Administration, Hospital, *Houston, Texas* 77031

Results and conclusions: The following work was carried out: (1) Determination of sensitivity and resolution of the instrument through the measurement of LSF and through scanning of a slanted cylinder using a 19-hole 3-inch focused collimator and a 43-hole 5-inch focused collimator. (2) Measurements of systems dead time and derivation of correction factors. (3) Systematized phantom work using sources of 2- 1000 cc of volume containing CO-57, I-131, and Sr-85 to determine the effect of source-volume, activity, and geometry on counts per microcurie. (4) Determination of transmission co-efficients for Co-57, I-131, and Sr-85 using the systematized phantom and human subjects. (5) Further editing and modifications of the computer program.

The results indicate that the instrumental set-up and the computer program are such that it has become possible with the arrival of a large-sized table a few days ago to obtain good approximations of the actual distribution and retention of radioisotopes in men through in vivo measurements. This will provide useful information for clinical diagnosis, for dosimetry of internal radiation, for evaluation of radiopharmaceuticals and of accidental exposures to internal emitters.

Plans for future: Completion of the systematized phantom work, initiation of measurements with the Alderson phantom and resumption of the in vivo measurements in normal subjects and in patients receiving nuclides and/or labeled compounds for medical purposes.

SUPPORTED BY U.S. Veterans Administration

5.0944, SPECTRAL MEASUREMENT OF NUCLEAR THERMAL OUTPUT FOR HAZARD PREDICTION

R.V. BARTHOLOMEW, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Techical Objective: Efforts to predict eye safe separation distances from nuclear detonations for aircrews are handicapped by a lack of data concerning the spectral thermal emissions of nuclear detonations. The objective of this effort is to design and develop instrumentation suitable for laboratory and field test thermal measurements. The instrumentation will be applicable to the problem of testing eye protective devices and quantitatively documenting the thermal emission characteristics of nuclear detonations for theoretical model verification.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0945, PERSONNEL EXPOSURE CRITERIA FOR OPERATIONAL RADIOFREQUENCY RADIATION ENVIRONMENTS

C.H. BONNEY, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: The primary objective is to establish appropriate personnel exposure criteria for operational radiofrequency radiation environments, current exposure guidelines as defined in AFM 161-7 and T.O. 31Z-10-4 are not adequate for many operational situations. The results of this work will be used as the biomedical data base to establish both normal and emergency exposure limits for specific operational situations. These data are needed to support site selections and site layout and to establish shielding requirements and operational maintenance procedures for systems such as the over- the- horizon (OTH) radar for CONUS defense.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0946, OPERATIONAL SAFETY CRITERIA FOR LONG TIME EXPOSURE TO LASER RADIATION

R.W. EBBERS, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

Technical Objective: To establish the ocular damage threshold for long time exposure (less than 1 sec.) to a Helium-Neon Laser (632.8 nm.) to determine safety criteria for Air Force Operational Laser Systems. Additionally, data will be useful in developing theoretical models of damage mechanism in the eye.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0947, P-N JUNCTION DIODE DOSIMETRY WITH TEMPERATURE COMPENSATION

L.H. DEITERMAN, U.S. Veterans Administration, Center, *Temple, Texas* 76501

At this time essentially all of the goals as stated in the original protocol for this project have been accomplished. We have studied in detail the temperature dependence of the radiation induced photocurrent and photovoltage for both silicon P-N Junction diode and gold barrrier diodes. We have developed two different methods of overcoming this temperature dependence. They are: a) Thermistor compensation of the d.c. gain of the preamplifier. b) Load impedance compensation of each diode in photocurrent mode.

We routinely use these diodes as radiation detectors for high energy (E greater than 1 MEV) gamma rays and x-rays. In fact, we have been contacted by the Texas Regional Medical Physicists organization located at M.D. Anderson Hospital, Houston, Texas, concerning the routine use of these detectors to map all megavoltage radiation fields in preparation for computer dosimetry of X-ray therapy treatment planning.

The larger sensitive volumes provided by the gold barrier type of detector allows their use in radiation fields below one rad per minute. This added sensitivity is needed to measure the dose distribution around radium implants, cobalt-60 wire implants, etc.

We have constructed several of these P-N junction diode probes and by eliminating the effect of diode temperature we have a radiation detector which can be used in many environments in which heretofore their use was impossible.

SUPPORTED BY U.S. Veterans Administration

5.0948, PREDICTION OF AIRCREW PERFORMANCE BY PSYCHOPHYSIOLOGICAL MONITORING

W.D. THOMPSON, Baylor University, School of Arts, *Waco, Texas* 76703 (F41609-70-C-0020)

Technical Objective: Man's vulnerability to nuclear stresses is expected to vary between individuals and this supposition has been demonstrated in experiments with trained primates. Current Air Force survivability estimates are based on averaged animal response. There is a need to be able to predict degree of radiation vulnerability on an individual basis to improve accuracy of mission completion estimates. The effort described herein attempts

to determine a predictable relationship between performance and basic psychophysiologic responses conducive to rapid and reliable evaluation in an operational environment.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0949, DEVELOPMENT OF PROCEDURES (METHODOLOGY) OF DETERMINATION OF NATURAL URANIUM IN DIFFERENT BODY ORGANS

N. DRAZNIN, Byelorussian Acad. of Sciences, *Minsk, Union of Soviet Soc. Republics*

Development of procedures (methodology) of determination of natural uranium in different body organs (part of a coordinated programme on determination and assessment of plutonium and uranium body burdens in man).

SUPPORTED BY Intl. Atomic Energy Agency - Austria

5.0950, RADIATION SAFETY COMMITTEE (U-109)

J.O. JENSEN, Utah State University, Agricultural Experiment Sta., *Logan, Utah* 84321 (UTA00557)

OBJECTIVE: Oversee all work, research or teaching, involving ionizing radiations whether these arise from radioactive isotopes or X- ray machines. The Committee is concerned that these operations are carried out with safety to the operators, students, and the general public, and that they are in compliance with safety rules established by the U.S. government.

APPROACH: Periodic surveys will be made of laboratories in which ionizing radiation is used. This includes about ten laboratories using radioactive isotopes, three laboratories using X-ray eqpupment, and two laboratories using neutron moisture meters. In some of these the primary use of isotopes in in research and graduate instruction, while in other the primary use if in formal course work. Monthly film badge service in also provided to the laboratories as needed

PROGRESS: All project leaders and instructors who use sources of ionizing radiations file a description of their experiments with the committee. The committee may require a preliminary 'dry run' of the proposed experiment under the supervision of its representative, the Radiological Safety Officer, who may suggest safety precautions. The Radiological Safety Officer also makes periodic surveys of laboratories for radiosotope contamination and supervises the film badge service. Periodic surveys are made of laboratories in which ionizing radiation has been used. This includes about ten laboratories using radioactive isotopes, three laboratories using X-ray equipment, and three laboratories using neutron moisture meters. In some of these the primary use of isotopes is in research and graduate instructions, while in others the primary use is in formal course work. Monthly film badge and finger badge service is also provided to the laboratories as needed.

SUPPORTED BY Utah State Government

5.0951, RELATIONSHIP OF LOCAL RADIATION DOSE OF BONE-SEEKING RADIONUCLIDES TO DAMAGE

W.S. JEE, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

The comparative toxicities of a single LVO chronic dose of a bone- seeking radionuclide Ra226, Ra228, Th228 and Sr90 ranging between 100 and .00068 mu c/kg upon the skeletons of adult beagles are being studied using techniques which will relate local radiation dose to resulting damage. The study was designed to determine the comparative toxicities of these radionuclides in beagles which will contribute information for extrapolation to define the maximum permissible dose of these various bone seeking radionuclides in man. Local radiation dose studies involved quantitative and qualitative autoradiographic techniques to define the initial deposition (non-uniform distribution of the radiation in contrast with the assumed uniform distribution derived from whole body retention), alterations in distribution with time (change in pattern and concentration due to internal remodeling), volume of cells at risk and loss of radionuclide from long term exchange. Radiation damage studies involved quantitative histopathologic techniques to determine incidence of bone tumors, abnormal bone tissues, changes in circulation and rates and patterns of internal reconstruction in selected cortical and cancellous bones. Microradiographic and quantitative histological studies are used to determine the characteristics of cortical and cancellous bones with age.

Results: Current activities have concentrated on improving methodologies for determining local bone dosimetey with a combination of two techniques: 1) alpha-particle or fission fragment registration in thin polymer foils by etching and 2) automatic counting of etched perforations by local evaporation of a thin metal layer with an electric spark. LVB bone section from dogs injected with 0.305 muCi of Pu 239/Kg was 3.2 pCi/cm squared and from a dog injected with 0.0148 muCi of Pu 239/Kg was 0.22 pCi/cm squared.

SUPPORTED BY U.S. Atomic Energy Commission

5.0952, RETENTION AND DOSIMETRY OF BONE SEEKING RADIONUCLIDES IN BEAGLES

R.D. LLOYD, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

The retention of Am241, Pu239, Ra228, Th228, Ra226, Ra224, Pb210, and Sr90 in beagles injected as young adults has been determined for up to more than 14 years after injection. For all of these radionuclides except Pu239, measurements have been made by total-body counting. Distribution among the various organs and tissues has also been studied. Calculation of average skeletal radiation dose-rates and cumulative doses are based upon these retention and distribution measurements. The relationship between observed biological effects of the injected radioactivity and radiation dosage parameters is being investigated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0953, SPECULATED RISK TO BONE AND LIVER FROM 239PU

C.W. MAYS, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

The permissible body burden of 239Pu in radiation workers is 0.04 mu Ci. A literature survey indicates that the Pu reaching the circulatory system from occupational exposure may redeposit roughly half in bone and half in liver. For a constant 0.02 mu Ci 239Pu in bone and 0.02 mu Ci 239Pu in liver, the 50 year doses to man are 14 and 57 rads, averaged over these respective organs. Probabilities of radiation- induced tumors from these doses are estimated as follows: Bone Cancers- Threshold model-0%, Dose-rate model 1%, Lifespan dose model -5%. Liver Tumors- Threshold model 0%, Dose-rate model 2%, Lifespan dose model 10%.

The threshold model is based on radium-containing humans, whereas the dose-rate and lifespan dose models are extrapolated from our experience with 239Pu in dogs. These risks refer to adult, not childhood, exposures. The hazards to the lung from inhaled plutonium, and hazards to wound puncture sites were not estimated.

No tumors attributable to 239Pu have yet been reported in 37 humans exposed to plutonium who were studied by Wright H. Langham. These persons are estimated to contain 0.04 to 0.54 mu Ci 239Pu and average about 0.12 mu Ci. The dose-rate model and the lifespan dose model, respectively, predict 1 and 5 bone cancers and 2 and 10 liver tumors among these 37 individuals at 50 years burden time whereas the threshold model predicts zero. The threshold model would be favored if the trend of no observed tumors attributable to 239Pu continues, but radiation- induced cancers in humans are notorious for their delayed appearance, and 50 years of burden time has not yet elapsed.

Improved estimates of the actual risks to humans of internally- deposited 239Pu are urgently needed. The full utilization of nuclear power will depend greatly upon how well these risks can be evaluated.

SUPPORTED BY U.S. Atomic Energy Commission

5.0954, BONE CANCER INDUCTION BY RADIONUCLIDES INCIDENCE VS DOSE

C.W. MAYS, Univ. of Utah, School of Medicine, *Salt Lake City, Utah* 84112 (AT(11-1)-119)

Dose-response relationships have been reviewed for several bone- seeking radionuclides in dogs, rodents, and humans. This includes beagles injected with 239Pu, 228Th, 228Ra, 226Ra, or 90Sr at the University of Utah; rats injected with 90Sr by Y.I. Moskalev et al., mice injected with 90Sr or 226Ra by Miriam Finkel et al., dial painters and other humans containing 226Ra and 228Ra by R.D. Evans et al., and A. J. Finkel et al.; and German patients injected with 224Ra who are being followed by H. Spiess.

For the beta-emitter 90Sr, a sigmoid dose-response relationship is seen, characterized by a low-risk region in which few if any bone cancers have been induced. This suggests that considerable recovery from beta-irradiation is possible, provided that the dose-rate is sufficiently low.

For the alpha-emitters, data on 226Ra in humans supports a practical threshold, below which few if any cancers should be induced; while data on 226RA in mice support a linear relationship in which cancer induction increases in direct proportion to dose, provided that the dose is not excessive. The other alpha-emitter results, each considered separately, can rule out neither the linear nor the threshold models although taken collectively, the threshold model seems better supported. It is possible that in general, the most probable response at low dosage is a sigmoid relationship somewhere in between the linear and threshold models.

SUPPORTED BY U.S. Atomic Energy Commission

5.0955, EFFECTS OF RADIOSTRONTIUM IN MINIATURE SWINE

W.J. CLARKE, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This study has as its main objective an increased understanding of the potential hazard of radiostrontium to large animals and man. The work is defining the biological effects of daily ingestion of Sr90 in miniature swine, a large animal species more comparable to man than the smaller laboratory animals. Approximately 160 animals are presently on daily feeding levels of from 1 to 625 muCi of Sr90. Nearly 1000 animals have been involved in the project since its inception in 1958.

RESULTS. Litters from the parent generation of swine, which ingested Sr90 from 9 months of age, showed no significant differences in litter size, percent stillborn, or birth weight between controls and animals ingesting up to 625 muCi per day. Among litters from swine exposed to Sr90 from conception (F1 generation), there were no significant differences in feeding through 125 muCi per day. There have been 73 cases of hematopoietic disorders in swine ingesting Sr90, and 2 in controls. Significant increases in these disorders have occurred only in the 125 and 625 muCi per day groups. Bone tumors have been seen in 7 animals of the 125 annd 625 muCi per day group.

SUPPORTED BY U.S. Atomic Energy Commission

5.0956, RADIATION DOSIMETRY

W.A. GLASS, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This study is primarily concerned with determining how to measure radiation to obtain correlation with biological effects. This is done by conceiving physical quantities that may serve the purpose, studying the principles that relate them to others previously known, determining how they are to be measured, and establishing how useful they are in correlating biological phenomena. Theoretical methods exist for calculating the probability density of the energy losses suffered by a charged particle while passing through a small volume. This study has extended these methods to calculating densities of such quantities as the energy deposited in the volume, the ionization produced there by the particle, or the ionization after multiplication in a proportional counter. The problem to be overcome was that while the possible increments to the energy-loss are the same everywhere along the track of the particle, the possible increments to the quantities mentioned differ from point to point along the track. Formulas were developed to allow for the point-to-point variation. It was also shown that if the correct average of the possible increments along the track of the particle were used, the same fast numerical methods developed for the energy-loss calculations can be used for the other quantities. Additional ionization data for protons passing at different distances from the center of a small volume have been obtained for 4 MeV protons. The limitations of the proportional counter technique for microdosimetry measurements were critically evaluated. The conclusion is that proportional counters will probably be limited to volumes larger than about 0.2 micrometer diameter sites. Measurements of the heat defect for 1.7 MeV protons on several materials were made using calorimetric techniques. Studies were completed for linear polyethylene, polystyrene, and polystyrene plus 20% carbon. A twin calorimeter was assembled and used for measurements of absorbed dose.

SUPPORTED BY U.S. Atomic Energy Commission

5.0957, INTERNAL DEPOSITIONS OF RADIONUCLIDES IN MAN

A.J. HAVERFIELD, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

These studies are concerned with the continued development and improvement of internal dosimetry of radiotoxic materials in man. Included are diagnostic techniques for assessment of internal depositions, interpretive methods for arriving at required dose estimates, modeling of anatomical features and physiological processes associated with the respiratory system, techniques for measuring quantities of radioactive pollutants in working environments, and maintenance of a program of evaluation of tissue specimens obtained postmortem from radiation workers and environmental residents.

In relation to human inhalation testing of promethium-143 oxide, an aerosol generator was designed, fabricated and tested. Particle size studies were performed to determine particle size distributions as a function of aerosol concentrations and other operation parameters. Promethium-147 and samarium-145 chloride were injected into rats for subsequent analysis after sacrifice to determine if gross differences exist in the metabolisms of these materials. An investigation of 'in vivo' detection of promethium-147 in humans was made utilizing phantoms. Measurement of a 0.12 MeV gamma ray which occurs 4x10 to the minus 5 of the time results in a minimum detectable activity of about 5 muCi in the lung. Analysis of bremstrahlung from promethium-147 resulted in a minimum detectable activity of about 1 muCi in the lung.

RESULTS. Investigation continued on methods of producing plutonium-237 at an appropriate purity for human testing application in establishing a quantitative relationship between body burden and excretion of plutonium-239 primarily in the presence of a standardized regimen of chelation therapy. Two irradiation sequences were completed, neither of which produced plutonium-237 of the desired purity. A plutonium tissue monitor was designed and a prototype built and tested in the morgue of the local hospital. The device is for use by the pathologists in screening autopsy cases for gross findings of plutonium in liver.

SUPPORTED BY U.S. Atomic Energy Commission

5.0958, MECHANISMS OF ENVIRONMENTAL EXPOSURE

J.F. HONSTEAD, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The purpose of this study is to identify and measure parameters of exposure pathways in the Hanford environment utilizing the monitoring and other environmental data generated in evaluating Hanford environmental dose. The study selects population segments of unique interest because of their diets, habits, or location and performs whole- body counting and diet surveys. The body burden data and diet information together with environmental sample analyses permit calculation of dose contributions from various pathways and the means of evaluating the validity of such calculations.

A special dietary questionnaire was developed to study seafood consumption in typical seafood producing communities along the Washington and Oregon coasts. Radioactive Zn65 is transported. The questionnaire used colored photographs of weighed seafoods to assist volunteers in communicating typical consumption levels. This questionnaire was used to obtain seafood consumption data from nearly 500 residents of two seafood production centers on the Pacific Coast. The volunteers were also measured in a mobile wholebody counter to determine their Zn65 body burdens from seafood consumption.

An effort was made to calculate the body burdens of Zn65 from each person's estimate of seafood consumption and the measured body burden. From the results, it was apparent that Zn65 consumed in different kinds of seafood contributed different body burdens, i.e., different fractions of Zn65 appeared to be absorbed. A regression analysis was programmed so that the resulting regression coefficients would represent the fractional uptake of Zn65 from oyster, clams, crabmeat and shrimp, the four seafoods representing most of the Zn65 ingestion in the communities. After computing body burdens, the file was sorted to include only those individuals for whom the measured-to-calculated Zn65n body burden ratio was between 0.5 and 2.0. This included about half of the total population studied. Each time a new regression analysis changed the apparent uptake fractions, a new iteration and resorting of the file took place until the fractional uptake values converged. The values obtained from all subjects in both communities studied gave the fractional uptake of Zn65 from oysters of 1 percent, from clams of 10 percent, from crabmeat of 5 percent and from shrimp of 22 percent. The fractional uptake values are in the inverse order of (Text Truncated - Exceeds Capacity)

SUPPORTED BY U.S. Atomic Energy Commission

5.0959, INHALATION STUDIES - KINETICS AND DOSIMETRY STUDIES

J.F. PARK, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

This project is concerned with studies of the deposition, retention, translocation and excretion of inhaled, primarily alpha emitting, radionuclides including 239Pu, 238Pu, 244Cm, 242Cm, 241Am, 241Pu, and 147Pm. Aerosols of various particle sizes and physical and chemical properties are administered to rats and dogs. Data from these studies are used to develop models describing the tissue or organ radiation dose, especially to lung and lymph nodes, for hazard evaluation and for interpretation of observed pathological effects.

RESULTS. Tissue distribution data were obtained from dogs exposed up to 4 years previously to aerosols of 147Pm203, and from a number of dogs sacrificed up to 9 years following inhalation of 239Pu02. The plutonium data indicate that tracheobronchial lymph nodes may attain 60% of the initial alveolar deposit; liver burdens may reach 15 to 20% at times up to 15 years after exposure; skeletal burdens rise to 5 or 6%. The lung washing technique combined with autoradiography was used to study the distribution of plutonium in macrophages. Further studies on dose distribution from individual inhaled plutonium particles were carried out using a computer simulation technique.

SUPPORTED BY U.S. Atomic Energy Commission

5.0960, INHALATION STUDIES - THERAPEUTIC REMOVAL STUDIES

J.F. PARK, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The objective of this project is to develop and evaluate effective therapeutic procedures for accelerating the clearance of inhaled radionuclides. Studies are conducted on rats and dogs.

RESULTS: Forty therapeutic agents were tested in continuing studies of the therapeutic removal of inhaled 239PuO2 from the lungs of rats. Promazine HCl, Diuril, Phenergan, Progesterone, Diamox and Miltown appear to show some effectiveness. When animals were treated with these drugs in combination with DTPA the primary drug treatment seemed to make inhaled super 239PuO2 more available for chelation by DTPA. Lung washing studies on rats indicate that pulmonary lavage is an effective method for removing plutonium from the lung. Studies were started using lung lavage to remove inhaled super 239PuO2 from dogs.

SUPPORTED BY U.S. Atomic Energy Commission

5.0961, INHALATION HAZARDS TO URANIUM MINERS - RADIOCHEMICAL STUDIES

R.W. PERKINS, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

To ensure that the composition of exposure material at the point of inhalation by an animal in biological studies is properly known and that its behavior in the animals subsequent to exposure is properly determined, it is essential that technology for characterization and measurement of the inorganic, organic, and radioactive exposure constituents be developed. If the results of the animal experiments are to be placed in proper perspective, the compositions of the aerosol and materials deposited in the respiratory system and other organs must be compared for the experimental animals and uranium miners. The objectives of this study are to provide detailed characterization of the inorganic, organic and radiochemical compositions of the atmospheres to which experimental animals are exposed; to determine uptake, retention, and translocation of the materials in experimental animals; and to compare these experimental conditions with the actual conditions of the uranium miners.

RESULTS: A procedure for the continuous direct measurement of radon daughter concentrations in uranium and in experimental animal chambers as a function of particle size employing both gamma-ray and alpha-particle spectrometry for air concentrations of RaA, RaB, RaC, and RaC' was developed. Radium-226 in animal tissues was determined utilizing a scintillation measurement of Rn-222 plus its alpha-emitting daughters, Po-218 and Po214. Neutron activation analysis procedures have been developed for the analysis of tissues.

SUPPORTED BY U.S. Atomic Energy Commission

5.0962, RADIOISOTOPES AS PARTICLES AND VOLATILES

G.A. SEHMEL, Battelle Memorial Institute, *Richland, Washington* 99352 (AT)

The objective of this work is to theoretically and experimentally determine the interaction of particles and vapors with surfaces. An improved understanding of particles and vapor interactions with surfaces will permit better estimates and interpretation of particle deposition and retention in ducts, tubes, surfaces in the open air, lung passageways samplers, and delivery lines. An objective is to establish through theory and experiments fundamental relationships among variables controlling deposition, and to develop models which correctly relate the variables. An attendant objective is to develop improved techniques and experimental methods for generating, sampling, characterizing and utilizing particles and radioactive gases and vapors.

Experimental particle concentration profiles above deposition surfaces are needed to check the validity of deposition model assumptions. Monodisperse uranine particles are used in wind tunnel studies to measure deposition velocities as a function of average air velocity, friction velocity, and particle size.

Results: Particle deposition velocities to the 0.7 cm high grass are nearly constant at 6 cm/sec for particle sizes from 6 to 16 mu m for a friction velocity of 70 cm/sec. For an increase in friction velocity to 144 cm/sec, the deposition velocity increases to 9 cm/sec. Particle eddy diffusion coefficients were estimated for the region less than 1 cm above the grass surface. The results show that effective particle eddy diffusivities must be much greater than those that can presently be predicted.

SUPPORTED BY U.S. Atomic Energy Commission

5.0963, RADIATION INSTRUMENTATION - RADIOLOGICAL CHEMISTRY

N.A. WOGMAN, Battelle Memorial Institute, *Richland, Washington* 99352 (AT(45-1)-1830)

The scope of the study includes the development of radiochemical instruments and analytical technology and their

application in radioisotope studies at very low levels and in special matrices encountered in environmental samples; the use of neutron activation analysis techniques in defining the stable element versus radioelement behavior in the environment; application of the methods of physical chemistry and radiochemistry to obtain detailed definition of the routes described by natural, tracer, or waste radioisotopes in environmental systems; and elucidation of chemical phenomena which determine the preferred routes.

RESULTS: An all sodium iodide anticoincidence shielded total absorption spectrometer designed for low-level radionuclide analyses was fabricated from a 34cm-diameter by 34-cm-thick NaI(Tl) ingot which surrounds an 18cm-diameter by 22cm-thick NaI(Tl) principal detector. The sensitivity of the system for single gamma-ray emitters is greater than that of any NaI(Tl) or Ge(Li) multidimensional gamma-ray spectrometer. The use of a large Ge(Li) diode inside a NaI(Tl) crystal provides an improved sensitivity for the measurement of most radionuclides which decay by emission of two or more photons.

SUPPORTED BY U.S. Atomic Energy Commission

5.0964, INVESTIGATIONS OF THERMOLUMINESCENT RADIATION DOSIMETRY

J.R. CAMERON, Univ. of Wisconsin, School of Medicine, *Madison, Wisconsin* 53706 (AT(11-1))

It is planned to continue our investigations in both the practical applications of thermoluminescent phenomena and the fundamental physical processes that may help us to better understand these phenomena. We plan to investigate new phosphors which might be useful for fast neutron dosimetry and we will also evaluate any new proposed commercial TLD phosphors to determine their dosimetry characteristics. Special effort will be made to develop an integrating fast neutron dosimeter using optical techniques on hydrogenous materials. We propose to study photoexcitation fluorescence, metastable exciton phosphorescence properties and photoconductivity resulting from fast neutron induced damage centers in a variety of promising hydrogen-rich solids. In addition we will use a laser to study neutron induced defect and impurity states in solids by the Raman effect. Materials to be studied include cyclic hydrocarbons, simple grouped organic solids and ammonium based solids. We will use new high intensity UV sources for some studies. We plan to continue our applications of thermoluminescence to UV dosimetry.

SUPPORTED BY U.S. Atomic Energy Commission

5.0965, THE VALUE OF RADIOPROTECTIVE COMPOUNDS

R.I. WANG, Marquette University, School of Medicine, *Milwaukee, Wisconsin* 53233

From the results of studying the cardiovascular effects and capillary permeability it can be concluded that a mixture of radioprotective compounds exert different mechanisms of action. The employment of this mixture containing (5-HT) 5-hydroxytryptamine, 2- aminoethylisothiouronium (AET) and 2- mercaptoethylamine (MEA) becomes scientifically justified.

In chronic irradiation the limiting factor of the chemical mixture continues to be the high incidence of chemical mortality.

Attempts will be made to reduce this toxicity by employing similar pharmacologically active compounds with less toxicity or by using pharmacological antagonists in the hope of reducing the toxicity without lowering the radioprotective effect. Study to reduce toxicity will also be made by using lower doses of each chemical against various doses of X-rays, even as low as 100 R, given at different intervals.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0966, STUDIES OF PROBLEMS RELATED TO CHEMICAL PROTECTION AGAINST RADIATION

A. HASEGAWA, U.S. Veterans Administration, Center, *Wood, Wisconsin* 53193

The radioprotective effect of a chemical mixture containing 2 mg. of 5-hydroxytryptamine (5-HT), 28 mg of 2-aminoethylisothiouronium (AET) and 17 mg. of 2-mercaptoethylamine (MEA) was investigated in rats. The mixture was administered intraperitoneally 10 min. before whole body X- irradiation. Control rats received saline before irradiation. The LD50(30) of the chemically protected rats was 1580 R whereas the LD50 of control rats was 860 R. The dose reduction factor was 1.83. The protective effect of this mixture was greater than that of any of its components.

The cardiovascular effects of the above mixture and its components have been studied in anesthetized rats and mice in order to elucidate possible mechanisms of radioprotective action. In rats, 5-HT (2 and 4 mg) produced a depressor response. A low does (28 mg) of AET produced no change but a high dose (70 mg) resulted in a 23% increase in blood pressure. The response to MEA (17, 34, 46 mg) was varied. The chemical mixture produced a marked decrease in blood pressure. In mice, 5 HT(0.8mg) produced a pressor response when the initial pressure was low and a depressor response when the initial pressure was high. AET(2 mg) and MEA(2.9 mg) produced pressor responses. The chemical mixture also exhibited pressor effects.

SUPPORTED BY U.S. Veterans Administration

DESCRIPTION OF RESEARCH TASKS

6. NOISE

A. AIR TRANSPORTATION

Sources Such As Airports, Airplanes, and Related Equipment

6.0001, SOUND PROPAGATION AND ATTENUATION CHARACTERISTICS OVER A HEAVILY VEGETATED TERRAIN

S.P. PAO, Wyle Laboratories, *Huntsville, Alabama* (DAHC04)

Technical objective: To establish a clear definition of the type of mesurements required in the field for evaluating the actual propagation loss due to real ground cover. When helicopters are operated over a heavily vegetated terrain, the noise produced does not propagate with the same intensity as it would over flat open land. Attenuation of the sound by the terrain is thus an important part of the problem of helicopter detection by noise. This aspect of noise is being studied by using inexpensive models in the laboratory and performing analyses predicting field behavior.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0002, SMALL TURBINE ENGINE NOISE REDUCTION

R.N. TEDRICK, Garrett Corporation, *Phoenix, Arizona* 85034 (F33615-71-C-1457)

Technical Objective: The overall objective of this program is to develop the technology base necessary to effectively reduce the noise signature of existing small turboprop and turbofan engines to acceptable levels for low altitude reconnaissance/surveillance and special operations missions. In this program, emphasis is placed on the application of sound suppression and attenuation techniques rather than internal engine design changes.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0003, PROGRAM TO REDUCE THE NOISE SIGNATURE OF THE OH-6A HELICOPTER

H.W. FERRIS, Hughes Tool Company, *Culver City, California* 90230 (DAAJ02)

Technical Objective: To obtain the maximum reduction in external noise level of the OH-6A helicopter within the constraints of time and money as imposed by this contract.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0004, PREDICTION OF NEAR-FIELD NOISE FROM FIGHTER, TRANSPORT AND OTHER MILITARY CONFIGURED VTOL AIRCRAFT

L.C. SUTHERLAND, Wyle Laboratories, *El Segundo, California* 90246 (F33615-69-C-1407)

Technical Objective: The near field noise environment associated with VTOL vehicles operating in the hover mode is of sufficient severity to result in structural fatigue, equipment malfunction, and degradation in ground and flight crew performance. The predominant source of this noise is the propulsion system. Methods of predicting propulsion system noise are lacking when the aircraft is in close proximity to the ground. This program will evaluate military VTOL aircraft configurations relative to their near field noise environment and will develop methods to predict the noise characteristics required to estimate structural response and internal noise levels. These predictions will allow the design of lightweight sonic fatigue resistant structure and insure that adequate standards of habitability are met from the acoustic standpoint thus decreasing potential causes of excessive maintenance and insuring conformance of aircraft crew stations with standards of acceptable noise.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0005, THEORETICAL ACOUSTICS

R.K. COOK, U.S. Dept. of Commerce, Environ. Research Laboratories, *Boulder, Colorado* 80302 (000180)

The principle objective is an improved determination of sound propagation through the real atmosphere, including the effects of winds, temperature gradients, turbulent eddies, and reflection and scattering. The results will lead to a better quantitative description of the pollution of the environment of unwanted sound and noise.

A manuscript now being prepared for publication on the 'total' reflection of a sonic boom by a water surface will summarize current theoretical researches.

Infrasonic apparatus is being assembled for a detailed study of microbarom sound waves on the eastern seaboard, at two stations about 70 miles apart. The data on microbaroms will be correlated with surface wave and meteorological conditions on the Atlantic Ocean, and will be complemented by an improved theory for the influence of winds on the propagation of microbarom waves.

Quantitative expressions have been found for the two 'infinitely' large spikes of sound pressure which are at the leading and trailing edges of a sonic boom reflected from a water surface. The infrasonic station at Gaithersburg, Md. has been refurbished, and is now in readiness to record the direction of propagation, horizontal phase velocity, and sound pressure amplitude of microbarom sound waves generated by surface waves on the Atlantic Ocean. A temporary station is being set up at Fredericksburg, Va.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

6.0006, OPTIMIZATION OF AUDITORY PERFORMANCE IN NAVAL AVIATION

C.E. WILLIAMS, U.S. Navy, Aerospace Medical Res. Lab., *Pensacola, Florida* 32512

Technical Objective: Optimize auditory performance in various naval aviation acoustical environments and minimize or eliminate various problems arising from the many forms of interaction between sound and man in naval aviation e.g., noise masking of acoustic signals of importance to the naval aviatior (speech, sonar, auditory warnings), auditory fatigue due to prolonged exposure to various flight operation noises, etc.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0007, METROPOLITAN AIRCRAFT NOISE ABATEMENT STUDY (LOGAN INTERNATIONAL AIRPORT)

P.A. FRANKEN, Bolt Beranek & Newman Inc., *Cambridge, Massachusetts* 02138 (000384)

Develop useful alternatives for achieving both preventive and remedial relief from aircraft noise exposure in the vicinity of a large metropolitan airport - Logan International Airport,

Boston, Massachusetts. Included are considerations of: basic causes, growth trends, and social-economic impact of aircraft noise exposure on individuals and communities near airports. The project will include preparation of alternative approaches for use by local, state, and Federal governments to guide them in land use development, airport development, and related aircraft operational procedures.

Develop a methodology for use by other airport and metropolitan planning officials.

Revised draft report in review by Government.

Document provided to SIE by the Highway Research Information Service

SUPPORTED BY U.S. Dept. of Transportation - N.A.O.

6.0008, DEVELOPMENT OF QUIET ENGINES FOR NAVAL AIRCRAFT PROPULSION

H.J. ALLEN, Curtiss Wright Corporation, *Rutherford, New Jersey* 07075 (N00019-69-C-0460)

Technical Objective. Reduce vulnerability of Naval observation aircraft by reducing the amount of noise emitted from the engine. Evaluate noise-reducing features, continue analytical and technical search for a low noise engine, and define an optimum power plant configuration.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0009, INVESTIGATION OF GEARBOX DESIGN MODIFICATIONS FOR REDUCING HELICOPTER GEARBOX NOISE

R.H. BADGLEY, Mechanical Technology Inc., *Latham, New York* 12110 (DAAJ02)

Technical Objectives: Using a computer program and analyzing procedures developed under a previous program, this study to reduce helicopter noise will focus its efforts on the dynamic behavior of the rotating components within the transmission and the manner in which the housing itself interacts with them.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0010, WHOLE-BODY EFFECTS OF AIR FORCE NOISE ON PEOPLE

C.W. NIXON, U.S. Air Force, Aerospace Med. Res. Lab. 6570, *Dayton, Ohio* 45433

Technical Objective: A wide range of intense Air Force noise environments not only effect hearing but may interfere with motor performance, physiological functioning, thought processes and contribute to fatigue in personnel. This effort investigates types of noises and exposure conditions in which accomplishment of the Air Force mission may be threatened because of these adverse whole-body effects. Results are used to formulate exposure limitations and establish specifications for Air Force activities responsible for assuring that personal noise exposures are nonhazardous.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0011, MECHANISMS OF NOISE GENERATION, PROPAGATION AND RECEPTION AS RELATED TO AIR FORCE BIOACOUSTIC PROBLEMS

R.G. POWELL, U.S. Air Force, Aerospace Med. Res. Lab. 6570, *Dayton, Ohio* 45433

Technical Objective: Many USAF operations (e.g. aircraft on the ground and inflight, engine test stands, escape systems, auxiliary equipment) produce high noise levels in areas where man must function. These levels frequently cause serious problems concerning communication, hearing loss, annoyance and performance. This work unit provides: (1) knowledge and engineering methods necessary to calculate these environments, and (2) quantitative information on the physical mechanics involved in the generation of speech and man's response to acoustic energy

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0012, QUIET PROPELLER CONCEPT EVALUATION

P.A. SHAHADY, U.S. Air Force, Aerospace Propulsion Lab., *Dayton, Ohio*

Technical Objective: The objective of this program is to evaluate the noise characteristics of various tail rotor configurations to determine the noise reduction potential of various new designs. Variables to be investigated include number of blades, blade to hub phasing angles and blade length.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0013, CONTROL OF HUMAN EXPOSURE TO ACOUSTIC ENERGY GENERATED BY AIR FORCE ACTIVITIES

H.C. SOMMER, U.S. Air Force, Aerospace Med. Res. Lab. 6570, *Dayton, Ohio* 45433

Technical Objective: To investigate all avenues of potential value for controlling personnel exposure in the wide variety of usual and unusual acoustic environs of Air Force operations, and to control, within acceptable limits, the intrusion of noise into residential areas neighboring on Air Force activities. The continuous growth of Air Force noise problems, currently reflected in higher levels of intensity and more frequent exposures, significantly increases exposure of persons in or near Air Force activities to possible adverse effects of the acoustic energy. This effort is to provide the principles, devices and procedures necessary to control, within safe and acceptable limits, human exposures to the many types of noise encountered in Air Force activities.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0014, AIR CREW PERSONNEL NOISE EXPOSURE

J.V. TOBIAS, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma*

Relatively little work has been done on the effects of aircraft noise inside new aircraft. Information on the determination of noise levels in helicopters, for instance, is quite limited and on noise levels in helicopters used commercially, even less data are available. Except for some measurements made on manufacturers, relatively little has been done on the determination of noise levels within cabins of commercial transport aircraft. Similar statements are true of general aviation aircraft. Further, although available measurements are reliable and accurate, they are frequently not as complete and thorough as might be desired, probably because the necessary analyzing equipment is not readily available. However, such data are important in the delineation of possible fatigue problems among people who fly regularly either as new crew members or as passengers. Further work is necessary to record noise levels in new and modified aircraft.(Text abridged)

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

6.0015, ACOUSTIC INTERFERENCE WITH COCKPIT COMMUNICATIONS

J.V. TOBIAS, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma* (000605)

In difficult transmission conditions, speech is often degenerated to the point of nearly complete unintelligibility. Particular problems arise during IFR conditions: the communication interference as a result of the weather may increase and the importance of correct interpretation of ATC instructions is simultaneously increased.

Normal communications - channel noise (AM, FM, and ambient) will be investigated for influence on speech intelligibility. These degenerated and masked signals will then be reinvestigated for relative intelligibility under several schemes of transmission improvement. Multiplex FM, infinite peak clipping, quantizing, differentiating, etc., will be used, and the best will be incorporated into an experimental system. The experimental series thus is designed to develop and evaluate a system which will transmit speech more intelligibly under a variety of adverse conditions.

Tests are nearly complete on the masking effects of noises comprising interrupted tones. Some delay was experienced in performing these tests because subjects who were originally exposed to the situation were unable to give accurate data. Several independent underlying causes were found and ultimately corrected. It is now practical to use the technique for determining the masking effectiveness of any signal that might serve to degenerate the quality of important transmissions. A report on the basic work leading to the development of this testing system will be prepared as soon as the final few data are collected. The rest of the experiments proposed will now be undertaken and should be relatively simple to complete.

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SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

6.0016, INVESTIGATION OF HELICOPTER TRANSMISSION NOISE REDUCTION BY VIBRATION ABSORBERS, DAMPING AND CASE DESIGN

H. STERNFELD, Boeing Company, *Philadelphia, Pennsylvania* (DAAJ02)

Technical Objective: Conduct design studies to determine the relative effectiveness of different methods of noise attenuation as they apply to the CH-47 helicopter forward transmission noise.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0017, INVESTIGATION OF NOISE GENERATION ON A HOVERING ROTOR

H. STERNFELD, Boeing Company, *Philadelphia, Pennsylvania* (DAHC04)

Technical Objective: To define the noise field generated by a rotor. Investigation of noise generation of a helicopter rotor is important for the army's effort to make its helicopters less noisy for more effective field operations. This research is important to the army in that it represents a long range effort to reduce army aircraft detection time.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0018, INVESTIGATION OF LOW SPEED AERODYNAMICS AND NOISE GENERATION MECHANISMS FOR DESIGN OF QUIET RECONNAISSANCE AIRCRAFT

R. KROEGER, Univ. of Tennessee, School of Engineering, *Knoxville, Tennessee* 37916 (F33615-70-C-1762)

Technical Objective: From a military standpoint it is desirable that aircraft operate in such a way as to avoid detection. One means by which aircraft are detected is by the noise they generate and propagate to a receiver. The primary noise associated with aircraft is emitted from the propulsion system and from sources associated with the aircraft in flight. Within aircraft performance limitations, the propulsion system noise can be controlled. When these sources are minimized, the noise associated with flight then becomes the dominate factor in aural detection. The objective of this effort is to conduct an investigation of the noise associated with flight and determine methods of suppressing the noise radiated from these sources. These methods will be incorporated into design information required to design an aircraft from the standpoint of minimum aural detection for covert reconnaissance operations.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0019, ENGINE AND PROPELLER NOISE

L.K. LOFTIN, U.S. Natl. Aero. & Space Adm., Langley Research Center, *Hampton, Virginia* 23365

The objectives of this work are accomplished by the following: (A) Identification and evaluation of the sources of noise that are significant under various operating conditions of jet engines (including exhaust jets, fans, compressors, and turbines) and propellers (with and without ducts), with a view toward noise reduction at the source by design. Such factors as jet velocity, temperature, density, and turbulence level; tip speed, number of blades, inflow angles, section characteristics, surface roughnesses wake interactions, etc. for propellers, fans, compressors, and turbines will be studied to determine their effects on the generated noise; (B) Noise reduction by means of the application of acoustic materials in the inlet, in the fan discharge ducts, in the main exhaust duct of an engine or by the application of jet exhaust noise suppressor; (C) Identification and evaluation of those factors significant in the attenuation of noise during propagation from air to ground or from ground to ground situations; (D) Development of adequate methods of prediction of noisespectra from aircraft power plants under various operating conditions and at various distances. This work will be accomplished by means of theoretical studies, by full- scale aircraft tests and by model tests in wind tunnels and special test cells. The investigator shown above is the Project Monitor whose telephone is 703-827-3285.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

6.0020, TURBOFAN

L.K. LOFTIN, U.S. Natl. Aero. & Space Adm., Langley Research Center, *Hampton, Virginia* 23365

Problem- To develop acoustic treatment designs for reducing the turbine noise and turbulence generated noise radiated from a jet engine tailpipe. Application- Although the acoustic treatment will be tailored to a specific engine, the design criteria will be presented in general terms so that it can be applied to current and future technology commercial fanjet engines. Approach- Contract for the design and development of an acoustically treated tailpipe for ground tests on a JT3D engine. Conduct noise measurements and engine performance analysis. The investigator shown above is the Project Monitor whose telephone is 703-827-3285.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

6.0021, PSYCHOACOUSTIC ASPECTS OF AIRCRAFT NOISE AND SONIC BOOM

C.H. NELSON, U.S. Natl. Aero. & Space Adm., Langley Research Center, *Hampton, Virginia* 23365

The objective of this work is to further the understanding of psychological and physiological effects of noise, to establish techniques for measuring subjective noise factors, and to apply psychoacoustic information to minimize the potential annoyance of noise on man by modifications of the noise characteristics. Studies will include subjective noise comparison tests, absolute judgement tests, sleep interference tests, auditory and non-auditory tests, startle tests, task performance tests, and acoustic-vibration tests. The tests will be accomplished in laboratories and under real life conditions of exposure to aircraft noise during flight. Special attention will be directed to bridging the gap between the flight exposure situation and laboratory tests. The tests will be complemented by survey studies (involving social, economic, and atttudinal factors) and by special analytical programs. The data obtained will be used to develop an information base having application to establishing international noise standards, to prediction of public reactions to future aircraft/airport operations, and to the evaluation of aircraft noise reduction approaches. The investigator shown above is the Project Monitor whose telephone is 703-827-3285.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

B. SURFACE TRANSPORTATION

Trains, Automobiles, Tractors, Buses, Trucks, and Highway Noise in General

6.0022, IMPACTS AND ALLEVIATION OF TRANSPORTATION NOISE

R. HORONJEFF, Univ. of California, School of Engineering, *Berkeley, California* 94720 (000658)

Make specific contributions to existing knowledge about the impact of transportation noise on community, physical, social, and economic environment; further explore methods for reducing transportation noise by analyzing their effectiveness, impact on system performance, cost, feasibility, and economic desirability;

provide urban planners, transportation system planners and operators, acousticians, governmental agencies and others with better measures of the community cost of transportation noise, and with better techniques for noise alleviation.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - N.A.O.

6.0023, STUDY OF THE NOISE PRODUCED BY TRANSPORTATION EQUIPMENT, DEVICES POWERED BY INTERNAL COMBUSTION ENGINES - STUDY OF COMMUNITY NOISE

K. ELDRED, Wyle Laboratories, *El Segundo, California* 90246 (68-04-0046)

As many sources of noise as possible will be identified and their current noise levels defined. In reporting the noise levels measured, the following information will be included: (1) Actual geometry of microphone placement (including directionality effects). (2) Sound pressure levels in 1/3-octave bands (if available) or octave bands. Reduction of spectral data to dB(A) and where possible data indicating attenuation of sound pressure level with distance. (3) Typical operating exposure (who, where, when, how long).

The human related problems associated with the subject noise sources will be identified. The coverage will be in the form of indicating the typical effects of noise. Where possible, the groups or organizations responsible for initiation of the noise abatement programs, i.e., government, industry labor organization, consumer, etc. will be identified.

The state-of-the-art of the application of noise abatement technology to the subject sources of noise will be assessed and trends will be identified. Existing noise standards and/or specifications relating to sources will be compiled. This reported information will include: (1) Reduction levels being achieved or anticipated in present programs. (2) Methods of approach. (3) Program pay offs. (4) Plans for further reduction of noise. (5) Determination of what noise reduction can be demonstrated on equipment for which minimal or no noise reduction technology is presently being applied.

A study of the total nature of community noise to determine the kinds of noise in the community and its effect.

SUPPORTED BY U.S. Environ. Protect. Agency - O.N.A.C.

6.0024, TRAFFIC NOISE NEAR HIGHWAYS AND THE EFFECTS OF DESIGN AND ENVIRONMENTAL VARIABLES

J.B. SKOG, State Div. of Highways, *Sacramento, California* 95814 (2R52082722)

The effects of design and environmental variables are being determined on the emanation of traffic noise from highways. Measurements are being made at discrete distances from highways in flat terrain, depressed section and elevated section. Other tests are being made in complaint areas involving special situations.

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SUPPORTED BY U.S. Dept. of Transportation - F.H.A.

6.0025, RAPID TRANSIT DESIGN & OPERATION STUDIES

UNKNOWN, San Fran. Bay Area Tran. Dist., *San Francisco, California* 94103 (000036)

Tests of equipment and facilities for the new BART system including sound and wind vibration reduction, propulsion and power supply etc. The end product is recommended design and construction criteria.

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SUPPORTED BY U.S. Dept. of Transportation - U.M.T.A.

6.0026, ESTABLISHMENT OF STANDARDS FOR HIGHWAY NOISE LEVELS

CLARK, Bolt Beranek & Newman Inc., *Van Nuys, California*

Acceptable ranges of highway noises are being developed to serve as a basis for adoption of standards. Those features of total highway and landscaping design are being determined which contribute significantly to the propagation or reduction of highway noise and a highway noise design guide (handbook) will be prepared for the highway engineer.

Document provided by Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - Public Rds.

6.0027, NOISE ABATEMENT PROBLEMS

H.E. WEIHMILLER, Unknown Inst. Or Indiv. Grant, *District of Columbia* (000079)

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SUPPORTED BY U.S. Dept. of Transportation - F.R.A.

6.0028, TIRE SOUND GENERATION INVESTIGATION

J.F. HALLDANE, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

Objectives: To determine through a study of tire sound generation whether the variations between tires can lead to an effective acoustical grading of tires. The project will be concerned with two areas of investigation: (a) the physical distribution and characteristics of sound generated by a representative range of commercial tires under various conditions, (b) a comparative assessment of the auditory responses to typical noises generated by tires.

Approach: A literature search will be conducted as well as a survey of the state-of-the-art in tire sound evaluation by visits to appropriate personnel and facilities. To determine the technical feasibility for a tire acoustical grading and auditory assessment program, a pilot study will be conducted by the Psychophysics Section of the National Bureau of Standards. Typical tire noises shall be taped and later compared both physically and psychophysically.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

6.0029, SELECTION AND DEVELOPMENT OF ANTI-SKID SURFACES

PAREY, Lab. Cent. Des Ponts Chaussees, *Paris, France* (002415)

Following the program of measurement on existing surfaces, the research is now extended to the following problems: (1) Cement concrete surfaces on new roads by roughening treatments transverse or otherwise - giving acceptable noise and good roughness on existing roads by improvement by roughening by special coatings. (2) Asphaltic concrete surfaces - compositions which will be favorable to a satisfactory roughness and will be durable, and (3) Surface coatings - characteristics required of the binder, the aggregate and the laying.

SUPPORTED BY French Government

6.0030, NOISE AND VIBRATION OF OFF-ROAD EQUIPMENT

R.R. YOERGER, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-10-0327)

OBJECTIVE: Understand the mechanism of noise generation, structural transmission, and emission and the inter-relationship between design and operating parameters for the major contributors to the operational noise level of agricultural and industrial equipment and study the vibrational response of off-road vehicles and resulting operator environment when subjected to periodic and random inputs.

APPROACH: Consideration will be given to the functional components making major contributions to the sound power level of engine powered prime movers in an attempt to attenuate the sound as near to the source as possible. Exhaust, fan, structural, mechanical and intake noise are the major sources. A study of the mechanism of air movement under the conditions and general limitations of the engine cooling environment is to be undertaken. An analytical model of an exhaust system, considering the expan-

sion chamber as the primary noise reducing element, which can be used to predict noise attenuation, back pressure, flow profiles, and properties of the exhaust gases for given input conditions considering both steady and unsteady flow.

PROGRESS:

SUPPORTED BY U.S. Dept. of Agriculture

6.0031, TRAFFIC NOISE

UNKNOWN, Acoustic Society of Japan, *Tokyo, Japan* (2R52065214)

A method of estimating traffic noise under various traffic and road conditions is to be developed.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY Japan Public Highway Corporation

6.0032, VENTILATION, ILLUMINATION, AND NOISE CONTROL IN TUNNELS

H. DATE, Japanese Ministry of Constr., *Tokyo, Japan*

Field tests and model tests in a laboratory will be conducted on ventilation, illumination and noise control which are special problems, in vehicular tunnels. Fundamental data will be obtained for rational scheme and design of tunnels.

Document provided by Highway Research Information Service.

SUPPORTED BY Japanese Government

6.0033, TRAFFIC NOISE

A. KANAIZUMI, Japanese Ministry of Constr., *Tokyo, Japan*

Noise levels of motor vehicle traffic, the relation between the noise and the type of pavement will be studied. The improvement of road design for better noise reduction will be developed.

Document provided by Highway Research Information Service.

SUPPORTED BY Japanese Government

6.0034, THE EFFECT OF A TUNNEL COVER ON SOUND ABSORPTION IN THE TUNNEL

UNKNOWN, Japanese Technical Development, *Tokyo, Japan*

The side wall of a tunnel is being covered with acoustic insulation to absorb the loudness of traffic noises. Its effectiveness is to be measured with before and after studies.

Document provided by Highway Research Information Service.

SUPPORTED BY Japan Public Highway Corporation

6.0035, A STUDY FOR RESEARCH AND REPORTING ON MASS TRANSPORTATION SYSTEMS (SUBWAYS) ACOUSTICAL ENVIRONMENT

P.A. FRANKEN, Bolt Beranek & Newman Inc., *Cambridge, Massachusetts* 02138 (000383)

Perform a study by reviewing available technical reports on the mass transit rail systems now in existence in foreign cities such as Toronto, Hamburg, London, Berlin, Paris, and Rotterdam. Select seven systems that appear to have the lowest noise levels. Make acoustical measurements and studies of these systems so as to complement existing data and provide additional data necessary to present a complete matrix of the acoustical environment. Analyze the results of the studies and tests and identify the parameters that define the systems acoustical environment. Rank the systems studied.

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SUPPORTED BY U.S. Dept. of Transportation - N.A.O.

6.0036, POLLUTION OF MICHIGAN URBAN ATMOSPHERES BY HIGHWAY GENERATED NOISE

P. MILLIMAN, State Dept. of Highways, *Lansing, Michigan* (2R52206494)

A study will be conducted to determine and characterize the sound spectra of highway noise. Experiments to validate the repeated correlation between the Zwicker method and human subjective response are to be conducted. Sound barriers are to be constructed using available materials and configurations to measure their effectiveness as absorbers and deflectors of highway generated noise. A computer program will be developed to predict the noise spectrum radiated from the highway under any given set of known conditions.

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SUPPORTED BY U.S. Dept. of Transportation - F.H.A.

6.0037, TREES AND SHRUBS FOR NOISE ABATEMENT

D.I. COOK, Univ. of Nebraska, School of Engineering, *Lincoln, Nebraska* 68508 (WO1503)

OBJECTIVE: Determine reduction in highway traffic noise by tree and shrub barriers, most effective placement, pattern and density of vegetation to reduce sound, and whether sound transmission can be used as quantitative measure of windbreak density.

APPROACH: Study traffic noise transmission adjacent to and behind tree and shrub barriers. Record traffic noise for playback and analysis under varied environmental conditions and with various tree and shrub barriers. Test sound reduction by various types of belts as affected by season, species used, and belt density. Compare sound transmission with wind velocity data to determine whether a useful correlation exists for prediction of one effect by other. Develop recommendations for traffic noise abatement plantings.

PROGRESS: Studies of noise from trucks, buses, and automobiles show that trees can reduce noise up to 50 percent when used as a screen between highway and listener. No significant differences were noted between belts of different species compositions when height and density were similar.

SUPPORTED BY U.S. Dept. of Agriculture

6.0038, OPERATOR COMFORT, HEALTH AND SAFETY IN MOBILE AGRICULTURAL OPERATIONS

G.W. STEINBRUGGE, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-11-025)

OBJECTIVE: Obtain information pertaining to effect of present mobile agricultural equipment upon comfort, health & safety of operator; evaluate new developments with respect to operator comfort, health & safety and determine effect on humans of new designs; determine principal causes of accidents and make suggestions with regard to safety; develop criteria for future design of mobile agricultural machines.

APPROACH: Tabulate information from various sources to determine specific causes of tractor tipping accidents. Determine significance of tractor forward motion during a sideways upset. Devise a static upset procedure for experimental upsets of tractors. Experimentally upset tractors to secure data and establish criteria of design or operation which will tend to decrease such upset possibilities. Develop test procedures with which to evaluate upset stability of new tractors.

PROGRESS: Four tractor cabs were tested for their ability to withstand the side impact Swedish pendulum test and three tractor cabs were tested for rear impact resistance as provided in the Swedish pendulum test. Results of these tests indicated that deflections of the cabs tested were well within the limits set by the Swedish standards, the English standards, and the proposed SAE-ASAE American standards. One tractor with cab similar to those used in the pendulum tests was upset sideways in static roll-over down a 13 ft. high embankment of 3 to 2 slope and the movies of the upset compared with movies taken of the pendulum tests. Results of the comparison showed the cab had to withstand greater force and deflection in the actual roll-over than in the pendulum test. This comparison throws some doubt as to the adequacy of the proposed standards when applied to the cabs used on large American tractors. Noise tests were begun for the purpose of establishing the adequacy and dependability of the procedure to be used in determining the sound pressure levels of tractors tested at Nebraska. Experiments were also begun for

determining the possibility of using an air screen as a tractor cab for noise and temperature control for the tractor operator. A tabulation of tractor tipping accidents in Nebraska was continued. Results were essentially the same as in previous years.

SUPPORTED BY U.S. Dept. of Agriculture

6.0039, COLLECTION, PROPAGATION, CULTURE AND EVALUATION OF PLANT MATERIALS
J.O. YOUNG, Univ. of Nebraska, School of Agriculture, *Lincoln, Nebraska* 68503

This is a research project for the collection, propagation, culture and evaluation of plant materials for windbreaks, snow control, noise abatement, traffic guidance and control of glare for safety and landscaping on highway rights of way.

SUPPORTED BY U.S. Dept. of Transportation - Public Rds.

6.0040, SUPPORT OF SOCIETY OF AUTOMOTIVE ENGINEERS, INCORPORATED, NOISE RESEARCH STUDY
F.C. WALTERS, Soc. of Automotive Engrs. Inc., *New York, New York* (000386)

Obtain data which is correlatable to urban noise levels for use in transportation noise abatement research. This program is to gather, catalog, analyze and summarize available noise data in 3 areas relative to noise associated with the operation of tractors and related equipment. Specifically, the 3 areas are: (1) Definition of the physical characteristics of typical noises to which operators of such equipment might be exposed. (2) The tolerance levels of such operators, both with and without protection. (2) Degree of possible hearing damage and operator disorientation from exposure to variable noise.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Transportation - N.A.O.

6.0041, EFFECTS OF DIFFERENT FOREST TYPES AND CONDITIONS ON STREAM REGIMEN AND WATER YIELDS
R.E. LEONARD, State University of New York, School of Forestry, *Syracuse, New York* 12224 (NE1604)

OBJECTIVE: Determine the influence of climatic, edaphic, and other environmental factors on hydrologic processes in relation to forest types and conditions.

APPROACH: This cooperative project with the New York State University College of Forestry is determining the reflection of solar radiation by a conifer forest; conducting a study of snow interception by coniferous tree crowns and its disposition under climatic conditions of central New York; and the effect of land-use changes on streamflow in the Allegheny Plateau Region of New York State.

PROGRESS: Approximately one-half of the precipitation falling on the forested areas of the Northeast is returned to the atmosphere by the process of evapotranspiration. The major source of energy for this process is solar radiation. A study of the energy relationships in a northern hardwood forest revealed that a 50 year old second growth forest absorbs 83 to 87 percent of the incident radiation in the summer months and 73 to 80 in the leafless winter months. Snow on the ground decreased the absorption to about 73 percent of the total solar energy available at the top of the canopy. Results from this investigation will be useful in management considerations of forest type changes on drainage areas. In an exploratory study of noise abatement by trees, it was found that approximately 8 decibels of noise was absorbed in three 30-meter wide strips of a pine plantation. This excess attenuation was dependent on frequency and location of the sound source relative to the orientation of the rows of trees. This information will be useful in assessing the use of trees to screen out unwanted sounds.

SUPPORTED BY U.S. Dept. of Agriculture

6.0042, TRAFFIC NOISE STANDARDS
E. JONSSON, Natl. Swedish Inst. Bldg. Res., *Stockholm, Sweden*

Object: This investigation aims at finding, by measuring reactions of inconvenience, a basis for establishing standards for permissible exposure to traffic noise.

The field work was carried out in two stages. In the first stage 59 areas were chosen, which were different according to factors related to the noise exposure. In these areas were carried out noise exposure measure, based upon technical measurements, and a reaction measure, based upon interviews. Characteristics of the road, the area and the dwelling were measured and classified. A second stage contains a mapping of the noise situation in five larger development areas.

The result is certain findings according to exposure and reaction and the arrangement in the development. The investigation has been submitted to the National Boards, whose responsibility it is to issue standards.

SUPPORTED BY Swedish Government

6.0043, CONCRETE BASE FOR RAILWAY TRACKS
J.C. LUCAS, Railway Technical Center, *Derby, England, United Kingdom* 10277 (002413)

This study is concerned with designing special rail tracks to cope with future high speeds and loads and requiring minimum maintenance. Design methods are being investigated for fastening tracks directly to tunnel inverts to give good acoustic behavior and vibration transmission. The slip-form paver was used to lay basic concrete slabs onto which various methods of track fastening have been applied. This track system is also being used to assist in the development of a mathematical model of track dynamics.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0044, DEVELOPMENT OF HYDROSTATIC POWER TRANSMISSIONS SYSTEMS TO IMPROVE PERFORMANCE - INVESTIGATION OF PARAMETERS WHICH INTRODUCE NOISE
UNKNOWN, Ministry of Technology, *Glasgow, Scotland, United Kingdom* (000862)

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0045, TRAFFIC NOISE
W.E. SCHOLES, Ministry of Pub. Bldg. & Works, *Herts, England, United Kingdom* (002890)

A study is to be conducted of noise reducing properties of control measures such as barriers and the reduction of noise with distance in relation to traffic parameters.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0046, TRAFFIC NOISE
UNKNOWN, Ministry of Pub. Bldg. & Works, *Herts, England, United Kingdom* (005065)

Information is being collected on the effect of one or more moving vehicles on a roadway in many differing circumstances, which will later be developed into a design model for computing in advance the noise level for any configuration of ground conditions. A subjective study of the effect of noise on passengers and other road users and on near-by inhabitants is being conducted with a view to establishing what may be regarded as a humanly acceptable level of noise.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0047, NOISE FROM MOTOR VEHICLES
D.W. ROBINSON, Ministry of Technology, *Teddington, England, United Kingdom* (002839)

The project attempts to obtain a current base line of traffic noise 'climate' with which to make future comparisons and to provide design information for highway engineers and local planning authorities project in abeyance until 1972.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0048, CORROSION OF EXHAUST SILENCERS IN SERVICE

R.J. LOVE, Motor Indus. Res. Assoc., *Warwickshire, England, United Kingdom* (005080)

The effect of different materials and protective treatments in the external and internal corrosion of exhaust silencers is being investigated under conditions of normal service. Silencers of different materials and with various surface treatments are in use on postal vehicles and will be examined at approximately yearly intervals. Corrosion will be assessed by visual examination.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0049, REDUCTION OF COMMERICAL-VEHICLE ENGINE NOISES BY ACOUSTIC TREATMENTS APPLIED TO THE VEHICLE

C.H. MILLS, Motor Indus. Res. Assoc., *Warwickshire, England, United Kingdom* (005074)

The advantages of efficient sealing, panel damping, high-transmission-loss and absorptive materials are being displayed in tests on a truck cab in an anechoic chamber with an artificial noise source. Enclosure of the noise source gave further reductions, but is only practicable to a limited extent in an actual vehicle. Future work is to be carried out on actual vehicles.

Document provided to SIE by the Highway Research Information Service

SUPPORTED BY United Kingdom - London

6.0050, MEASUREMENT OF NOISE EMITTED BY MOTOR VEHICLES

C.H. MILLS, Motor Indus. Res. Assoc., *Warwickshire, England, United Kingdom* (005075)

Investigations undertaken in collaboration with the National Physical Laboratory have justified the use of sound level A as a measure of noise emitted by vehicles and have established a relation between DB(A) and subjective ratings. M.I.R.A. has also worked closely with the Ministry of Transport and has provided most of the objective data for consideration in the drafting of proposed legal regulations concerning vehicle noise.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0051, RESEARCH INTO VARIOUS ASPECTS OF MOTOR VEHICLES INCLUDING NOISE, DYNAMIC BEHAVIOR, SAFETY, AERODYNAMICS AND AIR POLLUTION

UNKNOWN, Motor Indus. Res. Assoc., *Warwickshire, England, United Kingdom* (000887)

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0052, A STUDY OF THE MAGNITUDE OF TRANSPORTATION NOISE GENERATION AND POTENTIAL ABATEMENT

H. SAFEER, Serendipity Incorporated, *Arlington, Virginia* 22202 (000429)

Determine the magnitude of the transportation noise abatement problem in the U.S. and develop a set of analytical tools which can be used to determine the extent of the problem in the future and to evaluate alternative proposals for noise abatement; provide a comprehensive analysis of the current technical, economic and legal limits of noise reduction, and estimates of what they may be in the future; determine the level of responsibility (public and private) for noise abatement, and the ability at each level to provide the necessary resources to implement noise abatement programs; determine the need for government standards and regulations for transportation noise abatement, to establish specific recommendations for standards and regulations and their means of enforcement; determine the scientific research needed to understand noise abatement and develop a research program which will maximize the expected return from all related resource allocations; determine how to provide transportation services that produce acceptable noise exposure in populated areas, given the operation, economic, social and political constraints.

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SUPPORTED BY U.S. Dept. of Transportation - N.A.O.

6.0053, EVALUATING THE NOISES OF TRANSPORTATION - A SYMPOSIUM ON ACCEPTABILITY OF CRITERIA FOR TRANSPORTATION NOISE

J.D. CHALUPNIK, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105 (000385)

Define and evaluate the noises of transportation with an overall goal of defining the requirements for uniform criteria and objectives for transportation noise abatement. Identify and quantify the parameters which characterize differences in the annoyance levels of different sources of transportation. A thorough understanding as to the application of differences in noise rating systems shall be developed such that an ultimate solution of the noise rating problems, i.e., the unified noise rating system, will result.

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SUPPORTED BY U.S. Dept. of Transportation - N.A.O.

C. URBAN AND INDUSTRIAL SOURCES

Includes Construction, Factory Noise, Home Environment, and Office Noise.

6.0054, WIND SENSING

C.G. LITTLE, U.S. Dept. of Commerce, Wave Propagation Laboratory, *Boulder, Colorado* 80302

Determine the ambient noise and noise pollution levels of an operational prototype acoustic doppler radar system, capable of measuring wind and turbulence profiles in the planetary boundary layer. The system will be demonstrated in Boulder, Colorado, to determine the feasibility of its use in urban areas, for engineering modification to minimize noise pollution, and for determining optimum system configurations.

SUPPORTED BY U.S. Environ. Protect. Agency - N.A.P.C.A.

6.0055, THE DETERMINANTS OF REAL ESTATE VALUES

D.M. GRETHER, Yale University, Graduate School, *New Haven, Connecticut* 06520

The basic objective of this research is the estimation of the effect on housing value of location and of various 'neighborhood effects.' Here, 'neighborhood effects' include tax burden, quality of public services including education facilities, and air and noise pollution.

Data made available by the New Haven Board of Realtors make it possible to estimate the evaluation by home buyers of various physical characteristics. The available information includes asking and selling price of each property, the length of time the house is on the market, the lot size, the size of the house in square feet, the number of rooms, the condition of the house, the type of flooring, the type of building material, type of heating, type of electrical system, and considerable detail on such extras as air conditioning, rugs, laundry facilities, and so on.

The data will enable the analysis of a number of questions unrelated to the characteristics of the houses, with excellent control for variation in the quality of the housing units. For example, in assessing the impact of air pollution on residential property values, it is crucial to know if the quality of homes in areas of heavy pollution is higher or lower than the quality of homes in other areas.

The effects of heterogeneity of land use (zoning) can also be investigated. In addition, it may be possible to determine whether blacks pay more for housing of comparable quality, and to what extend financing arrangements inflate the price of housing for low income groups.

SUPPORTED BY U.S. National Science Foundation

6.0056, PLANNING STANDARDS FOR APPLICATION WITH THE LAND USE ACTIVITY ALLOCATION MODEL (LUAAM)

UNKNOWN, East West Gateway Coord. Coun., *East Saint Louis, Illinois* 62201 (002977)

In this analysis, the residential densities from the living patterns study were translated into holding capacities for use in the land use activity allocation model. The holding capacities for the activity allocation model are the suggested minimum and maximum number of people or employees which could be accommodated in each zone. The development of the maximum and minimum holding capacities and any necessary adjustments that were deemed desirable were based upon local agency studies and knowledge of a particular zonal area and its growth factors. Growth impact factors are concerned with the effects on the physical environment such as existing parks, vacant land, and developed areas. In an attempt to understand the effects of growth on a zone, the analysis was concerned with the general findings for the following items: (1) The good quality homes and businesses that would be displaced by growth. (2) The land area that would be required for new transportation facilities. (3) The effects of heavy traffic on existing business districts. (4) Byproducts of growth such as pollution and noise. (5) The maintenance of basic neighborhood integrity within a zone. The results of the previously mentioned studies were the maximum acreage, density, number of employees, and population for each zone.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY U.S. Dept. of Housing & Urban Development

6.0057, IMPORTANCE OF NOISE AND ITS POTENTIAL EFFECT ON WOOD USE IN GARDEN APARTMENTS

D.R. PRESTEMON, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (WO4302)

OBJECTIVE: Determine importance of noise control in selection of wall and floor-ceiling systems for garden apartments; and oportunities to modify wood systems to meet noise isolation standards.

APPROACH: Develop techniques for evaluating the importance of noise, and estimate the influence of noise on tenant satisfaction, severity of the problem, and types of objectionable noise by interview in three metropolitan areas. Develop cost estimates of basic apartment construction systems (wood frame, masonry, steel,), determine factors affecting selection of these systems, and estimate additional costs of insulating each type to FHA standards.

PROGRESS: No progress reported this period (active project).

SUPPORTED BY U.S. Dept. of Agriculture

6.0058, STUDY OF NOISE PRODUCED BY CONSTRUCTION EQUIPMENT AND BUILDING EQUIPMENT AND HOME APPLIANCES

E. BENDER, Bolt Beranek & Newman Inc., *Cambridge, Massachusetts* 02138 (68-04-0047)

As many sources of noise as possible will be identified and their current noise levels defined. In reporting the noise levels measured, the following information will be included: (1) Actual geometry of microphone placement (including directionality effects). (2) Sound pressure levels in 1/3-octave bands (if available) or octave bands. Reduction of spectral data to dB(A) and where possible data indicating attenuation of sound pressure level with distance. (3) Typical operating exposure (who, where, when, how long).

The human related problems associated with the subject noise sources will be identified. The coverage will be in the form of indicating the typical effects of noise. Where possible, the groups or organizations responsible for initiation of the noise abatement programs, i.e., government, industry, labor organization, consumer, etc. will be identified.

The state-of-the-art of the application of noise abatement technology to the subject sources of noise will be assessed and trends will be identified. Existing noise standards and/or specifications relating to sources will be compiled. This reported information will include: (1) Reduction levels being achieved or anticipated in present programs. (2) Methods of approach. (3) Program pay offs. (4) Plans for further reduction of noise. (5) Determination of what noise reduction can be demonstrated on equipment for which minimal or no noise reduction technology is presently being applied.

SUPPORTED BY U.S. Environ. Protect. Agency - O.N.A.C.

6.0059, STUDY OF OUTSIDE NOISE GENERATED BY INDUSTRIAL PLANTS

A. SENKO, Goodfriend Ostergaard, *Cedar Knolls, New Jersey* 07927 (68-04-0044)

As many industrial plants as possible will be surveyed and their current noise levels defined. As many sources of noise as possible will be identified and their current noise levels defined. In reporting the noise levels measured, the following information will be included: (1) Actual geometry of microphone placement (including directionality effects). (2) Sound pressure levels in 1/3-octave bands (if available) or octave bands. Reduction of spectral data to dB(A) and where possible data indicating attenuation of sound pressure level with distance.

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SUPPORTED BY U.S. Environ. Protect. Agency - O.N.A.C.

6.0060, MANAGEMENT AND CONTROL OF URBAN NOISE

D.P. LOUCKS, Cornell University, School of Civil Engineering, *Ithaca, New York*

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Resources for Future Inc. - Wash., D.C.

6.0061, ENVIRONMENTAL INFLUENCES ON BEHAVIOR

D.C. GLASS, New York University, Graduate School, *New York, New York* 10003

Life in an urban metropolis has not only become increasingly complex, but there is also growing evidence of serious physical and psychological health hazards in the city. We know something of air and water pollution, but we know little about the hazard potential of noise and overcrowding, and the consequences of

these factors. One of the aims of the project is a systematic exploration of the effects of these physical-environmental stressors on individual and social behavior. More specifically, it is concerned with cognitive, interpersonal, and psychophysiological consequences of adaptation to noise and crowding. Parelleling this effort in the physical environment will be research into the psychosocial environment, including experimentation on feelings of control or lack of control over the environment. These research activities will take two forms: (1) theoretical, leading to the preparation of a monograph on models of psychological stress, specifically urban stress; and (2) empirical, consisting of a series of laboratory experiments on the issues described above.

SUPPORTED BY Russell Sage Foundation - New York, N.Y

6.0062, BARRIERS FOR NOISE ATTENUATION
J.N. MACDUFF, Duke University, School of Engineering, *Durham, North Carolina* 27706

An experimental and theoretical study of the usefulness of barriers and lightweight panels in attenuating the noise generated by industrial machines is proposed. The design, construction, measurement and evaluation of movable noise attenuating barriers will be undertaken. The types of barriers to be investigated will be such as could be used to (1) partially enclose a work space on the factory floor for personnel such as timekeepers, foremen, etc.; (2) be placed adjacent to machines in either a horizontal or vertical orientation to reduce the noise reaching areas by direct or secondary transmission.

The initial studies will be made with pure tones and rather small, rigid barriers. Barrier configuration, the effect of sound absorbing facing and of interior cavities will be studied. The pure tone experimental work will be paralleled by analytical studies. In this phase it is planned to investigate the feasibility of the finite element methods as a means of predicting noise levels in enclosed spaces.

SUPPORTED BY North Carolina State Government - Raleigh

6.0063, ENVIRONMENTAL FACTORS IN RELATION TO TRAFFIC
F.D. HOBBS, Univ. of Birmingham, *Birmingham, England, United Kingdom* (005246)

By means of a sociological survey of a selected sample of residential developments, the effects of noise, fumes and traffic movement upon residential areas is under study. Also being considered is the relationship between layout and road safety.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY University of Birmingham

6.0064, NOISE
W.E. SCHOLES, Ministry of Pub. Bldg. & Works, *Herts, England, United Kingdom* (005098)

Noise is being studied in relation to factories, motorways and road traffic, airfields, etc., and the way it affects the design of buildings and planning of towns.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0065, EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS
P.G. BARTELS, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2014-4159-003)

OBJECTIVE: Determine effect of ultrasound on morphology, physiology, and membrane permeability of various species of aquatic plants; determine relative differences in above effects as a function of frequency, intensity, and time of exposure to ultrasonic waves.

APPROACH: Several species of aquatic plants will be subjected to ultrasonic waves and examined microscopically for morphological changes in cells and their inclusions. Respriation and photosynthetic rates will be measured using standard Warburg manometric techniques and infrared gas analyzer techniques. Permeability changes in membranes will be studied using standard radioisotope absorption techniques. A variable frequency ultrasonic generator and various piezoelectric transducers will be used to vary frequency and intensity of ultrasonic waves. Exposure times also will be varied.

PROGRESS: We have been investigating the effects of ultrasound on the ultrastructure of plant cells. In the past, we have used the plant Chara as the experimental plant to sonicate since they are very susceptible to this treatment. Currently, we are doing similar experiments with Potamogeton and Elodea, which are two common aquatic weeds causing many problems in the U.S. waterways. The chloroplasts were found to be the first organelle of the plant cell which appears injured. The fret or large thylakoid membranes become disrupted and with continued ultrasonic treatment, the grana membranes are destroyed. Another symptom of the ultrasound treatment is the swelling of the fret and grana membranes. In addition, Mr. Sidlowski is building some new ultrasonic lenses in order to focus high intensities of radiation on to an area where the plants will be positioned. In constructing these lenses, several characteristics must be considered. First, the acoustic impedence of the lens material and the medium should be matched as closely as possible. The most convenient material that we used was plexiglass or polystyrene.

SUPPORTED BY U.S. Dept. of Agriculture

6.0066, THE EFFECTS OF GRAVITY COMPENSATION, RADIATION AND MAGNETIC FIELDS ON LIVING ORGANISMS
C.A. TOBIAS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

These studies aim to measure possible synergistic effects between gravity compensation and radiation on developing organisms. In addition, separate investigations will study relationships between effects of ultrasonic vibrations and radiations. The results are expected to be of value in interpreting biological effects of space environment; for example, the apparent synergism obtained between radiation and weightlessness in Biosatellite II. The results may also be of value in considering the radiobiology of tumor cells.

Results: Construction was completed on a monochromatic, ultrasonic vibrator to be used in biological studies. Exposures can be made at various power levels and frequencies in the domain of 0.1 to 5 MHz. Intensity distribution of the instrument in the vibration exposure field was calibrated with a piezo-electric instrument and is routinely monitored by means of thermocouples.

SUPPORTED BY U.S. Atomic Energy Commission

6.0067, THE EFFECTS OF GRAVITY COMPENSATION, RADIATION AND MAGNETIC FIELDS ON LIVING ORGANISMS
C.A. TOBIAS, Univ. of California, Lawrence Radiation Laboratory, *Berkeley, California* 94720 (W-7405-ENG-48)

These studies aim to measure possible synergistic effects between gravity compensation and radiation on developing organisms. In addition, separate investigations will study relationships between effects of ultrasonic vibrations and radiations. The results are expected to be of value in interpreting biological effects of space environment; for example, the apparent synergism obtained between radiation and weightlessness in Biosatellite II. The results may also be of value in considering the radiobiology of tumor cells.

Ultrasonic vibration studies are carried out on a variety of biological systems with specially constructed monochromatic generators. Earlier this laboratory identified the ultrasonic component as having the greatest biological effects at the cellular level than sonic vibrations. Mammalian cells have been used.

Results: Microscopic examination shows disruption of cells at high intensities and a shrinking of cells at low intensities. The lethal effects which are dose-rate dependent, are observed only in the presence of liquid medium during sonication. No lethal effects are observed if cells are sonicated in the 'frozen state'. Cells that survive heavy doses grow at a slower rate as indicated by their smaller colony size. Dose-fractionation studies show that prior ex-

posure to ultrasound sensitizes the cells to a subsequent exposure. Synergism between ultrasound and x-rays has been observed.

SUPPORTED BY U.S. Atomic Energy Commission

6.0068, INTRAMETROPOLITAN RESIDENTIAL MOBILITY
M.D. VANARSDOL, Univ. of Southern California, Graduate School, *Los Angeles, California* 90007

The objectives of this research on intrametropolitan residential mobility are: to determine the effects of past and present residences upon subsequent mobility plans, choices and behaviors; to specify the social and psychological factors which interact with residence histories to generate mobility attitudes and behaviors; to specify how changes in urban environments influence mobility patterns. The data for this research includes interviews obtained in 1961 and 1962, census information, and information on environmental hazards in the Los Angeles-Long Beach, and the Anaheim-Garden Grove-Santa Ana Standard Metropolitan Statistical Area. The interview data includes residence history, information on the family life cycle and familism, social mobility and aspirations, perceptions of the residential environment and residence needs and aspirations, social and locality participation. Neighborhood characteristics of population and housing are available from census tapes. Environmental hazards data include information on brush fires, floods and slides, air pollution, air traffic noise, and juvenile delinquency. Thus, the researchers will be able to integrate demographic, ecological and social psychological perspectives in the study of metropolitan residential mobility.

SUPPORTED BY U.S. National Science Foundation

6.0069, PHYSIOLOGICAL AND PSYCHOLOGICAL ADJUSTMENT TO NOISE
K.D. KRYTER, Stanford Research Institute, *Menlo Park, California* 94025

The major objective of the study is to determine to what extent persons, of somewhat different personality 'types', physiologically and psychologically adapt over several months to near daily exposures to various steady-state and intermittent background noise. The effect of the noises upon the learning and performance of certain mental tasks will also be studied. The results of the studies should contribute valuable information for the estimation of the present or potential detrimental effect, if any, of environmental noise upon the mental health and general well-being of people.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0070, NOISE INDUCED DEAFNESS - MASKING AND SPEECH PERCEPTION
K.D. KRYTER, Stanford Research Institute, *Menlo Park, California* 94025

The general objective is the understanding of the performance characteristic of the normal human ear and the ear that suffers from hearing loss, primarily noise-induced deafness. The principal research approaches to be used to meet this objective are: 1. To study and explore, by means of perceptual tests, under controlled laboratory conditions, the relative capacities of the normal and deafened ear to detect and discriminate simple and complex acoustical signals. The tests will be disigned to define and delineate most probable underlying neuro-physiological mechanisms involved in such discriminations in the normal and deafened ear. 2. To study the ability of persons with normal hearing and persons with deafness to understand speech that has been narrow-pass-band filtered and processed in various ways. It is hypothesized that the speech may be made more understandable to the deafened ear as the result of processing and 'packaging' the speech signal in either or both the frequency-amplitude and time domains in ways that might best match the remaining performance characteristics of the deafened ear. 3. To test and evaluate the knowledge gained in the proposed research for the alleviation of hearing loss sustained in industry and elsewhere due to exposure to excessive noise.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0071, WORLD ELECTRONIC INDUSTRIES
S.A. WALTON, Stanford Research Institute, *Menlo Park, California* 94025

World electronics industries will have a chapter dealing with environmental instrumentation. This will include instruments for water, air, and noise monitoring. The research objective is to define technical and market trends in equipment and to define potential opportunities or gaps in the present market. Projection period is 1968- 1980.

SUPPORTED BY No Formal Support Reported

6.0072, COMMUNICATIONS--FUNDAMENTAL INFORMATION TO GUIDE THE DESIGN OF NAVY AUDITORY DISPLAYS
E.D. SCHUBERT, Stanford University, Graduate School, *Palo Alto, California* 94305 (NOOO14-67-A-0112-0034)

Technical Objective: Understand the mechanical relationships within the inner ear affecting wave propagation and mechanical to neural energy conversion. This knowledge will allow designers of navy auditory displays to produce more efficient presentation devices as well as to aid in setting realistic hearing protection goals.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0073, CONSTRUCT MICROWAVE NOISE CALIBRATION SERVICES
UNKNOWN, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Boulder, Colorado*

A constant current supply was constructed and components purchased to establish four (4) NBS Coaxial Working Standards. These will be used to assure the accuracy of NBS Microwave Noise Calibrations.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

6.0074, HH-43B HELICOPTER NOISE REDUCTION FEASIBILITY DEMONSTRATION PROGRAM
H.E. HOWES, Kaman Corporation, *Bloomfield, Connecticut* 06002 (DAAJ02)

Technical Objective: To achieve and demonstrate a six decibel reduction in the external noise level of the modified HH-43B helicopter over most of the audible frequency range from those levels as measured by the government under contract no. DAAJ02-69 C-0019.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0075, DEVELOPMENT OF DAMAGE RISK CRITERIA AND HABITABILITY STANDARDS FOR EXPOSURE TO SONAR TRANSMISSIONS
P.F. SMITH, U.S. Navy, Submarine Medical Res. Lab., *Groton, Connecticut* 06340

Technical Objective: To develop hearing conservation standards for submariners exposed to intense tonal stimuli such as are transmitted to compartments within attack submarines by active sonar systems. To specify performance interference levels for sonar operation and other shipboard tasks. Further, to determine the habitability of ships compartments subjected to prolonged and intense sonar signals.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0076, SURVEY OF EXISTING FEDERAL, STATE AND LOCAL NOISE CONTROL ORDINANCES
L.H. MAYO, George Washington University, Prog. of Pol. Stud. Sci. Tech., *Washington, District of Columbia* 20037 (68-04-0032)

The work shall be performed as follows: A. Collect and systematize relevant legal data, categorizing existing laws or regula-

tions as follows. 1. Level of government enacting or promulgating laws or regulations. 2. Authority for the enactment. 3. Source of or nature of noise covered by law or regulation. 4. Standards or criteria prescribed in the law or regulation. 5. Categories of persons, organizations, industries, common carriers, activities, or places covered by or subject to the law or regulation. 6. Liability or penalties provided. 7. Mode or manner of enforcing the standards prescribed. B. Analyze existing legal framework for noise abatement and control including the following key factors: 1. Legality of existing laws and regulations. 2. Uniformity or lack thereof in legal treatment of noise problems. 3. Gaps in legal coverage of existing noise sources which are social intrusions that can be reduced or eliminated. 4. Ambiguities and weaknesses in existing legal structure, particularly with regard to noise standards and their relationship to noise measurements. 5. Relationship of standards and remedies to 'unquantified environmental amenities and values' referred to in Section 102 (2) (B) of the National Environmental Policy Act of 1969, Public Law 91-190. 6. Degree to which particular statutory or regulatory schemes treat a particular source of objectionable noise without reference to all sources contributing to environmental noise level.

SUPPORTED BY U.S. Environ. Protect. Agency - O.N.A.C.

6.0077, PERSONNEL TECHNOLOGY - NAS/NRC ADVISORY SERVICES ON OPERATIONAL PROBLEMS OF VISION AND HEARING

M.A. WHITCOMB, Natl. Academy of Sciences, *Washington, District of Columbia* 20037 (NONR2300(05))

Technical Objective: The Armed Forces frequently require a ready source of consultation which provides information and recommendations on Armed Forces/DOD operational problems in vision, Hearing, vibration, and impact. The Armed Forces-National Research Council Committee on Vision and the Committee on Hearing, Bioacoustics and Biomechanics provide such a source by means of working groups composed of nationally prominent experts. This work will continue to influence military standards for exposure of personnel to noise, carrier lighting for night flight operations, procedures for testing vision and hearing, and vision standards for flying personnel.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0078, STUDY OF NOISE MEASUREMENT AND CRITERIA, THE EFFECT OF NOISE ON PROPERTY, AND THE SOCIAL AND ECONOMIC IMPACT OF NOISE

R. COOK, U.S. Dept. of Commerce, Natl. Bureau of Standards, *Washington, District of Columbia* 20234

A study of the measurement of noise will be made and a critique of current methods of measurement will be offered. Also, the limitation of such current methods will be highlighted with regard to unknowns such as atmospheric conditions and attenuation with distance and over obstacles.

Current literature will be searched to determine what is known of the effects of noise on property, with particular attention to impulsive noise.

Existing data will be examined to determine what is known concerning the social and economic impact of noise.

SUPPORTED BY U.S. Environ. Protect. Agency - O.N.A.C.

6.0079, OPTIMIZATION OF SPEECH COMMUNICATIONS IN NAVAL AVIATION

C.E. WILLIAMS, U.S. Navy, Aerospace Medical Res. Lab., *Pensacola, Florida* 32512

Technical Objective: Optimize speech communications in naval aviation acoustical environments and to develop acoustical analysis techniques for detecting psychological and physiological stress in the speech of naval aviation personnel.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0080, BEHAVIORAL TOXICITY OF NOISE IN IMMATURE MICE

W.B. ITURRIAN, Univ. of Georgia, School of Pharmacy, *Athens, Georgia* 30601

Immature mammals are notoriously more sensitive than adults to infections (e.g., rubella induced deafness), certain drugs (e.g. Thalidomide induced phocomelia) and several poisons. Recent reports (Iturrian and Fink, 1967; Iturrian, 1969) add noise to the list of environmental factors having dramatic deleterious effects upon the growing animal but produce a mild reaction in the adult. We demonstrated that mice considered to be resistant to audiogenic seizures become uniformly audio-sensitive if subjected to a single sensitizing sound stimulus (95 db doorbell for 30 sec.) at a critical age (age 15-22 days for CF-1). Additional factors dramatically affecting audio- sensitization include (1) the interval in days between the initial and second (test sound); (2) the duration of the initial (sensitizing sound); (3) the physical characteristics of the stimulus, most importantly the frequency range; and (4) extraneous environmental noise. (Iturrian, 1969).

The objectives of this exploratory proposal are to: (1) standardize more completely the procedure and occurrence of audiosensitization; (2) assess the relative potential of environmental noises such as sonic boom and flight noise of the new large transport turbojects to induce audio-sensitivity and/or to alter the temporal parameters of audio-sensitization; and (3) to assess the effects of such environmental noise upon pesticide toxicity, drug effectiveness and behavioral responses of immature mice.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0081, INTERACTION OF ULTRASOUND AND BIOLOGICAL MEDIA

F. DUNN, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

The ultrasonic thresholds for irreversible functional and histological changes in the mammalian central nervous system are to be determined as a function of frequency, acoustic intensity, pulse length, and temperature. The lumbar enlargement of the spinal cord of young mice will be used to study the functional changes and the adult cat brain will be employed to study the histological changes. The results of this study will establish safe operating conditions for the clinical employment of ultrasound as a diagnostic tool and is expected to aid in the elucidation of the physical mechanisms of interaction of ultrasound and tissue.

SUPPORTED BY U.S. National Science Foundation

6.0082, ULTRASONIC ABSORPTION BY BIOLOGICAL MATERIALS

F. DUNN, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

Ultrasound employed as an agent in medical diagnosis and theerapy and as an experimental tool for analysis of biological systems continues to receive ever increasing attention. However, relatively little is known and understood of the physical mechanisms of interaction of ultrasonic waves and biological media. An important adjunct to the elucidation of the fundamental physical mechanisms is a deep insight into the absorption processes and this research is addressed to these questions.

The ultrasonic absorption coefficient is determined in tissue structures in vivo by the transient thermoelectric method. Absorption measurements are made as a function of frequency, temperature, hydrostatic pressure, concentration, type of solvent and wave amplitude.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0083, TRAUMATIC ORIGINS OF HEARING LOSS

G.A. LUZ, U.S. Army, Med Research Laboratory, *Fort Knox, Kentucky*

Technical Objective: To provide information that may allow a more precise screening of noise-susceptible individuals at the time of their induction and to evaluate devices and techniques for the protection of Army personnel during normal military operations. Information in this area will also contribute to the development of better hearing protective devices for the soldier.

6. NOISE

SUPPORTED BY U.S. Dept. of Defense - Army

6.0084, HEARING AND VOCAL OUTPUT
C.I. BERLIN, Louisiana State University, School of Medicine, *New Orleans, Louisiana* 70112

Hearing and vocal output in normal, hard-of-hearing, and deaf mice are being studied. Evoked cortical potential, cochlear potential, and single unit recordings are being used as measures of auditory function. Findings to date show a peak vocalization during distress which is directly related to the auditory sensitivity curve. Studies of ultrasonic vocalization in infant mice and rats have shown to date that these are not specifically attractants for mother rodents. However, in the course of this study, major auditory differences between feral and laboratory mice have been uncovered.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0085, IMPROVED WEAPON NOISE EXPOSURE CRITERIA
D.C. HODGE, U.S. Army, Human Engineering Labs., *Aberdeen Proving Ground, Maryland* 21005

Technical Objective: a. to develop predictive models of noise effects on soldiers' performance- (b) to improve existing noise criteria including effects of long-term exposure- (c) to optimize methods for assessing human auditory capabilities-(d) to provide consultative assistance to DOD, national and international acoustical advisory groups.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0086, SMALL BOAT NOISE REDUCTION
D.C. THOMSON, U.S. Navy, Ship Research & Dev. Lab., *Annapolis, Maryland* 21402

Technical Objective: To reduce radiated airborne noise of small boats and to improve onboard habitability.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0087, RESPONSE OF CAGED MINK TO SONIC BOOM
J.R. MENEAR, U.S. Dept. of Agriculture, Agricultural Engin. Res. Div., *Beltsville, Maryland* 20705 (214-024-B317)

OBJECTIVE: Determine the effects of sonic boom on production of caged mink.

APPROACH: Determine instrumentation requirements for measuring sonic boom over-pressures, and associated structural vibrations, in typical mink housing; coordinate measurement technique with boom propagation by Air Force units. Assemble, test, and calibrate a complete instrument system for field use. Coordinate electric power requirements for these instruments and those used by other units during tests. Operate system during tests; determine necessary corrections in flight conditions to approach specified over-pressures. Calibrate and test a sonic boom simulator to produce over-pressures equal to previous booms; operate simulator and instrument system during tests with simulated booms. Analyze over-pressure and vibration data to determine intensity of significant variable. Report procedure and results, and cooperate with other units in reporting entire experiment.

SUPPORTED BY U.S. Dept. of Agriculture

6.0088, SURVEY OF NOISE CONTROL EFFORTS OF FOREIGN COUNTRIES
K. LIEBHOLD, Informatics Incorporated, *Riverdale, Maryland* 20840 (68-01-0157)

A study will be made of foreign efforts to determine: 1. What kinds of laws exist and the extent of their effectiveness regarding enforcement and the results of that enforcement. 2. What programs exist and the extent to which those programs accomplish their goals. 3. What noise control technology is being applied and the extent to which the applied technology is succeeding in reducing noise.

SUPPORTED BY U.S. Environ. Protect. Agency - O.N.A.C.

6.0089, SYSTEMS STUDY OF HELICOPTER NOISE REQUIREMENTS
R.W. SIMPSON, Mass. Inst. of Technology, Graduate School, *Cambridge, Massachusetts* 02139 (DAHCO4)

Technical Objective: To establish a new methodology for systems analysis which includes noise criteria and to develop a new wind tunnel facility for making useful noise measurements on V/STOL aircrafts types. It is important for the Army to reduce the noise levels of its helicopters so that the missions of surveillance, reconnaisance and target acquisition can be performed better, without giving too much warning of approach to the Army. The mission accomplishment may still be performed better if just the right combination of noise reduction and performance of the helicopter existed. The question that remains unanswered is- what is the most desirable combination of these parameters so the mission effectiveness will be maximized. This project is aimed towards answering this question.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0090, THE DETERMINATION OF SUSCEPTIBILITY TO HEARING LOSS
W.D. WARD, Univ. of Minnesota, School of Medicine, *Minneapolis, Minnesota* 55455

This research will examine in the chinchilla the relations among (1) the temporary changes in auditory sensitivity caused by severe but subtraumatic exposures to noise, (2) the permanent changes in sensitivity produced by a more severe noise exposure, and (3) the structural and ultrastructural changes observed in the affected cochleae. Behavioral testing is accomplished by means of conditioned- avoidance techniques. Particular attention will be paid to possible histological sequelae of noise exposure that are not associated with a loss of auditory sensitivity. The fundamental question, however, is: Can individual differences in temporary effects of noise be used to predict individual differences in resistance to permanent effects from more severe exposures?

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0091, STUDY OF THE EFFECT OF NOISE ON HUMANS
J. MILLER, Central Inst. for the Deaf, *Saint Louis, Missouri*

This is a study and compilation of the known effects of noise on humans. A comprehensive description of all major known physiological and psychological effects will be presented, along with an indication of possible effects.

SUPPORTED BY U.S. Environ. Protect. Agency - O.N.A.C.

6.0092, THE EFFECTS OF AGE, FOOD DEPRIVATION, AND WHITE NOISE ON READINESS TO EAT AND EXPLORATORY TENDENCIES IN RATS
L.F. JAKUBCZAK, U.S. Veterans Administration, Hospital, *Saint Louis, Missouri* 63125

The purposes of this experiment were (1) to test the generality of an earlier finding; (2) to determine whether or not there were age differences in the effects of noxious stimulation on readiness to eat in rats under moderate and high levels of food deprivation and; (3) to determine the role played by age differences in exploratory tendencies (if any) in age differences in readiness to eat (if any).

A 3x2x2 experiment was run, consisting of three age groups of rats (2, 11, and 24 months old), two levels of acute food deprivation (24, 96), and two levels of aversive stimulation (ambient vs white noise). The dependent variables were readiness to eat (Bolles, 1965) and the frequency of exploratory behavior admitted during the first three minutes of the test (deLorge and Bolles, 1961). Preliminary analysis of the data indicates that the main effects of duration of food deprivation and of age were significant but the effects of aversive stimulation on readiness to eat was not. The results are consistent with those of Bolles in that with increasing age there was a decreasing readiness to eat at a

given level of food deprivation. Thus the original inconsistency between the Bolles' results and those of Jakubczak are probable due to differences in methodology.

Manuscript in preparation for publication in the Journal of Gerontology.

SUPPORTED BY U.S. Veterans Administration

6.0093, STUDIES IN COMPARATIVE AUDITORY NEUROPHYSIOLOGY

N. SUGA, Washington University, School of Arts, *Saint Louis, Missouri* 63130

Studies on neural mechanisms of hearing and sensory mechanism in the lateral line system are to be carried out by recording single unit activity from both the peripheral and central nervous systems with microelectrodes. The following points will be investigated: 1) transducer and gating mechanisms in receptors, 2) integration in and among auditory neurons, 3) specialization of single auditory neurons to pure tones, FM sounds, and noise bursts (three basic components in communication sounds of various animals, including human), 4) biosonar systems, 5) environment sensing with electro receptors, 6) species- specificity (or evolution) in information processing, 7) neural basis of psycho-acoustic phenomena, 8) control of auditory information processing and modification of usage of auditory information by higher auditory centers or other sensory systems or condition of an animal, and 9) neural-modeling. The use of a variety of animals is emphasized.

The project will contribute to the basic understanding of the neural mechanisms of hearing in animals, including man, and may lead to practical advances in environment sensing by the blind.

SUPPORTED BY U.S. National Science Foundation

6.0094, COMFORTABLE LISTENING LEVELS FOR NOISE

W. HILL, U.S. Veterans Administration, Hospital, *Bronx, New York* 10468

The purpose of the present investigation was to examine Most Comfortable Loudnss (MCL) for four noise stimuli. Using a modified Bekesy audiometer, the effects of the following variables on MCL were investigated: (1) attenuation rate (a fast attenuation rate of 2.5 dB/sec. versus a slow attenuation rate of 1.25 dB/sec.); (2) four noise stimuli (white noise and narrow bands of noise centered at the frequencies 500 Hz, 1000 Hz and 2000 Hz); (3) method of subject response (a conventonal Bekesy response switch versus a modified Bekesy response switch); (4) subject sex (male versus female); and (5) variability over time (session one and session two).

Thirty-two male and 32 female subjects participated in the investigation. All subjects possessed hearing sensitivity within normal limits, and had no prior experience with Bekesy audiometry or prior experience in an experiment involving listening behavior. One half of the subject sample (16 males and 16 females) tracked MCL using the conventional response switch, and the other half tracked MCL using the modified response switch. Each subject tracked MCL for 90 seconds for each of eight experimental conditions.

For the conventional response record, each peak and each trough was measured and recorded. These levels were averaged across each 90 second period. When using the modified response switch, each MCL level chosen by a subject was shown by a horizontal line. These levels, as with the levels recorded for the conventional trackings, were averaged across each 90-second period. The main statistical treatment of these data was a repeated measures factorial analysis of variance procedure.

Within the limitations of the investigation, the following conclusions were proposed: (1) Most comfortable loudness (MCL) varies significantly as a function of the type of noise stimulus used. (2) Attenuation rate should be considered as an important variable in the measurement of MCL. (3) MCL for noise has low intra-subject variability, but relatively high inter-subject variability. It cannot be assumed that the level averaged for all subjects is most comfortable for all people. Each person's MCL must be measured independently, for there is no apparent way to predict MCL based on threshold information, or on the results of the present investigation.

SUPPORTED BY U.S. Veterans Administration

6.0095, EFFECTS OF SONIC BOOM ON MINK

H.F. TRAVIS, U.S. Dept. of Agriculture, Fur Animal Experiment Station, *Ithaca, New York* 14850 (033401421433)

OBJECTIVE. Study the effects of sonic boom on reproduction and behavior of farm-raised minks.

APPROACH. Expose pregnant and nursing mink to booming devices developed for the national sonic boom evaluation program. Research will be conducted to determine critical indications of possible harmful effects which can be attributed to sonic boom during gestation, parturition, whelping and early postnatal development.

PROGRESS. Claims amounting to over 3/4 million dollars have been filed against the U. S. Air Force by mink farmers for alleged damage to mink from sonic booms during the reproductive season. During the calendar year 1970 a sonic study is being conducted in Petersburg, Alaska in cooperation with the University of Alaska. Two hundred adult females and their progeny were boomed three times by USAF aircraft on May 11 with booms of 6 pounds per square foot overpressure. On the date of booming 41% of the females had whelped. On the following day 120 adult females and their young at a different site were boomed with a N.A.S.A. simulator with booms of approximately the same magnitude. Two hundred adult females and their young at a third site were used as controls. Thirty male and 30 female kits from each group will be raised to pelting (Nov. 1970). Evaluation will be by reproductive performance, kit mortality, kit growth, pelt quality, and histological analysis of organs related to stress.

SUPPORTED BY U.S. Dept. of Agriculture

6.0096, ACOUSTICAL SOCIETY OF AMERICA STANDARDS ACTIVITIES ON NOISE

H.W. KOCH, Amer. Inst. of Physics, *New York, New York*

This grant will provide funds for the participation of the foremost United States experts in the meetings of international working groups devoted to the establishment of international standards on noise, noise abatement and other acoustical standards.

SUPPORTED BY U.S. National Science Foundation

6.0097, COMPARATIVE STUDY OF VOCAL LEARNING

P.R. MARLER, Rockefeller University, Graduate School, *New York, New York* 10021

Man is the only primate known to be capable of vocal imitation. Only among birds do we find recurrence of the same capability. Previous work has established that vocalizations of certain birds are transmitted by learning in nature. The processes underlying avian vocal development are the subject of the present research request, with special reference to critical periods during life at which learning occurs most readily, and to the ontogenetic importance of the bird's ability to hear its own voice. Pilot experiments show that bilateral removal of the cochlea results in abnormal vocal development in canaries. Birds raised in high level white noise until their singing behavior had fully matured showed a pattern of singing behavior when the noise was turned off which resembled that of deaf birds. Some of the abnormalities were subsequently corrected. We now propose a more detailed study of the effects of surgical deafening and exposure to a masking sound at various ages on subsequent song development in canaries. In a parallel series of experiments, the redwinged blackbird has been found suitable for studies on song development. Males raised in isolation from 6 days of age develop songs which are normal in some respects, though they differ in detail from the patterns found in the population from which they came. Playback of recorded songs from 40 to 70 days of age for one hour per day in two individuals resulted in learning. In more detailed study of development in this species, birds will be trained at different ages to see whether there is a critical period for learning. Effects of surgical deafening will also be explored in birds deafened both early in life, and later, after training with playback of recorded songs has occurred. In this way we propose to test the hypothesis that hearing is important in song development, not only for the bird to hear sounds from the environment, but also for it to hear its own voice during development.

6. NOISE

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0098, ELECTRICAL AND ACOUSTICAL STUDIES OF CELLS
E.L. CARSTENSEN, Univ. of Rochester, School of Engineering, *Rochester, New York* 14627

Dielectric techniques are used in studies of cell structure and function including dependence of internal ion concentration of intact bacterial and mammalian cells on the environmental ion concentration, resistance (permeability) of cytoplasmic and nuclear membranes, stability of osmium-fixed erythrocytes, fixed charge concentration in the cell walls of bacteria.

Acoustical studies include investigation of the mechanism of the action of ultrasound on tissue and identification of the 'structures' which give rise to echoes in ultrasonic diagnosis.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0099, DISSIPATION RATES OF SELECTED NOISE LEVELS ENCOUNTERED IN OUTDOOR RECREATION ENVIRONMENTS
H.E. ECHELBERGER, State University of New York, U.S.D.A. Forest Service, *Syracuse, New York* 13210

To describe the dissipation rates of selected producers of noise in recreation environments.

SUPPORTED BY U.S. Dept. of Agriculture

6.0100, EFFECTS OF AIR FORCE NOISES ON POPULATIONS SURROUNDING AIR BASES
G. ROSINGER, Battelle Memorial Institute, *Columbus, Ohio* 43201 (F33615-71-C-1288)

Technical Objective: Aviation noise environments generate well defined physiological responses and little defined psychological responses of people. The objective is to investigate in the laboratory the acceptability of specific approaching versus receding aircraft noises, and accompanying physiological responses that may occur. Approaching noises are much less acceptable than non approaching sounds, yet this difference has not been quantified. This effort will quantify the psychological judgments of acceptability and identify the presence or absence of simultaneous physiological changes. Results will be utilized in the revision and updating of land use planning documents for Air Force installations.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0101, RESEARCH ON PERMANENT AND TEMPORARY SHIFTS IN HEARING THRESHOLD PRODUCED BY EXPOSURE TO AIR FORCE NOISE
D.J. LIM, Ohio State University, School of Medicine, *Columbus, Ohio* 43210 (F33615-71-C-1461)

Technical Objective: AF function - to insure safety and unimpaired performance of AF personnel in hostile noise environments. Deficiency - insufficient criteria to establish a practical protection system. Research - use both animals and man in noise environments and obtain essential data. How research contributes - establishes noise levels for minimum detectable damage and describes mechanism of damage. There is a need to study the response of the nervous system to the stresses that are expected to occur in aerospace environments in order to determine the fundamental principles for establishing protective devices and techniques to insure safety and unimpaired performance of the nervous system. Investigation is needed on the problem of excessive noise reducing the effectiveness of our speech communications. Present Air Force operational situations require personnel to be exposed to sound environments for extended periods, in excess to the normal eight-hour working day. After exposure to moderate sound for a long time there is a loss in hearing. A thorough knowledge of the biochemical activity and anatomical changes within the inner ear is essential to making intelligent judgments on possible methods to combat this loss.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0102, AUDITORY RESPONSES TO ACOUSTIC ENERGY EXPERIENCED IN AIR FORCE ACTIVITIES
H.C. SOMMER, U.S. Air Force, Aerospace Med. Res. Lab. 6570, *Dayton, Ohio* 45433

Technical Objective: To examine various characteristics of human hearing such as resistance to noise, temporary hearing loss, recovery from hearing loss, relative effects of frequency, intensity, duration and intermittency of hearing loss, high frequency hearing (above 8000 HZ), and long term level effects in order to establish general principles of behavior of the human ear in noise. To determine the potential hazard of specific Air Force problem noise environs and provide means for minimizing or eliminating these effects. One of the most prevalent and serious effects of noise in Air Force operations is over exposure of the human auditory system, resulting in impairment of hearing. Effective preventive and control measures must be based upon the definition and understanding of the functioning of the human auditory system in the presence of noise. This work is related to the infrasound program and assessment of damage risk criteria for infrasound.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0103, VOICE COMMUNICATION DURING AIR FORCE IN-FLIGHT AND GROUND OPERATIONS
H.C. SOMMER, U.S. Air Force, Aerospace Med. Res. Lab. 6570, *Dayton, Ohio* 45433

Technical Objective: Noise continues to be a major factor limiting or interfering with noise communications in the Air Force, creating serious command and control problems and safety hazards during routine as well as emergency operations. Other elements such as vibration, windblast and reduced pressure may also reduce talker and listener performance. These studies evaluate voice communication to identify interfering factors, to determine biological limitations and to consider conventional as well as unique approaches to specific operational problems. Results will be applied to design of future military communications systems for use in high noise environments.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0104, PSYCHOLOGICAL AND PHYSIOLOGICAL ADAPTATION TO SIMULATED SONIC BOOMS - PHASE I
W.E. COLLINS, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma*

Based on the recommendation of the Human Response Panel, a laboratory study will be undertaken using a model of the sonic boom simulator developed for NASA at the Stanford Research Institute. Three groups of six male subjects each will be tested; one group will be in the 21-25 year age-range; a second group will be in the 40-45 year age- range, and the third will be in the 60-70 year age-range. Subjects will spend 3-4 weeks (20-28 consecutive days) in the study. The first 5-7 days will be an environmental adaptation period (no booms). During the next 10-14 days, subjects will be exposed to 8 booms nightly. All booms will be 0.9 psf and will be sounded hourly from 2300 hours through 0600 hours. The final 5-7 days will be used to examine recovery effects (no booms). Continuous recordings will be made of EEG (brain wave activity), ECG (heart activity), eye movement, and EWL (evaporative water loss) throughout each night as indications of depth of sleep, stages of sleep, bodily changes, and fatigue. Subjects will also perform complex tasks on a special performance device at approximately 0700 hours and 1900 hours every day for a one-hour period to evaluate skilled performance. The tasks will involve such basic psychological, perceptual, and motor functions as vigilance, reaction time, monitoring, and mental performance. Subjects will be free to conduct their normal duties during the day but will not be permitted to sleep. The electrophysiological and the performance records will be analyzed to determine the influence of the booms on sleep, skills, bodily reaction, and behavioral changes. Appropriate statistical comparisons of pre- boom and post-boom phases will be made.

Tape recordings were made for the analysis of the boom characteristics produced by the CAMI device to assure that the

spectral components agree with those created by a true sonic boom. The first recordings obtained by Stanford Research Institute were not adequate for analysis; SRI representatives returned and took additional recordings on 28 January 1970. Results of the analyses were received on 5 March. Notification of acceptance of the simulator was made to the Contract Officer on 13 March.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

6.0105, MOTOR PERFORMANCE UNDER SUDDEN STRESS - PHASE II
R.I. THACKRAY, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma*

Sudden, unexpected startling situations may cause a considerable disruption in performance and under extreme conditions can even result in temporary behavioral immobility or 'freezing.' The available information concerning pilot response times to sudden emergencies, such as near mid-air collisons, is extremely limited. In addition, little is known regarding the possible effects such 'emotional shocks' may have on subsequent control of the aircraft. Research directed toward this problem area would have relevance to selection of personnel by establishing those characteristics of subjects who demonstrate impaired performance under sudden stress. It would also provide information regarding the extent and duration of impairment under such conditions.

Performance impairment resulting from a sudden stress (startling) situation will be evaluated with simulated pilotry tasks (e.g., perceptual-motor tracking). Simulated sonic booms resulting from a sonic boom generator will serve as the startle stimuli. Different groups of subjects will be exposed to overpressure levels ranging from 0.9 to 4.0 pounds per square foot. Durations and rise times of the pressure waves will be held constant over groups. Concurrent physiological measures will include heart rate, respiration rate, and skin conductance. The physiological and performance data will be recorded on the CAMI Data Acquisition System and the converted results subjected to computer analysis.

Phase I demonstrated that an unexpected, startling, white noise stimulus resulted in a 65 percent increase in tracking error during the first five-second period following startle, with performance returning to pre-stimulus levels within 15 seconds following stimulation. Startle also produced comparable changes in heart rate.

The primary purpose of Phase II is to replicate the essential features of Phase I, using simulated sonic boons as the startle stimuli, and to compare these results with those obtained in Phase I.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

6.0106, TURBOJET ENGINE OUT OF AIRFRAME STATIC RUN-UP NOISE SUPPRESSOR
L. KOCIUBA, U.S. Navy, Air Engineering Center, *Philadelphia, Pennsylvania* 19112

Technical Objective: Develop a portable noise suppressor adaptable to existing portable turbo-jet engine test stands used by Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0107, PENETRATIVE AND METABOLIC EFFECTS OF LOW INTENSITY ULTRASOUND IN NERVE AND MUSCLE WITH AND WITHOUT EXTERNALLY ADDED CORTISOL
J.E. GRIFFIN, Univ. of Pennsylvania, School of Medicine, *Philadelphia, Pennsylvania* 19104

In earlier work (1962, 1963, 1965) we studied ultrasonic movement of cortisol through swine skin and into paravertebral muscle and nerve, in situ, using standard duration of treatment for a small area but with higher intensity than some patients can tolerate. We wish to repeat these studies using intensities tolerable to all patients but for longer duration than has been used clinically to see if equivalent amounts of cortisol can be recovered.

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SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - S.R.S.

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H.H. SMOOKLER, Univ. of Pittsburgh, School of Medicine, *Pittsburgh, Pennsylvania* 15213

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SUPPORTED BY Swedish Government

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B.D. KAIMAN, U.S. Veterans Administration, Center, *Johnson City, Tennessee* 37684

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SUPPORTED BY U.S. Veterans Administration

6.0112, LITERATURE SEARCH TO DETERMINE THE EFFECTS OF NOISE ON WILDLIFE

J. BLACKWELL, Memphis State University, Div. of Research & Services, *Memphis, Tennessee* 38111 (68-04-0024)

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SUPPORTED BY U.S. Environ. Protect. Agency - O.N.A.C.

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R.D. FINCH, Univ. of Houston, School of Engineering, *Houston, Texas* 77004

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This is an area of growing importance, and one which has been neglected in the past. A grant from the National Science Foundation, supplemented by University funds, will permit the acquisition of a wide variety of sound generation and sound analysis equipment, and will provide the facilities for many research programs including such areas as a study of transmission of sound through panels and shells, vibrations and structural acoustics, pulse excitation of railway wheels and machinery noise reduction.

SUPPORTED BY U.S. National Science Foundation

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D.C. GASAWAY, U.S. Air Force, School of Aerospace Med., *San Antonio, Texas* 78235

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SUPPORTED BY U.S. Dept. of Defense - Air Force

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UNKNOWN, Ministry of Technology, *Teddington, England, United Kingdom* (000866)

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

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C.H. MILLS, Motor Indus. Res. Assoc., *Warwickshire, England, United Kingdom* (002888)

Measurements have been made of the noise environments experienced by commerical-vehicle drivers and passengers in public service vehicles.

Document provided to SIE by the Highway Research Information Service.

SUPPORTED BY United Kingdom - London

6.0117, SONIC BOOM EFFECTS

L.K. LOFTIN, U.S. Natl. Aero. & Space Adm., Langley Research Center, *Hampton, Virginia* 23365

The objectives of this work are to identify and to quantify the detrimental effects of noise and sonic booms on ground based structures and equipment in order that design and operational procedures may be devised to minimize such effects. The emphasis is on building structures for which vibrations, noise transmission and superficial damages due to repeated loads, are of particular concern. The development of simulators is also included. This work will be accomplished by means of theoretical studies, as well as both model component and full-scale tests involving airplane flyovers, laboratory acoustical excitation and the use of simulators. The investigator shown above is the Project Monitor whose telephone is 703-827-3285.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

6.0118, NEUROLOGICAL VARIABLES AFFECTING ULCERATION RATE

P.A. HORNBUCKLE, Virginia Commonwealth Univ., School of Arts, *Richmond, Virginia* 23219

Recent research by the present investigator and others has suggested a positive correlation between levels of neurological activity and rate of gastric ulceration in the rat where ulceration was induced by simple locomotor restraint. The object of the proposed study is to continue the investigation of this relationship by manipulating additional variables which are believed to influence neurological activity. Rats will be subjected to either lesions of the caudate nucleus or sham control lesions four days prior to 23 hours of locomotor restraint. Half of each of these groups will subsequently be restrained under either white noise or quiet sensory conditions. Since both noise and lesions of the caudate nucleus have been shown to increase neural activity via the reticular formation, it is expected that Ss with caudate lesions and Ss restrained noise conditions will show a higher frequency of ulceration than sham-controls or Ss restrained under quiet conditions.

spectral components agree with those created by a true sonic boom. The first recordings obtained by Stanford Research Institute were not adequate for analysis; SRI representatives returned and took additional recordings on 28 January 1970. Results of the analyses were received on 5 March. Notification of acceptance of the simulator was made to the Contract Officer on 13 March.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

6.0105, MOTOR PERFORMANCE UNDER SUDDEN STRESS - PHASE II

R.I. THACKRAY, U.S. Dept. of Transportation, Civil Aeromedical Institute, *Oklahoma City, Oklahoma*

Sudden, unexpected startling situations may cause a considerable disruption in performance and under extreme conditions can even result in temporary behavioral immobility or 'freezing.' The available information concerning pilot response times to sudden emergencies, such as near mid-air collisons, is extremely limited. In addition, little is known regarding the possible effects such 'emotional shocks' may have on subsequent control of the aircraft. Research directed toward this problem area would have relevance to selection of personnel by establishing those characteristics of subjects who demonstrate impaired performance under sudden stress. It would also provide information regarding the extent and duration of impairment under such conditions.

Performance impairment resulting from a sudden stress (startling) situation will be evaluated with simulated pilotry tasks (e.g., perceptual-motor tracking). Simulated sonic booms resulting from a sonic boom generator will serve as the startle stimuli. Different groups of subjects will be exposed to overpressure levels ranging from 0.9 to 4.0 pounds per square foot. Durations and rise times of the pressure waves will be held constant over groups. Concurrent physiological measures will include heart rate, respiration rate, and skin conductance. The physiological and performance data will be recorded on the CAMI Data Acquisition System and the converted results subjected to computer analysis.

Phase I demonstrated that an unexpected, startling, white noise stimulus resulted in a 65 percent increase in tracking error during the first five-second period following startle, with performance returning to pre-stimulus levels within 15 seconds following stimulation. Startle also produced comparable changes in heart rate.

The primary purpose of Phase II is to replicate the essential features of Phase I, using simulated sonic boons as the startle stimuli, and to compare these results with those obtained in Phase I.

SUPPORTED BY U.S. Dept. of Transportation - F.A.A.

6.0106, TURBOJET ENGINE OUT OF AIRFRAME STATIC RUN-UP NOISE SUPPRESSOR

L. KOCIUBA, U.S. Navy, Air Engineering Center, *Philadelphia, Pennsylvania* 19112

Technical Objective: Develop a portable noise suppressor adaptable to existing portable turbo-jet engine test stands used by Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0107, PENETRATIVE AND METABOLIC EFFECTS OF LOW INTENSITY ULTRASOUND IN NERVE AND MUSCLE WITH AND WITHOUT EXTERNALLY ADDED CORTISOL

J.E. GRIFFIN, Univ. of Pennsylvania, School of Medicine, *Philadelphia, Pennsylvania* 19104

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UNKNOWN, Ministry of Technology, *Teddington, England, United Kingdom* (000866)

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6.0119. STUDY OF THERMAL EFFECTS DUE TO PROPAGATION OF SOUND WAVES IN TISSUES

A.W. GUY, Univ. of Washington, School of Medicine, *Seattle, Washington* 98105

Purpose: The proposed research has as its initial objective the development of models for biological materials such as fat, muscles, and bones, which can describe the propagation and thermal effects of sound waves. The objective of this research is to study, with the development of these models the thermal effects of sound waves in layered biological material.

There are three aspects of this program of research that must be developed in parallel: 1. Theoretical studies to determine a model of propagation which explains data available. 2. Measurements in tissues and other biological materials to determine the adequacy of the proposed models. 3. Construction of analogs which simplify the measurements. As usual, simple models are chosen initially; then they are compared with available data or experimental results. Limitations and range of applicability of the models are determined; then these models can be refined to extend the range of applicability and to take into account possible anomalies detected during the experimental studies. 4. An interesting phenomenon that could be evaluated in these studies is the excitation of piezoelectric currents in bone due to ultrasound waves. This opens up the interesting possibility of possible interaction between ultrasound waves and electromagnetic waves.

Significance and Relationship to Rehabilitation: Past investigations on ultrasound as a thereapeutic tool were mostly experimental. No control over this tool has ever been developed. A systematic theoretical investigation of the heat generation by ultrasonic waves propagating in biological materials will assist in the research of optimized frequencies of the sound wave for therepeutic heating and improve the design of applicators.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - S.R.S.

★ U.S. GOVERNMENT PRINTING OFFICE : 1972 O-L.T - 457-260 (Pt. I)